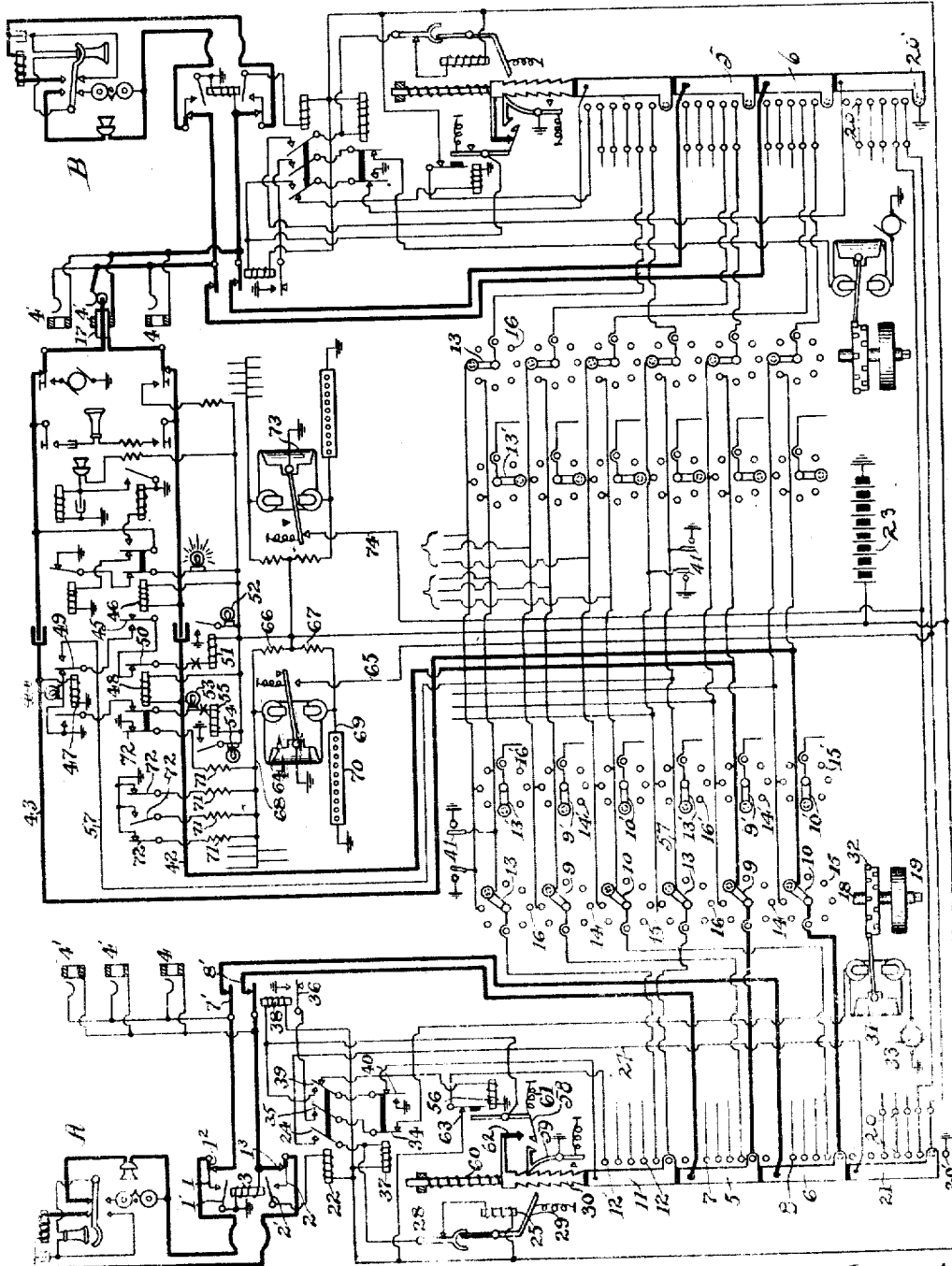


F. W. DUNBAR,
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED MAR. 3, 1905.

Patented June 18, 1918.

5 SHEETS-SHEET 1.

1,270,127.



Witnesses:

Leon Stroh
Chas. F. Barlett

Fig. 1

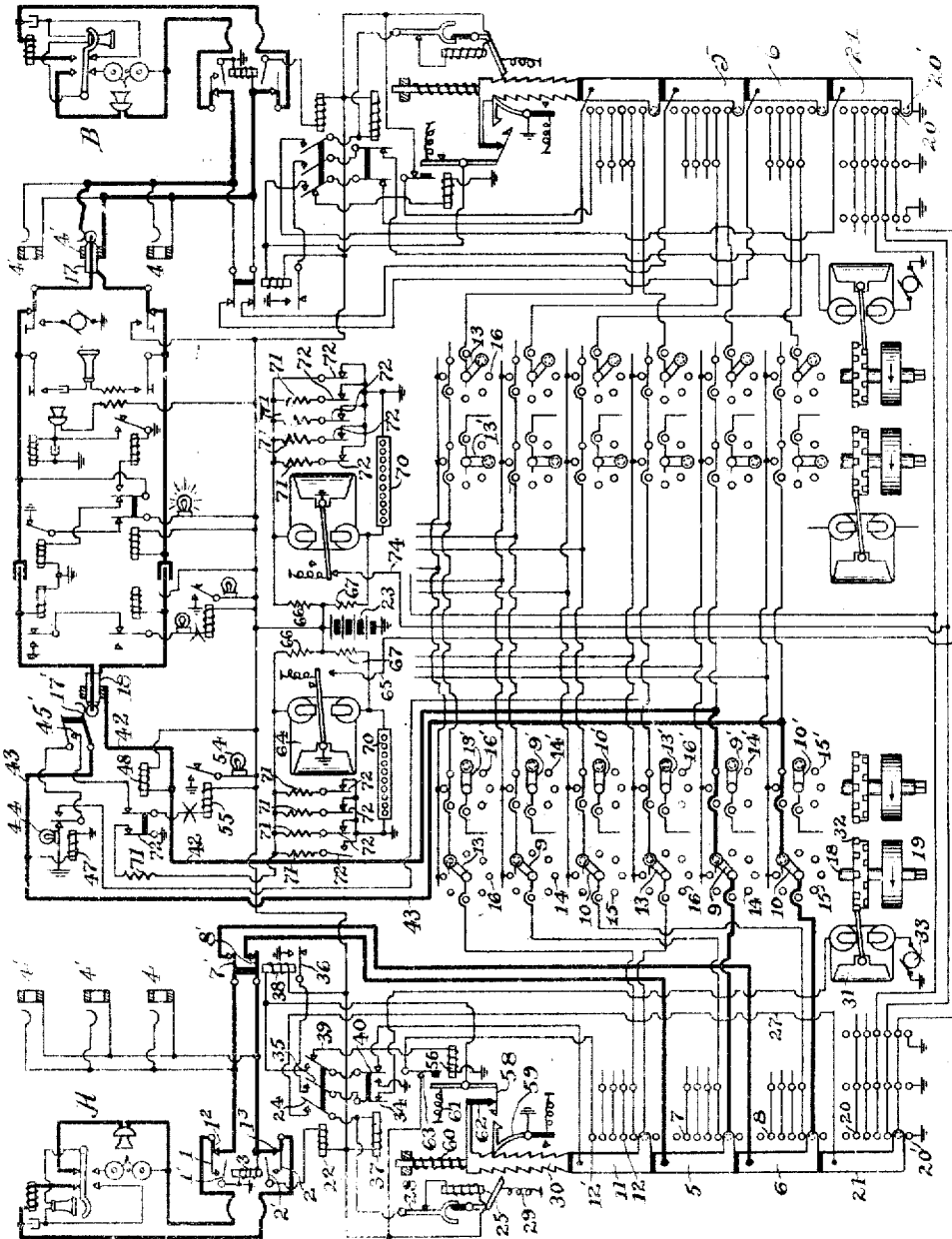
Inventor:
Francis W. Dunbar
By *L. L. Gray* Atty.

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5 SHEETS—SHEET 2.



Witnesses:

Leon Stark
Chas. H. Brown

Fig. 2.

Inventor:

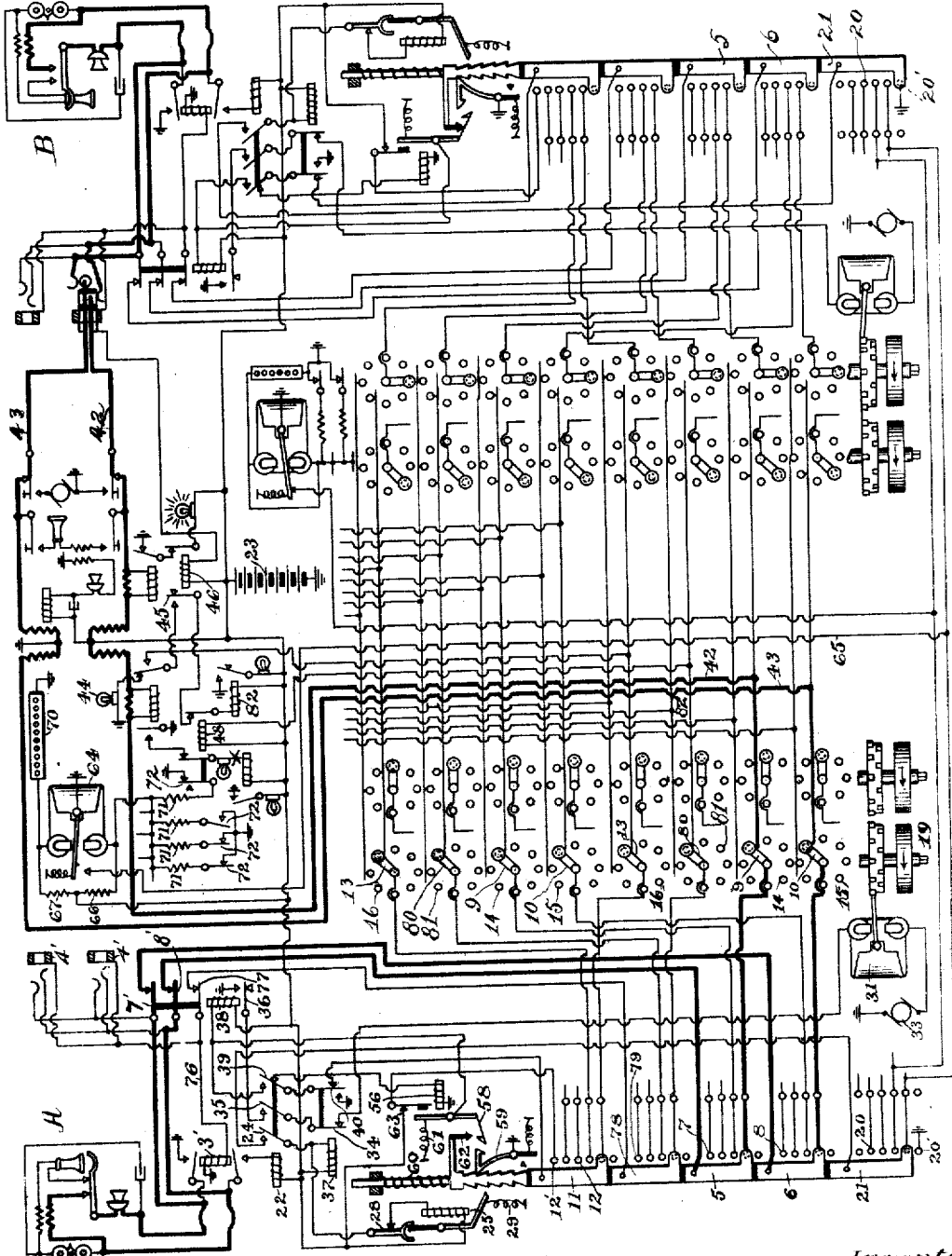
Francis W. Dunbar

By *H. L. Craig*
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F. W. DUNBAR.
 TELEPHONE EXCHANGE SYSTEM.
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 5 SHEETS—SHEET 3.

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Witnesses:

Leon Stroh
Chas. F. Barrett

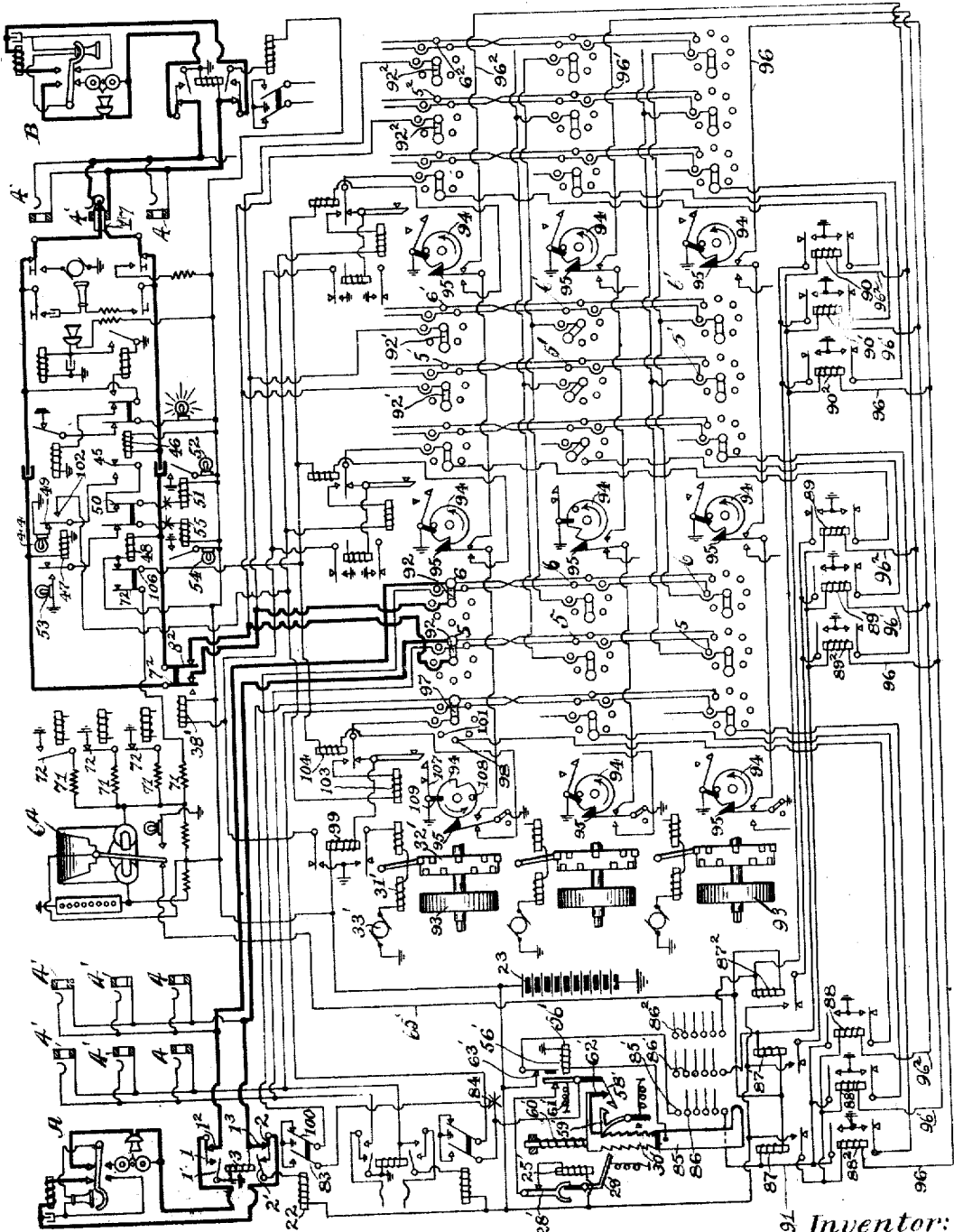
Fig. 3

Inventor:

Francis W. Dunbar

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 Atty

1,270,127.



Witnesses:

Levin Stark
Chas. F. Barrett

Fig. 4

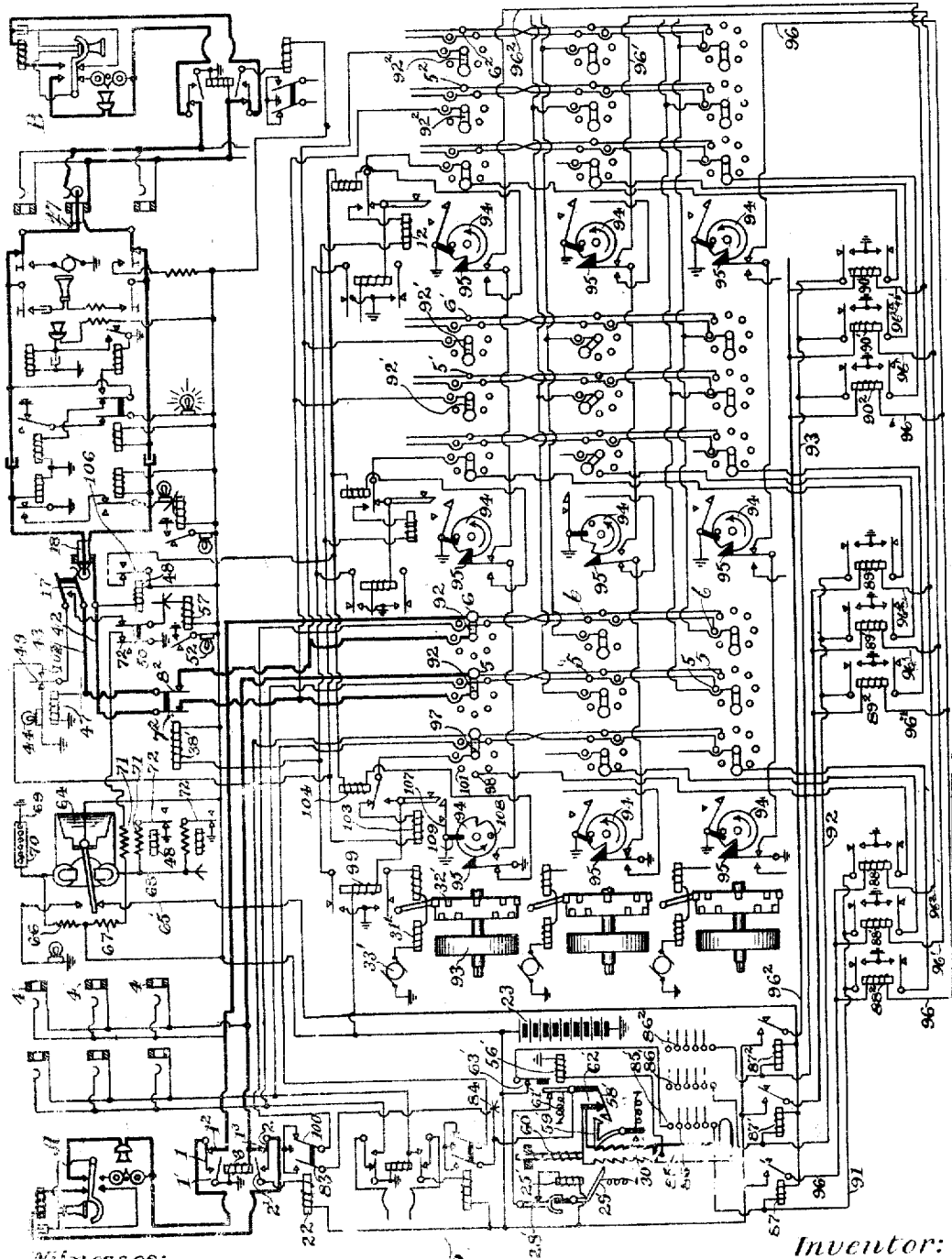
Inventor:

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F. W. DUNBAR.
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5 SHEETS—SHEET 5.

1,270,127.



Witnesses:

Leon Stroh
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Aug. 5.

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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

1,270,127.

Specification of Letters Patent.

Patented June 18, 1918.

Application filed March 3, 1905. Serial No. 248,242.

To all whom it may concern:

Be it known that I, FRANCIS W. DUNBAR, citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to telephone exchange systems, and is adapted to those classes of telephone exchange systems in which cord circuits are employed for uniting subscribers' lines for conversation. The invention has for its object the provision of a system wherein the calls are automatically distributed among the operators as the said operators are free to manipulate the cord circuits. This distribution of the calls is preferably automatically effected in the order in which the operators are free to take up the work of effecting connections; that is, a new call appears at the board or position of the first free operator. Thus, the first operator in a series of operators is fully supplied with work before the next operator is called upon to make connections, this next operator is fully supplied with work before the next operator is called upon to make connections, etc., the operators as they become free being in position to receive new work, the operators who become free preferably receiving the new work serially in their order. The signals operated by the calling lines are distributed among the operators' positions or sections, and apparatus is employed whereby signals appearing at the different operators' positions or sections are dependent upon the number of cord circuits actually in use at said positions. Taking, for example, three adjacent operators' positions in an exchange, the first operator is capable of handling, say, eight cord circuits, the second operator is capable of handling seven cord circuits and the third operator is capable of handling six cord circuits. As long as the first operator has any of her eight cord circuits to use, incoming calls are initiated at her position. If her eight cord circuits are in use and all of the cord circuits at the next operator's position are not in use, further calls are then initiated at the second operator's position. If this second operator has all of her cords in

service, the cords of the first operator then, of course, being in service, further calls are initiated at the third operator's position, and so on. There is, as hitherto stated, in the system, apparatus whereby calling signals are not effected at those operators' positions where the cord circuits are in service, but which are initiated at those positions where there are cords not in service, the invention being preferably so practised that the first operator in the series that is free to make connection, is the one at whose position a call is initiated. In accordance with this preferred embodiment of the invention, this call may be received by operator No. 1, operator No. 12, or any operator in the series that is free and the first in order of the free operators. I do not wish to be limited, however, in all embodiments of my invention to the order of sequence in which the free operators are selected to effect connection between calling and called lines. The great advantage of my present invention will be apparent to those skilled in the art, for by means of the invention the work of the operators is graded to their capacity and the calls are automatically distributed among the operators not according to the physical positions of the board sections, but according to the busy or free condition of the operators, an operator being "free" who has not in use at her position all of the cord circuits that have been assigned to her.

In the preferred embodiment of my invention, the cord circuits are associated with the line signals, there being preferably one such signal for each cord circuit and the answering ends of the cord circuits are preferably automatically connected with calling lines, the connecting plugs being the only plugs that the operators preferably have to manipulate, though I do not wish to be limited in all embodiments of my invention to this precise way of practising the same.

The apparatus that controls the appearance of line signals at the operators' positions, is preferably regulated by the cord or link circuits themselves, it preferably requiring the coöperation of all the link circuits assigned to a given operator to prevent the appearance of a calling signal at the said operator's position, whereby if any of said link circuits thus assigned are not in use, a signal may be received that will cause this operator to use said circuit in effecting con-

nection between lines. There is preferably one signal for each cord or link circuit at each operator's position, but I do not wish to be limited to this characteristic. Where

5 the answering end of a link or cord circuit is automatically connected with the calling line, I preferably employ apparatus interposed between subscribers' lines and the cord
10 circuits of all the operators, which apparatus first associates a calling line with the apparatus of an operator that is free to make connections, and thereafter automatically to
15 connect the answering end of an idle link or cord circuit belonging to said operator with said line. Thus, the first function of this
interposed apparatus is to effect association between a calling line and the apparatus of
20 a free operator, after which the said apparatus is free to effect connection between said calling line and one of the link or cord circuits that is free to be used. The apparatus
for thus effecting association between calling lines and link circuits, is prevented from
25 becoming associated with a calling signal at an occupied operator's position, by reason of the instrumentality jointly governed by the link circuits assigned to that operator, which
is so operated when all of the assigned link
30 circuits are in service, that the apparatus for effecting the association of calling lines with link or cord circuits, is forced to pass the
apparatus of an occupied operator's position and to seek connection with the apparatus of
35 a free (or partially occupied) operator's position.

Thus, viewing my system generally, there are located at the various operators' positions calling signals in association with apparatus whereby said signals may only be
40 operated at a free operator's position, the cords at the different sections of the board determining the operability of these signals.

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

Figure 1 illustrates the adaptability of the invention to one well known type of multiple switch-board, the invention, however, not being limited to multiple switch-board practice.
50

Fig. 2 illustrates the application of the invention to another well known type of multiple switch-board.

Fig. 3 illustrates one of several modifications of the invention.
55

Figs. 4 and 5 show other embodiments.

Like parts are indicated by similar characters of reference throughout the different figures.

60 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
65 is removed. I do not deem a detailed de-

scription 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
70 arrangement of subscriber's station apparatus, it will be obvious to those skilled in the art that other arrangements may be employed at the sub-stations, and I do not wish to be limited to the arrangement and apparatus shown, nor do I wish to be limited in
75 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
80 circuits), said lines extending in two branches to the exchange, where they terminate in normal contacts 1--2 normally engaged by the armatures 1'--2' of a cut-off
85 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
90 1'--2' are released. The contacts 1²--1³ constitute the terminals of the office end of the line, which is supplied with the line-jack 4. The system illustrated being a multiple
switch-board system, there are also provided upon other sections of the board than where
95 jack 4 is located, other jacks 4' in similar connection with the contacts 1²--1³. That which in a multiple switch-board would correspond to an answering-jack and in any other switch-board would correspond to a
100 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 7'--8' of the relay 38. The terminals 5--6 and
105 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
110 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
115 similar to the arms 10. Certain local control to be hereinafter specified, is obtained by the brush or contact 11, the said elements or switch parts 5--6 moving together. The brush 11 rides over contacts 12, each preferably connected with a rotating arm 13. All
120 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
125 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 130

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
 5 a link circuit corresponding to said signal, there being desirably as many signals as there are link circuits.

In the system shown in Figs. 1 and 3 the link circuit terminates at one end in the
 10 contact buttons 9-10-13 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 there-
 15 upon being effected, so that the operator thereupon uses the connecting plug 17 corresponding to the signal.

In the system shown in Fig. 2 the link circuit terminates in an answering-jack 17' that may be assigned to operators and distributed among them according to their capacity, signals being associated with these answering-jacks whose operativeness is governed by the operator's connecting apparatus, so that the capacity of the operator at a given position will not be overtaxed. In connection with the system shown in Fig. 2 an ordinary form of cord circuit may be employed, including an answering-plug 18 for
 30 insertion within the answering-jack 17', the connecting plug 17 serving to be connected with the called subscriber.

Each line of a group of subscribers' lines has as many buttons 7, as many buttons 8
 35 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
 45 connected with the arms 9-10-13 of 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 9'-10'-13' correspond to another subscriber and extend to contact buttons similar to contact buttons 7-8-12 cooperating with another subscriber's switch including parts similar to parts 5-6-11. All of these
 60 arms 9'-10'-13' are adapted for simultaneous operation by a link circuit motor corresponding to the subscriber to whom the elements 9'-10'-13' belong. By apparatus to be specified, the switch elements
 65 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
 70 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
 75 circuit condition that will cause the motor mechanism operating 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
 80 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
 85 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 cooperate with a switch element or contact 21 that is mechanically coupled with the
 90 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
 100 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 20' with which the element 21 is
 105 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
 110 20 and a button 20' 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
 115 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
 120 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
 130

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.

5 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, 10 establishes a circuit at the exchange which may be traced from the grounded armature 1', over the subscriber's line, to the contacts 2—2', the line-relay 22, to the grounded battery 23, whereby the armature-switches 15 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 20 the ground at 20', 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 25 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 30 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 20' into engagement with the next button. Now, if 35 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 40 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 continued, this operation being carried on until the brush element 21 45 comes into contact with a button 20 that corresponds with a free operator, whereupon circuit through the magnet 25 is effectively opened, so that the parts 5—6—11—21 cannot be further moved thereby. In the instance illustrated at the left of Fig. 1 the 50 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 55 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 60 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 65 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 70 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 75 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 80 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, 85 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 90 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 95 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, 100 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 105 through the generator 33. This connection 34 is provided because the magnet 38 is preferably employed to operate the switches 7'—8' temporarily to disconnect the parts 5—6 from the calling subscriber's line, circuit being established through said magnet 110 38 by the armature-switch 39 engaging its front contact, the armature-switch 40 engaging its front grounded contact, the magnet 38, to the grounded battery 23. It might 115 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 120 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 125 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 130

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 7'—8' 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 8', 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 armature 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 7' and its contact, over the telephone line of the calling subscriber, the armature-switch 8', 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—16' coöperating with the arms 13—13' are multiplied. In order that the arms 9—10 and 9'—10' may be connected with any idle link circuit, the contact buttons 14—14' are multiplied, as are also the buttons 15—15'. The ground is placed upon and removed from the buttons 16—16' 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—16' is indicated at the grounded terminal of the

relay 56. When the switch-arm 13 (or 13', etc.) has encountered a button 16 (or 16', etc.) having no connection with a ground (the windings 25 and 37 having been de-energized 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 2' 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—16', 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 of 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 7—8', 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 re-operation thereof. To this end, I preferably provide a supplemental contact button 12' 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 12'. 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 Fig. 1 at the left when all of the serviceable 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 section 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 eight, 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. The system shown in Fig. 2 employs link circuits terminating in answering-jacks 17', cord circuits, each including a connecting plug 17 and an answering plug 18, being also employed.

The subscriber's line and exchange apparatus possess parts similar in function, arrangement and operation to parts that are correspondingly designated in Fig. 1. The link conductors 42—43 extend from the buttons 14—15 to the sleeve and tip elements of the answering-jack 17' adapted for electrical connection respectively with the sleeve and tip of the answering plug 18 when said plug is inserted. The magnet or relay 47 is connected with the conductor 43, as in the system shown in Fig. 1. The calling signal manifested at 44 is effaced when the operator inserts the answering plug 18 because the circuit of said signal includes a switch 45' that is opened by said answering-plug when thus inserted.

The elements in association with the link circuit illustrated in Fig. 2 that are designated similarly to elements shown in association with the link circuit of Fig. 1 have similar functions. The cord circuit apparatus illustrated in Fig. 2 is well understood to those skilled in the art and need not be described.

The apparatus illustrated in the system shown in Fig. 3 is generally similar to that shown in Fig. 1, and parts possessing similar functions are similarly designated. In the system shown in Fig. 3 the cut-off relay 3' depends for its circuit control upon a conductor 76 that is not a talking conductor as

is the case of the conductor that is depended upon for this control of the cut-off relay 3 of Fig. 1. This conductor 76 includes not only the cut-off relay 3', but an armature-switch 77 operated by the magnet 38, a switch brush 78 and one of a set of connected buttons 79, there being one such set of connected buttons for each group of cord circuits. A switch-arm 80 operated by the motor 19, is on the same shaft with the switch-arms 9—10—13, said switch-arms 80 riding over buttons 81 having connections similar to that established by a conductor 82' with the battery 23, whereby the cut-off relay 3' is energized upon the connection of a calling line with an idle link circuit. Various parts of the system shown in Fig. 3 are given characters of reference, the parts having designations similar to parts in Fig. 1 having similar functions.

It is understood that there is one conductor 65 to each group of link circuits assigned to an operator. I have shown only one link circuit 42—43, though it is to be understood that there are as many such link circuits as there are buttons 14 including the button 14 connected with the conductor 42 and as there are buttons 15 including the button 15 connected with the conductor 43. The switch-arms 9—10 are adapted temporarily to constitute the traveling terminals of any calling line that has selected the same, which traveling terminals ride over the answering buttons of the link circuits. In the selective mechanism illustrated, the line that calls, first selects the switches 9—10 that have the capacity of being connected with an idle link circuit; that is, it selects such switches 9—10 whose associate link circuits are not all busy. In this way the selective mechanism may interchangeably select the terminals 9—10 as continuations of different calling telephone lines for the purpose of having the same temporarily act as the traveling line terminals of the calling line, such selective mechanism being dependent upon the electrical condition of the button 20 engaged by the element 21. If there are, for example five thousand lines and thirty operators assigned to the same, there are thirty groups of traveling switches 9—10 operated by each motor and coupled with any associate switches, as the switch 13, in the case of Fig. 3. There are, consequently, as many buttons 20 as there are operators, which may be said also of the buttons 8, the buttons 7, the buttons 12, and the button 79. There are as many motors 19 as there are devices containing the parts 5—6—11, etc. Inasmuch as in the embodiment of the invention shown the parts 5—6 are preferably associated with the telephone line, there are thus, in the example stated, five thousand such motors 19 each adapted to operate thirty groups of switches 9—10—13. To

make the illustration more clear, it may be specifically stated that all of the link circuit conductors leading from the contact buttons 14—15, etc., associated with each set of arms 9—10, etc., extend to one operator's position, the link circuits extending from another set of such buttons extending to another operator's position, and so on for each of the thirty in the example chosen. The lowermost set of buttons 14—15, etc., may, for example, be connected with all of the link circuits extending to the first operator's position, the group of buttons 14—15, etc., next above the last group mentioned may extend to the second operator's position, and so on until all of the thirty operators have received their link circuits. While I employ a rectilinear operating switching appliance 5—6—11—21 for each subscriber, I do not wish to be limited to a selecting device having this characteristic, nor do I wish to be limited to the rotating arms 9—10, etc., nor to the precise motor mechanism and its control for effecting movement of said arms, nor to the Wheatstone arrangement controlled by the link circuits of each set for governing the appearance of calling signals at the operator's position corresponding to said set.

In Fig. 4 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 observed by those skilled in the art that other arrangements may be employed at the sub-stations, and I do not wish to be limited to the arrangement and apparatus shown, nor do I wish to be limited 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. In Fig. 4 these lines terminate in normal contacts 1—2 normally engaged by the armatures 1'—2' 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 1'—2' are released. The contacts 1²—1³ constitute the terminals of the office end of the line, which is supplied with the line-jack 4. The system illustrated being a multiple switch-board system, to which my invention is not limited, however, there are also provided upon other sections of the board than where jack 4 is located other jacks 4' in similar

connection with the contacts 1²—1³. When a subscriber initiates a call, a circuit is established, that may be traced from the grounded battery 23, to the line-relay 22, the now released armature 2', the contact 2, over the line of the calling subscriber, the contact 1, to the now released grounded armature 1'. The armature-switch 83 is thereby moved against its contact, that is grounded, thereby establishing a circuit that may be traced from the grounded contact of switch 83, to the armature of magnet 56' (which, with its associate apparatus, is common to a group of lines, taps 84 extending from the switches 83 of all the subscribers' lines belonging to said group being shown in common connection with the said armature of magnet 56') the contact normally engaged by said armature through the agency of the spring 61', the lazy arm 28', the operating magnet 25', to the grounded battery 23. A terminal of the winding 25' is in the form of a contact with which the lazy arm 28' is adapted to have separable engagement, the lazy arm being bifurcated to receive between its bifurcated ends an extension of the armature 29'. The armature 29' is thus intermittently operated (during the continuation of conditions hereinafter to be set forth) to engage the teeth 30' upon a bar to effect the movement of a switch part 85 over a group of contact buttons 86, there being one such element 85 and one such group of contacts 86 for each group of subscribers' lines. Each horizontal row of buttons 86—86'—86² is connected with a conductor, such as 65', associated with a group of link or cord circuits, and there are as many such groups of cord circuits as there are horizontal rows of such buttons. The electrical character of these buttons depends upon whether or not their associate cord circuits are fully occupied. By apparatus to be presently set forth, if a group of cord circuits in coöperation with any of the buttons 86—86'—86² is not fully occupied, that button is grounded through battery 23; if said group is fully occupied, battery is removed from said button, with the results to be presently set forth. The link circuits associated with the buttons 86—86'—86², etc., may be distributed among the operators as desired. The lowermost contact buttons of the groups 86—86'—86² are shown in circuit relation, from which illustration the circuit relations of the remaining contact buttons will readily be understood. Each conductor 65' is connected with an armature of the polarized relay 64 and thereby with the grounded battery 23 whenever sufficient sections of resistance 71 have been cut out of circuit by the released armature-switches 72, properly to direct the current through the winding of said relay, to force a movement of its armature to effect this connection. There are magnets 87—87'—87², etc., one for each of the contacts 86—86'—86², etc., all of which are connected with the operator's conductor 65' and with the buttons of the sets 86—86'—86², that are connected with said conductor. Thus, whenever said conductor 65' is connected with a grounded battery 23, through the agency of the armature of the polarized relay 64, all of said relays 87—87'—87² are connected with said battery. When the element 85 or similar element riding over a group of contact buttons 86, or similar group, encounters a button of such group that is thus grounded, the grounded relay 56' connected with the element 85 is thrown into connection with said battery 23, a circuit at the same time being established through the corresponding magnet 87, 87' or 87², etc. The armatures of a magnet 87, 87' or 87² having been attracted, circuit is either wholly or partially completed through the magnets 88—88'—88² corresponding to the magnet 87 and its group of subscribers or 89—89'—89² corresponding to the magnet 87' and its group of subscribers, or the magnets 90—90'—90² corresponding to the magnet 87² and its group of subscribers, whereby apparatus that will be specified, is set into operation to connect a link circuit with the terminals 5—6 of a calling line, but, before describing this operation, I will state how the element 85 and the associate parts are restored to their initial positions in readiness to be operated by another calling subscriber of the same group, to initiate a new connection. Particular description hereafter will be given of the apparatus coöperating with the element 85 and one line of the group of subscribers to which the said element belongs, for from this description the operation of the exchange apparatus associated with the other groups of subscribers' lines will readily be understood.

Speaking now of the release and restoration of the element 85 and its associate parts, ground is imposed upon the conductor 91 through the agency of an armature or armatures connected therewith and belonging to the magnets 88—88'—88². Prior to the location of this ground upon this conductor 91, the magnet 56' is energized to withdraw its armature and effect engagement between the hook 58' and the detent 59', and, upon the connection of the conductor 91 with the ground, the magnet 56' is shunted, whereupon the spring 61' may move the hook 58' and withdraw the detent 59' from the engaging tooth 30', whereupon the spring 60' will restore the element 85 to its initial position. In case the element 85 should have traveled its full course without having become operatively associated with a conductor 65' extending to a free operator, a supplemental button 85' is provided,

which is connected with the battery 23 through the agency of the switch 63'. When the element 85 engages the button 85', circuit through the magnet 56' is closed and its armature is attracted to engage the hook 58' with the detent 59', whereafter said armature engages the switch 63' to open the circuit through the magnet 56', permitting the spring 61' to withdraw the detent 59', so that the spring 60' may restore the element 85 and its associate parts to their initial positions. As was the case with the parts numbered 62 and 58 in Figs. 1 and 2, so with the parts 62' and 58' in the present instance, the post 62' moves the hook 58' out of engagement with the detent 59' just as the spring 60' is completing the restoration of the element 85.

Having now operated the element 85 to select a conductor 65' associated with a free operator and having placed a ground upon the conductor 91 in the manner hereinafter to be specified, whereby circuits through the magnets 87—87'—87² are maintained independently of the element 85, I will now describe the way in which the answering ends of link circuits seek the terminals of calling lines.

In order that further description of the system now being considered may be more readily understood, I will first slightly refer to the link circuit apparatus and some of the mechanism whereby connection is effected between a link circuit and a calling line.

Each line terminates in a pair of contact buttons 5—6 that are in multiple with the line-jacks 4—4', and each link circuit terminates in traveling switch-arms 92—92'—92², etc. Each subscriber has a pair of contacts 5—6 in each cord or link circuit of a group of such link circuits, such contacts of one link circuit being multiplied with similar contacts of the other link circuits. Each cord or link circuit has contacts for each subscriber's line and switches, such as 92, riding over the contacts of all of the corresponding group of subscribers' lines, the first division of each cord or link circuit having the contacts 5—6 of the group of subscribers' lines corresponding to the first row of buttons 86, the next division having the contacts 5'—6' of the group of subscribers' lines corresponding to the second row of buttons 86', and the next division having the contacts 5²—6² of the group of subscribers' lines corresponding to the third row of buttons 86², and so on, each cord circuit being divided into as many divisions as there are groups of subscribers' lines. In passing, it should be stated that as each conductor 65' is associated with an operator or a group of link circuits and is connected through the relays 87—87'—87² with the buttons 86—86'—86² in the same horizontal row, each horizontal row of such buttons is

operatively associated with the link circuits of one operator or at one board section in the illustration shown. There are as many such sets of switches 92—92'—92² as there are groups of subscribers and the switches of one set are in multiple with the switches of each of the other sets. Each set of switches has a motor that serves to operate the same independently of each of the other sets, a motor 93 being shown for the set of switches 92, it being understood that the set of switches 92' and 92² each have a cord or link circuit motor similar to 93 for operating the same, this being the preferred form of motor for the purpose desired. Each button of the set 86 has a magnet 87 and conductor 91 associated therewith, each group of subscribers, therefore, having as many such magnets 87 and conductors 91 as there are buttons 86; in other words, as there are groups of cord or link circuits with which said buttons 86 cooperate. The armature of each magnet 87 partially controls the circuits of and cooperates with as many magnets 88—88'—88² as there are cord circuit motors 93, each cord circuit motor as 93, having a magnet, such as 88, controlling its operability. All of the cord circuit motors adapted independently to operate the switches 92—92'—92² belonging to a single link circuit, have assigned thereto the controlling magnets, as 88—88'—88². All of the cord circuit motors illustrated are understood to be associated with the link circuits of a single group, there being as many sets of said cord or link circuit motors as there are cords that may be made available for service in each group, those cord or link circuits that an operator is unable to handle being operatively dissociated in this system. Space does not permit illustration of another group of cord or link circuit motors, but it is to be understood that each conductor 65', and, therefore, each horizontal row of buttons 86—86'—86², etc., has such a group of cord circuit motors and associate apparatus. A free operator having been selected, the cord or link circuit of such operator that is not in service, is now to be selected, to which end only the link circuit motor that corresponds to the group of subscribers containing the calling subscriber is to be operated. The motors that belong to each link or cord circuit are, therefore, made to partially control the circuits including such magnets as 88—88', etc., so that such magnets will only effect the operation of motors associated with idle link circuits. To this end each motor has upon its shaft a notched wheel 94 upon which rides the tooth of a switch 95. When the link circuits associated with motors are not in use, the teeth of the switches 95 are in the notches of the wheels 94, whereby the switches 95 engage their normal contacts,

which, with the switches, are serially included in the conductors 96—96'—96², and when said conductors 96—96'—96² are thus closed, circuits are completed including the same, when the armatures of the magnets 87—87'—87² are attracted, these armatures constituting terminals of said conductors, the circuit ultimately closed by said armatures containing the battery 23. The conductors 96—96'—96² include the magnets 88²—89²—90²—88'—89'—90'—88—89—90 in circuit, these magnets connected with said conductors 96—96'—96² being connected in parallel. The magnet 88 governs the left hand motor 93 of the top cord circuit apparatus, the magnet 89 governs the next motor to the right, and the magnet 90 governs the next motor to the right, and so on. A subscriber of any group is thus enabled to become associated with any operator, but each subscriber is limited to coöperation with those sections of the cord or link circuits of a selected operator that correspond to the subscriber's group. The first section of each cord circuit thus corresponds to the group of lines associated with the buttons 86, the second section of each cord circuit corresponds to the group of lines associated with the buttons 86', and the third section of each cord circuit corresponds to the group of lines associated with the buttons 86². Thus, the first section of each link circuit is effective in completing connection with a calling line associated with the group of buttons 86, the second section of each cord circuit is effective in completing connection with a calling line associated with the group of buttons 86', and the third section of each link circuit is effective in completing connection with a calling line associated with the group of buttons 86². It will be seen that each circuit (for example the circuit associated with the top row of elements 94) is capable of having the magnets 88—89—90 associated therewith, the magnet 88 thus corresponding to the first section of this particular cord circuit, and, consequently, being associated with the group of lines associated with the buttons 86, the magnet 89 corresponding to the second section of this particular cord circuit, and, consequently, being associated with the group of lines associated with the buttons 86', and the magnet 90 corresponding to the third section of this particular cord circuit, and, consequently, being associated with the group of lines associated with the buttons 86². In the illustration, however, one of the elements 94 has been shifted because the associate link circuit is busy, so that no one of the magnets 88—89—90 may be operated. The link circuit associated with the next lower row of elements 94 is also busy, as indicated at the central element 94 belonging to said link circuit, thereby pre-

venting the operation of the magnets 88'—89'—90'. The bottom row of elements 94, however, are in a normal position, so that circuit may be closed through one of the magnets 88²—89²—90² according to which of the magnets 87—87'—87² is energized and according to the group containing the calling subscriber. If the call should be from the group of subscribers corresponding to the button 86, the magnet 87 would be energized and, consequently, the magnet 88², so that the lowermost motor 93 at the left will be operated, as this is the motor that corresponds to the magnet 88², the magnet 87, the group of contact buttons 86, and the group of lines associated with said buttons. It will be better for the understanding of the invention, however, to assume that connection has thus been effected between a calling line of the first group of subscribers' lines (corresponding to the buttons 86) and that link circuit corresponding with the upper row of elements 94, to which end, prior to making such connection, it should be assumed that the left hand element 94 has its notch engaging the tooth of the switch 95, whereby the armature of magnet 87, operated, by the calling subscriber, is attracted, to establish a circuit that may be traced from the battery 23 by way of said armature of the magnet 87, to the magnet 88, thence by way of the conductor 96² through the switches 95, to the ground at the left hand switch. The magnet 88 is thus energized to establish the ground upon the conductor 91 that causes the short circuiting of the magnet 56', with the results hitherto specified, and to place a ground upon the lowermost armature of said magnet 88, this latter armature establishing a circuit which may be traced from the ground put thereupon, to the rotating switch 97 upon the same shaft of the switches 92, said armature of magnet 88 being connected with a button 98, the switch 97 normally resting in contact with the button 98, which normal contact is effected when the notch of the associated element 94 engages the tooth upon the associate switch 95. Thus, it will be apparent that there are as many groups of magnets 88—88¹—88²—89—89¹—89², etc., as there are divisions of cord circuits and as there are groups of telephone lines, the first divisions of the cord or link circuits, the first group of magnets, such as 88, and the first group of telephone lines corresponding to buttons 86 being coöperatively related, while the second divisions of the cord or link circuits, the second group of magnets, such as 89, and the second group of telephone lines (those associated with buttons 86¹) are coöperatively related, and so on throughout the system. There are as many magnets 88—88¹, etc., 89—89¹, etc., and 90—90¹, etc., in each group of magnets as

there are cord circuits, whereby each cord circuit has as many magnets as there are divisions of telephone lines, and whereby each section of each cord circuit has one of such magnets. The calling subscriber having thus selected a free operator and his section of a free cord or link circuit belonging to said operator, causes the motor 93 to start, whereby the traveling answering ends or terminals 92—92 are caused to travel to seek the terminal contacts 5—6 of the calling subscriber's line. It is well here to state that if there should happen to be several link or cord circuits idle at a selected operator's position, a motor 93 of each of said circuits will be set into operation, the arms 92—92 that first encounter a multiplied pair of contacts 5—6, however, being the arms that are employed to effect connection between the link circuit and the calling subscriber's line, to which end the multiplied buttons 5—6 of different sections are preferably circularly displaced, so that two cords will not be simultaneously connected with the same line. Since, as soon as a line is selected, its line relay 22 is de-energized responsive to the operation of cut-off relay 3 hereafter described, the armature 100 retracts and reconnects ground to the multiple contact buttons 101 of the line so that the arms of any other started selectors engaging the contact buttons of a selected line will pass on and continue their travel in a complete circle to normal, unless of course there be a second calling line in the group, in which case the arms of one selector will select the buttons of such line. As hitherto stated, the subscribers of the first group corresponding to buttons 86 have their terminals 5—6 in the first sections of the link circuits; the subscribers of the second group corresponding to buttons 86¹ have their terminals 5¹—6¹ in the second sections of the link circuits; and the subscribers of the third group corresponding to buttons 86² have their terminals 5²—6² in the third sections of the link circuits. It will be seen that any operator when free may have her link or cord circuits operatively associated with a calling line in any group of telephone lines.

I will now describe the mechanism whereby the selected motor 93 is permitted to operate.

Said motor has a wheel upon the same shaft that carries the arms 92—97, which wheel is provided with teeth 32' arranged in peripheral rows, an armature of a polarized relay 31¹ oscillating from side to side alternately engaging the teeth of said rows, the teeth of one row being offset with respect to those of the other, permitting a step-by-step movement of the shaft, thereby effecting movement of the arms from contact to contact. The relay 31¹ has a source

of alternating current 33¹ adapted for inclusion in its circuit through the agency of the lower armature switch of magnet 99, said magnet, when energized, attracting its armature to establish the circuit containing said elements 31¹ and 33¹. The line-relay 22 of each subscriber is provided with an armature-switch 100, which, when released, is grounded. There is but one button 98 in each group engaged by the switch-arm 97 that is grounded by a relay, as 88. The companion buttons 101 are connected each with an armature-switch 100, there being as many of these buttons 101 as there are subscribers in the group to which the elements 92—97 are assigned, the buttons 101 in all of the cord circuits (in this case the first sections of the cord circuits, as it is the first group of lines that is therewith associated) being multiplied. As long, therefore, as the arm 97 engages buttons, as 101, that are grounded at 100, which is the case when the lines corresponding to said buttons 101 thus grounded are idle, the circuit through the magnet 99 is maintained, said magnet 99 preferably having another armature (that illustrated above its core) which is grounded so long as the arm 97 is thus grounded, whereby circuit is established through the magnet 38¹ to withdraw the switches 7²—8² to remove the link circuit apparatus and connections, which is desirable until connection between a link circuit and a calling line is effected. The free end of the arm 97, that engaging the buttons 98 and 101, is desirably flared, so that a contact with one button is made before contact with the preceding button is broken. A calling line will have its armature-switch 100 removed from ground, so that, when the arm 97 strikes the button 101 corresponding to the calling line, circuit through the magnet 99 will be opened, whereby the armature of relay 31¹ will cease its oscillation and the brushes or arms 92 will be brought to rest upon the terminals 5—6 of the line circuit, which terminals correspond in position to button 101 belonging to the calling subscriber and last engaged by the arm 97. By the same operation the upper armature of magnet 99 is released, so that the magnet 38¹ is de-energized and the switches 7²—8² are restored to their normal positions, thereby completing the continuity of the sides of the selector's link circuit. The magnet 48 thereupon becomes energized, circuit being established therethrough that may be traced from the ground at cut-off relay 3, whose armatures are thus attracted to complete the connection of the terminals 5—6 with the calling line, the button 5, the arm 92, the switch 8², said relay 48, to the grounded battery 23, whereby another resistance section 71 is cut into circuit for the purpose hitherto ex-

plained. The calling signal is at this time manifested at 44 the operator in response to this signal effecting connection of the selected link circuit with the called line either by the insertion of the connecting plug 17 when the link circuit is of the form shown in Fig. 4 or by the insertion of the answering plug 18 and the connecting plug 17 in the system shown in Fig. 5. In the system shown in Fig. 4 the calling signal 44 is immediately effaced when the connecting plug 17 is inserted. In the system shown in Fig. 5 this calling signal is immediately effaced upon the insertion of the answering plug 18 that opens the circuit containing the signaling device 44. When the subscribers are through conversation, the operator withdraws the plug or plugs of the cord circuit, whereupon the contact 102 is connected with the armature 49, which armature is now released because the magnet 47 is deenergized as its circuit is opened at the calling subscriber's sub-station, the calling subscriber having restored his receiver. When the cord circuit apparatus is restored to its normal idle condition and the armature 49 has thus been released, circuit is established that may be traced from the grounded battery 23, to the armature 49, the contact 102, the relay 103, the armature of magnet 104 (which latter magnet has had a circuit established for it that may be traced from the spring 95 grounded directly or through contact as illustrated, the winding of magnet 104, the armature 106, its magnet 48 still being energized, to the grounded battery 23), the switch-arm 97 to which the same is connected, thence to ground at 100, because the button 101 now engaging said arm 97 is now grounded. The magnet 103 is thus energized to attract its armature into locking engagement with a grounded spring arm 107, whereby a circuit is established for the magnet 99 that may be traced from the grounded battery 23, through the magnet 99, the armature of magnet 103, the locking spring 107 in locking engagement with said armature, to ground. The armatures of magnet 99 are thereupon again attracted to break the link circuit at 7²—8² and to close circuit through the relay 31¹, permitting a reoperation of the motor 93 until the tooth upon the switch 95 engages the notch in the element 94. As this engagement is being completed, a pin 108 strikes an extension 109 of the spring arm 107 to disengage said spring arm from the armature of magnet 103, so that the circuit including magnet 99 will be opened at said spring arm, whereby the circuit including the relay 31¹ will be opened, causing the operation of the motor 93 to cease.

The parts of Fig. 5 that have functions similar to corresponding parts in Fig. 4 are

given similar characters of reference, and a detailed description, therefore, of the system shown in Fig. 5 need not be given.

In each of the systems illustrated, there is a pilot signal 52; that is, a signal belonging to a board section or operator's position. It is apparent that it is not necessary in all embodiments of my invention to provide a signal 44 for each link circuit, for said link circuits may be so governed in their connection with calling lines that the first unoccupied link circuit is the one that first has connection with a calling line, so that, if an operator were limited to a single signal 52 for her entire group of cord or link circuits, she would employ said circuits, or rather the idle ones thereof, in their serial order, and she would only cease the employment of said circuits when the pilot signal 52 becomes effaced.

It will be seen that the calling signals that are displayed among the operators according to their condition to receive work, are continuously displayed until the circuit of the calling subscriber is manually attended to by the operator. That is, there are switch parts in association with the calling line that are manipulated by the operator in attending to the wants of the calling subscriber, whereby the calling signal is effaced automatically. Prior to this manual control of the calling subscriber's circuit, however, the subscriber may efface his own signal. Of course, if this signal is a signal that is common to a plurality of subscribers, such signal is not effaceable until all of the lines of said subscribers are connected or the receivers of the calling subscribers have been restored before connection.

The conductors 65—65¹ constitute circuit fractions that are complementary to the circuit arrangement of the selecting mechanism including the elements 21 and 85.

A non-numerical switch is one that does not respond 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. It is obvious that many changes may be made in the embodiments of my invention herein shown without departing from the spirit of the invention, and I do not, therefore, wish to be limited to the precise arrangements and apparatus herein disclosed, but, having thus described my invention, I claim as new and desire to secure by Letters-Patent the following:—

1. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuits for uniting telephone lines in conversation, each link circuit including manu-

ally controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, and selecting mechanism for each group of link circuits for interchangeably associating the call signal devices with calling telephone lines and jointly acted upon by the link circuits of its group.

2. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuits for uniting telephone lines in conversation, each link circuit including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, selecting mechanism for interchangeably associating said groups of link circuits with calling telephone lines and automatic means for connecting a link circuit of a group with a calling line.

3. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuits for uniting telephone lines in conversation, each link circuit including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits serving to associate the groups of link circuits with calling lines and to effect connection between the answering ends of idle link circuits and calling lines.

4. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuits for uniting telephone lines in conversation, each link circuit including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, and selecting mechanism for each group of link circuits for interchangeably associating the call signal devices with calling telephone lines and controlled by the link circuits of its group acting together and a calling telephone line.

5. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuits for uniting telephone lines in conversation, each link circuit including manually controlled terminals, and selecting mechanism for each group of link circuits for in-

terchangeably associating the call signal devices with calling telephone lines and jointly acted upon by the link circuits of its group.

6. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuits for uniting telephone lines in conversation, each link circuit including manually controlled terminals, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits serving to associate the groups of link circuits with calling lines and to effect connection between the answering ends of idle link circuits and calling lines.

7. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuits for uniting telephone lines in conversation, each link circuit including manually controlled terminals, and selecting mechanism for each group of link circuits for interchangeably associating the call signal devices with calling telephone lines and controlled by the link circuits of its group acting together and a calling telephone line.

8. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, apparatus for each group of link circuits and jointly governed by the link circuits of its group and inter-related with the aforesaid selecting mechanism, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

9. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to

effect effacement of the signals occasioned thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

10. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism for each group of link circuits associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

11. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting

telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group and inter-related with the aforesaid selecting mechanism, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

12. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected group and calling lines.

13. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, said link circuits being divided into

groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism for each group of link circuits associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

14. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group and inter-related with the aforesaid selecting mechanism, whereby the association of groups of link circuits with calling lines may be determined, automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines, said electro-magnetic apparatus including a polarized relay whose armature governs the capacity of each group of link circuits for association with a calling line, a Wheatstone bridge circuit for the said relay, one side of the bridge circuit including a manually adjustable resistance, the other side including sectional resistances adapted for inclusion in circuit abreast, and a relay for the link circuit of each group, the relays of all the operative link circuits controlling the circuit relation of the sectional resistances, the said polarized relay being included in bridge of its circuit.

15. A telephone exchange system includ-

ing telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation

of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, automatically operated selecting switching mechanism for each group of link circuits associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups with calling lines, said electro-magnetic apparatus including a polarized relay whose armature governs the capacity of each group of link circuits for association with a calling line, a Wheatstone bridge circuit for the said relay, one side of the bridge circuit including a manually adjustable resistance, the other side including sectional resistances adapted for inclusion in circuit abreast, and a relay for the link circuit of each group, the relays of all the operative link circuits controlling the circuit relation of the sectional resistances, the said polarized relay being included in bridge of its circuit.

17. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, apparatus for each group of link circuits and jointly governed by the link circuits of its group and inter-related with the aforesaid selecting mechanism, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

18. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association

with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

19. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism for each group of link circuits associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selecting groups and calling lines.

20. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, electro-magnetic ap-

paratus for each group of link circuits and jointly governed by the link circuits of its group and inter-related with the aforesaid selecting mechanism, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

21. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

22. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each

group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism for each group of link circuits associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

23. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group and inter-related with the aforesaid selecting mechanism, whereby the association of groups of link circuits with calling lines may be determined, automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines, said electro-magnetic apparatus including a polarized relay whose armature governs the capacity of each group of link circuits for association with a calling line, a Wheatstone bridge circuit for the said relay, one side of the bridge circuit including a manually adjustable resistance, the other side including sectional resistances adapted for inclusion in circuit abreast, and a relay for the link circuit of each group, the relays of all the operative link circuits controlling the circuit relation of the sectional resistances, the said polarized relay being included in bridge of its circuit.

24. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station, serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and comple-

mental to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the associations of groups of link circuits with calling lines may be determined, automatically operated selecting mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines, said electro-magnetic apparatus including a polarized relay whose armature governs the capacity of each group of link circuits for association with a calling line, a Wheatstone bridge circuit for the said relay, one side of the bridge circuit including a manually adjustable resistance, the other side including sectional resistances adapted for inclusion in circuit abreast, and a relay for the link circuit of each group, the relays of all the operative link circuits controlling the circuit relation of the sectional resistances, the said polarized relay being included in bridge of its circuit.

25. A telephone exchange system including telephone lines extending from sub-stations to an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, automatically operated selecting switching mechanism for each group of link circuits associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and call-

ing lines, said electro-magnetic apparatus including a polarized relay whose armature governs the capacity of each group of link circuits for association with a calling line, a Wheatstone bridge circuit for the said relay, one side of the bridge circuit including a manually adjustable resistance, the other side including sectional resistances adapted for inclusion in circuit abreast, and a relay for the link circuit of each group, the relays of all the operative link circuits controlling the circuit relation of the sectional resistances, the said polarized relay being included in bridge of its circuit.

26. A telephone exchange system including telephone lines extending from sub-stations to an exchange, a plurality of groups of link circuits for uniting telephone lines in conversation, call signal devices operable by the apparatus at the stations of calling subscribers, an apparatus for each group of link circuits governing the association of said call signal devices with the telephone lines, said apparatus including a polarized relay whose armature governs the association of call signal apparatus with calling lines, a Wheatstone bridge circuit for said relay, one side of the bridge circuit including a manually adjustable resistance, the other side including sectional resistances adapted for inclusion in circuit abreast, and a relay for the link circuit of each group, the relays of all the operative link circuits controlling the circuit relation of the sectional resistances, the said polarized relay being included in bridge of its circuit.

27. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuits for uniting telephone lines in conversation, each link circuit including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, and selecting mechanism for each group of link circuits for interchangeably associating the call signal devices with calling telephone lines and jointly acted upon by the link circuits of its group.

28. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuits for uniting telephone lines in conversation, each link circuit including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned there-

by, selecting mechanism for interchangeably associating said groups of link circuits with calling telephone lines, and automatic means for connecting a link circuit of a selected group with a calling line.

29. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuits for uniting telephone lines in conversation, each link circuit including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits serving to associate the groups of link circuits with calling lines and to effect connection between the answering ends of idle link circuits and calling lines.

30. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuits for uniting telephone lines in conversation, each link circuit including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, and selecting mechanism for each group of link circuits for interchangeably associating the call signal devices with calling telephone lines and controlled by the link circuits of its group acting together and a calling telephone line.

31. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuits for uniting telephone lines in conversation, each link circuit including manually controlled terminals, and selecting mechanism for each group of link circuits for interchangeably associating the call signal devices with calling telephone lines and jointly acted upon by the link circuits of its group.

32. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuits for uniting telephone lines in conversation, each link circuit including manually controlled terminals, selecting mechanism for interchangeably associating said groups of link circuits with calling tele-

phone lines, and automatic means for connecting a link circuit of a selected group with a calling line.

33. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuit for uniting telephone lines in conversation, each link circuit including manually controlled terminals, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits serving to associate the groups of link circuits with calling lines and to effect connection between the answering ends of idle link circuits and calling lines.

34. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, a plurality of groups of link circuits for uniting telephone lines in conversation, each link circuit including manually controlled terminals, and selecting mechanism for each group of link circuits for interchangeably associating the call signal devices with calling telephone lines and controlled by the link circuits of its group acting together and a calling telephone line.

35. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, apparatus for each group of link circuits and jointly governed by the link circuits of its group and inter-related with the aforesaid selecting mechanism, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

36. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting tele-

- phone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, 5 said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction 10 for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism 15 and in another electrical condition to cause the selecting mechanism to cease its operation, apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby 20 the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone 25 lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.
- 30 37. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable 35 by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned 40 thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits 45 for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation 50 of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby 55 the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism for each group of link circuits 60 associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.
- 35 38. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable 70 by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, 75 said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, electro-magnetic apparatus for each group of link circuits 80 and jointly governed by the link circuits of its group and inter-related with the aforesaid selecting mechanism, whereby the association of groups of link circuits with 85 calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection 90 between the answering ends of idle link circuits of selected groups and calling lines.
39. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable 95 by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned 100 thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving 105 in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and 110 jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and 115 said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.
40. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable 120 by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned 125 thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.
40. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable 130 by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism for each group of link circuits associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

41. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group and inter-related with the aforesaid selecting mechanism, whereby the association of groups of link circuits with calling lines may be determined, automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines, said electro-magnetic apparatus including a polarized relay whose armature governs the capacity of each group of link circuits for association with a calling line, a Wheatstone bridge circuit for the said relay, one side of the bridge circuit including a manually adjustable resistance, the other side including sectional resistances adapted for inclusion in circuit abreast, and a relay for the link circuit of each group, the relays of all the operative link circuits controlling the circuit relation of the sectional resistances, the said polarized relay being included in bridge of its circuit.

circuit for the said relay, one side of the bridge circuit including a manually adjustable resistance, the other side including sectional resistances adapted for inclusion in circuit abreast, and a relay for the link circuit of each group, the relays of all the operative link circuits controlling the circuit relation of the sectional resistances, the said polarized relay being included in bridge of its circuit.

42. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the associations of groups of link circuits with calling lines may be determined, automatically operated selecting mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines, said electro-magnetic apparatus including a polarized relay whose armature governs the capacity of each group of link circuits for association with a calling line, a Wheatstone bridge circuit for the said relay, one side of the bridge circuit including a manually adjustable resistance, the other side including sectional resistances adapted for inclusion in circuit abreast, and a relay for the link circuit of each group, the relays of all the operative link circuits controlling the circuit relation of the sectional resistances, the said polarized relay being included in bridge of its circuit.

43. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling

subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals serving to act upon circuits of said call signal devices to effect effacement of the signals occasioned thereby, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, automatically operated selecting switching mechanism for each group of link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines, said electro-magnetic apparatus including a polarized relay whose armature governs the capacity of each group of link circuits for association with a calling line, a Wheatstone bridge circuit for the said relay, one side of the bridge circuit including a manually adjustable resistance, the other side including sectional resistances adapted for inclusion in circuit abreast, and a relay for the link circuit of each group, the relays of all the operative link circuits controlling the circuit relation of the sectional resistances, the said polarized relay being included in bridge of its circuit.

44. A telephone exchange system including telephone lines extending from substations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, apparatus for each group of link circuits and jointly governed by the link circuits of its group and inter-related with the aforesaid selecting mechanism, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the

telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

45. A telephone exchange system including telephone lines extending from substations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

46. A telephone exchange system including telephone lines extending from substations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and auto-

matically operated selecting switching mechanism for each group of link circuits associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

47. A telephone exchange system including telephone lines extending from substations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group and inter-related with the aforesaid selecting mechanism, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

48. A telephone exchange system including telephone lines extending from substations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

49. A telephone exchange system includ-

ing telephone lines extending from substations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, and automatically operated selecting switching mechanism for each group of link circuits associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines.

50. A telephone exchange system including telephone lines extending from substations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group and inter-related with the aforesaid selecting mechanism, whereby the association of groups of link circuits with calling lines may be determined, automatically operated selecting switching mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines, said electro-magnetic apparatus including a polarized relay whose armature governs the capacity of each group of link circuits for association with a calling line, a Wheatstone bridge circuit for the said relay, one side of the bridge circuit including a manually adjustable resistance, the other side including sectional resistances adapted for inclusion in

circuit abreast, and a relay for the link circuit of each group, the relays of all the operative link circuits controlling the circuit relation of the sectional resistances, the said polarized relay being included in bridge of its circuit.

51. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the associations of groups of link circuits with calling lines may be determined, automatically operated selecting mechanism associated with the telephone lines and said link circuits for effecting connection between the answering ends of the idle link circuits of selected groups and calling lines, said electro-magnetic apparatus including a polarized relay whose armature governs the capacity of each group of link circuits for association with a calling line, a Wheatstone bridge circuit for the said relay, one side of the bridge circuit including a manually adjustable resistance, the other side including sectional resistances adapted for inclusion in circuit abreast, and a relay for the link circuit of each group, the relays of all the operative link circuits controlling the circuit relation of the sectional resistances, the said polarized relay being included in bridge of its circuit.

52. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, call signal devices operable by the apparatus at the stations of calling subscribers, link circuits for uniting telephone lines in conversation including manually controlled terminals, said link circuits being divided into groups, selecting mechanism at the exchange and operable by the apparatus at a calling subscriber's station serving to select an incompletely occupied group of link circuits for association with

a calling line, a circuit fraction for each group of link circuits and complementary to the circuit arrangement of the selecting mechanism serving in one electrical condition to permit the continuation of the operation of the selecting mechanism and in another electrical condition to cause the selecting mechanism to cease its operation, electro-magnetic apparatus for each group of link circuits and jointly governed by the link circuits of its group determining the electrical character of said circuit fractions, whereby the association of groups of link circuits with calling lines may be determined, automatically operated selecting switching mechanism for each group of link circuits associated with the telephone lines and said link circuits for effecting connection between the answering ends of idle link circuits of selected groups and calling lines, said electro-magnetic apparatus including a polarized relay whose armature governs the capacity of each group of link circuits for association with a calling line, a Wheatstone bridge circuit for the said relay, one side of the bridge circuit including a manually adjustable resistance, the other side including sectional resistances adapted for inclusion in circuit abreast, and a relay for the link circuit of each group, the relays of all the operative link circuits controlling the circuit relation of the sectional resistances, the said polarized relay being included in bridge of its circuit.

53. A telephone exchange system including telephone lines extending from sub-stations in multiple to different board sections at an exchange, a plurality of groups of link circuits for uniting telephone lines in conversation, call signal devices operable by the apparatus at the stations of calling subscribers, an apparatus for each group of link circuits governing the association of said call signal devices with the telephone lines, said apparatus including a polarized relay whose armature governs the association of call signal apparatus with calling lines, a Wheatstone bridge circuit for said relay, one side of the bridge circuit including a manually adjustable resistance, the other side including sectional resistances adapted for inclusion in circuit abreast, and a relay for the link circuit of each group, the relays of all the operative link circuits controlling the circuit relation of the sectional resistances, the said polarized relay being included in bridge of its circuit.

54. A telephone system including telephone lines divided into groups, a link-circuit for use in establishing connection between calling and called lines, selective switches individual to said link-circuit at the answering end thereof, one switch for each line group, multiple terminals of said lines groupwise distributed at said switches, line

relays, one for each line responsive to currents over their lines, master-switch mechanisms, one for each line group, connections from the line relays of each group to its
 5 respective master-switch whereby any line may actuate the master-switch mechanism of its group, other link-circuits having connections and apparatus similar to said first-mentioned circuit, stationary contacts at
 10 said master-switch mechanisms, means associated with said link-circuits for altering the electrical conditions of said contacts to render them busy, test means for said master-switches enabling them when actuated
 15 to seek out idle ones of said contacts, and starting mechanism for each master-switch effective when an actuated master-switch is engaging an idle contact to start a link-circuit selective switch having multiple
 20 terminals of the line group pertaining to the actuated master-switch.

55. A telephone system including telephone lines divided into groups, a link-circuit for use in establishing connection between calling and called lines, selective
 25 switches individual to said link-circuit at the answering end thereof, one switch for each line group, multiple terminals of said lines groupwise distributed at said switches,
 30 line relays, one for each line responsive to currents over their lines, master-switch mechanisms, one for each line group, connections from the line relays of each group to its respective master-switch whereby any
 35 line may actuate the master-switch mechanism of its group, other link-circuits having connections and apparatus similar to said first mentioned circuit, stationary contacts at said master-switch mechanisms, means
 40 associated with said link-circuits for altering the electrical conditions of said contacts to render them busy, test means for said master-switches enabling them when actuated to seek out idle ones of said contacts,
 45 starting mechanism for each master-switch effective when an actuated master-switch is engaging an idle contact to start a link-circuit selective switch having multiple terminals of the line group pertaining to the actuated
 50 master-switch, and a switch controlled by the line relay of a line when operated to alter the normal electrical condition of its multiple terminals to render them selectable by the started switch whereby the
 55 link-circuit of a started switch is connected with said line.

56. A telephone system including telephone lines divided into groups, a link-circuit for use in establishing connections between calling and called lines, selective
 60 switches individual to said link-circuit at the answering end thereof, one switch for each line group, multiple terminals of said lines groupwise distributed at said switches, line
 65 relays, one for each line responsive to cur-

rents over their lines, master-switch mechanisms, one for each line group, connections from the line relays of each group to its respective master-switch whereby any line
 70 may actuate the master-switch mechanism of its group, other link-circuits having connections and apparatus similar to said first mentioned circuit, stationary contacts at said master-switch mechanisms, means associated with said link-circuits for altering the electrical
 75 conditions of said contacts to render them busy, test means for said master-switches enabling them when actuated to seek out idle ones of said contacts, starting mechanism for each master-switch effective
 80 when an actuated master-switch is engaging an idle contact to start a link-circuit selective switch having multiple terminals of the line group pertaining to the actuated master-switch, a switch controlled by the
 85 line relay of a line when operated to alter the normal electrical condition of its multiple terminals to render them selectable by the started switch whereby the link-circuit of a started switch is connected with said
 90 line, circuit connections for placing the other switches of a link-circuit in inoperable condition while one switch is in use, and connection devices for extending the calling end of said link-circuit to a desired telephone line.
 95

57. A telephone system including telephone lines divided into groups, a link-circuit for use in establishing connection between calling and called lines, selective
 100 switches individual to said link-circuit at the answering end thereof, one switch for each line group, multiple terminals of said lines groupwise distributed at said switches,
 105 line relays, one for each line responsive to currents over their lines, master-switch mechanisms, one for each line group, connections from the line relays of each group to its respective master-switch whereby any line may actuate the master-switch mechanism of its group, other link-circuits having
 110 connections and apparatus similar to said first mentioned circuit, stationary contacts at said master-switch mechanisms, means associated with said link-circuits for altering the electrical conditions of said contacts to render
 115 them busy, test means for said master-switches enabling them when actuated to seek out idle ones of said contacts, starting mechanism for each master-switch effective when an actuated master-switch is engaging
 120 an idle contact to start a link-circuit selective switch having multiple terminals of the line group pertaining to the actuated master-switch, a switch controlled by the line relay of a line when operated to alter the
 125 normal electrical condition of its multiple terminals to render them selectable by the started switch whereby the link-circuit of a started switch is connected with said line, circuit connections for placing the other
 130

switches of a link-circuit in inoperable condition while one switch is in use, connection devices for extending the calling end of said link-circuit to a desired telephone line, a device for transmitting currents over a circuit including a switch contact of a selective switch and a terminal of the calling line for determining to connection with what line the link-circuit shall be extended, and means for restoring an operated selective switch to normal.

58. A telephone system including telephonic lines divided into groups and provided with terminals, a plurality of selective switches each having terminals for the lines of one group, a link-circuit individual to said plurality of switches, means normally responsive to initiation of a call over any line of a group for starting the particular switch of the group, means thereon effective to prevent the starting of another of said switches, and circuits for effecting continued travel of the started switch into engagement with terminals of a calling line whereby said link-circuit is connected with said line.

59. A telephone system including telephonic lines divided into groups and provided with terminals, a plurality of selective switches each having terminals for the lines of one group, a link-circuit individual to said plurality of switches, means normally responsive to initiation of a call over any line of a group for starting the particular switch of the group, means thereon effective to prevent the starting of another of said switches, circuits for effecting continued travel of the started switch into engagement with terminals of a calling line whereby said link-circuit is connected with said line, apparatus for extending the calling end of said link-circuit to desired points, and release means for operatively dissociating said link-circuit from said line to restore its switches to normal condition.

60. A telephone system including telephone lines having terminals arranged in groups, a link-circuit for use in connecting calling to called lines, selective connection devices individual to said link-circuit, one for each of said terminal groups, circuit controlling electromagnets, one for each connection device, means for operating the magnet of the connection device for a group responsive to initiation of a call over any line of said group, and circuit connections thereon effective to render the magnets of the connection devices of the other groups inoperable.

61. A telephone system including telephonic circuits divided into groups, terminals therefor divided into corresponding groups, a link-circuit for connection with said telephonic circuits, selective switches for said link-circuit for establishing connection

thereof with the terminals of said telephonic circuits, one switch for each group of terminals, common master-switch mechanisms, one for each group of circuits, a starting circuit controlled by each master-switch and extending to the selective switch of the respective group, and means for actuating the master-switch mechanism of any group responsive to initiation of a call over one of its circuits to render effective the starting circuit of the respective selective switch.

62. A telephone system including telephonic circuits divided into groups, terminals therefor divided into corresponding groups, a link-circuit for connection with said telephonic circuits, selective switches for said link-circuit for establishing connection thereof with the terminals of said telephonic circuits, one switch for each group of terminals, common master-switch mechanisms, one for each group of circuits, a starting circuit controlled by each master-switch and extending to the selective switch of the respective group, means for actuating the master-switch mechanism of any group responsive to initiation of a call over one of its circuits to render effective the starting circuit of the respective selective switch, and automatic selective means enabling the started switch to select the calling circuit whereby said link-circuit is connected with said circuit.

63. A telephone system including telephonic circuits divided into groups, terminals therefor divided into corresponding groups, a link-circuit for connection with said telephonic circuits, selective switches for said link-circuit for establishing connection thereof with the terminals of said telephonic circuits, one switch for each group of terminals, common master-switch mechanisms, one for each group of circuits, a starting circuit controlled by each master-switch and extending to the selective switch of the respective group, means for actuating the master-switch mechanism of any group responsive to initiation of a call over one of its circuits to render effective the starting circuit of the respective selective switch, automatic selective means enabling the started switch to select the calling circuit whereby said link-circuit is connected with said circuit, and mechanism effective when one switch is in use for preventing the master-switch mechanism of another group from rendering effective the starting circuit of its switch.

64. A telephone system including telephonic circuits divided into groups, terminals therefor divided into corresponding groups, a link-circuit for connection with said telephonic circuits, selective switches for said link-circuit for establishing connection thereof with the terminals of said telephonic circuits, one switch for each group of terminals

minals, common master-switch mechanisms, one for each group of circuits, a starting circuit controlled by each master-switch and extending to the selective switch of the respective group, means for actuating the master-switch mechanism of any group responsive to initiation of a call over one of its circuits to render effective the starting circuit of the respective selective switch, automatic selective means enabling the started switch to select the calling circuit whereby said link-circuit is connected with said circuit, mechanism effective when one switch is in use for preventing the master-switch mechanism of another group from rendering effective the starting circuit of its switch, and restoring means for returning said link-circuit to its normal electrical associations.

65. A telephone system including telephonic lines having their terminals arranged in groups and normally unselectable in character, link-circuits for connecting said lines, a plurality of selective switches, one for each line group, individual to each link-circuit, an automatic master-switch for each line group common to and initially operable responsive to currents over the lines of the respective group, terminals at said master-switches multiplied from switch to switch, means controlled by said link-circuits for altering the electrical conditions of said terminals to render them busy, traveling test means for said master-switches enabling them on initial operation to select an idle terminal, and starting circuits controlled by said master-switches, automatically effective for initiating travel of selective switches of their responsive line groups on selection of idle terminals, a separate starting circuit being provided for each multiple terminal of each master-switch mechanism.

66. A telephone system including telephonic lines having their terminals arranged in groups and normally unselectable in character, link-circuits for connecting said lines, a plurality of selective switches, one for each line group, individual to each link-circuit, an automatic master-switch for each line group common to and initially operable responsive to currents over the lines of the respective group, terminals at said master-switches multiplied from switch to switch, means controlled by said link-circuits for altering the electrical conditions of said terminals to render them busy, traveling test means for said master-switches enabling them on initial operation to select an idle terminal, starting circuits controlled by said master-switches, automatically effective for initiating travel of selective switches of their respective line groups on selection of idle terminals, a separate starting circuit being provided for each multiple terminal of each master-switch mechanism, line relays for

said telephonic lines for operation to control said master-switch and alter the normal electrical conditions of the line terminals of their respective lines to render them selectable, and test means for the selective switches enabling them when started to select and connect with terminals of a calling line.

67. A telephone system including telephonic lines having their terminals arranged in groups and normally unselectable in character, link-circuits for connecting said lines, a plurality of selective switches, one for each line group, individual to each link-circuit, an automatic master-switch for each line group common to and initially operable responsive to currents over the lines of the respective group, terminals at said master-switches multiplied from switch to switch, means controlled by said link-circuits for altering the electrical conditions of said terminals to render them busy, traveling test means for said master-switches enabling them on initial operation to select an idle terminal, starting circuits controlled by said master-switches, automatically effective for initiating travel of selective switches of their respective line groups on selection of idle terminals, a separate starting circuit being provided for each multiple terminal of each master-switch mechanism, line relays for said telephonic lines for operation to control said master-switch and alter the normal electrical conditions of the line terminals of their respective lines to render them selectable, test means for the selective switches enabling them when started to select and connect with terminals of a calling line, and apparatus for extending the calling ends of said link-circuits to desired points.

68. A telephone system including telephone circuits arranged in groups, link-circuits for connecting said circuits in pairs, selective switches at the answering ends of said link-circuits normally at rest and arranged in groups corresponding to said groups of circuits, a common starting device for each group of telephone circuits, responsive to currents over the circuits of the group, contacts for said starting devices multiplied from device to device, means controlled by said selective switches for rendering said multiple contacts busy, a traveling test member for each starting device for engaging said contacts, apparatus controlled thereby sensitive to the idle or busy conditions of said contacts, starting circuits controlled by each starting device equal in number to its multiple contacts for starting selective switches of its group, and means for causing a started selective switch to connect its link-circuit to the telephone circuit operating the starting device.

69. A telephone system including circuits

arranged in groups, contact terminals for said circuits arranged in corresponding groups, a selective switch having a number of sets of traveling contact members, one for each group of contact terminals, an auxiliary switch for selecting a set of said traveling contact members, multiple terminals included in said auxiliary switch for determining the particular set of traveling members to be selected, means for changing the electrical character of said terminals to render them busy whereby said auxiliary switch, when initially operated, will pass over them to seek an idle terminal, means for simultaneously moving the entire number of traveling members of a selective switch over their contact terminals, when a set has been selected, and means for stopping a selective switch when the selected set of members engages terminals of an idle circuit.

70. A telephone system including telephone lines provided with normally open instrument circuits, line selecting switches for making connections to said lines as calling lines, a line relay for each of said lines responsive to the closure of its associated normally open instrument circuit, means controlled by the energization of the line relay of one of said lines to set in travel a plurality of said switches in search of said line, and a battery at the central office to furnish all necessary operating current.

71. A telephone system including telephone lines provided with normally open instrument circuits, line selecting switches for making connections to said lines as calling lines, a line relay for each of said lines responsive to the closure of its associated normally open instrument circuit, means controlled by the energization of the line relay of one of said lines to set in travel a plurality of said switches in search of said line, a battery at the central office to furnish all necessary operating current, circuit connections for arresting the switch first to reach the calling line in connection therewith, and means for preventing any switch subsequently reaching said calling line from remaining in connection therewith.

72. A telephone system including telephone lines, line selecting switches for making connection therewith as calling lines, means responsive to initiation of a call over one of said lines to set in travel a plurality of said switches in search of said line, circuit connections for arresting the switch first to reach the calling line in connection therewith, and means for automatically restoring the remaining started switches to normal.

73. A telephone system including telephone lines, line selecting switches for making

connection therewith as calling lines, means responsive to initiation of a call over one of said lines to set in travel a plurality of said switches in search of said line, circuit connections for arresting the switch first to reach the calling line in connection therewith, and apparatus for arresting the travel of the remaining started switches at a normal point.

74. A telephone system including telephone lines, line selecting switches for making connection therewith as calling lines, means responsive to initiation of a call over one of said lines to set in travel a plurality of said switches in search of said line, circuit connections for arresting the switch first to reach the calling line in connection therewith, means for preventing any switch subsequently reaching said calling line from remaining in connection therewith, and apparatus for arresting the travel of the remaining started switches at a normal point.

75. A telephone system including telephone lines provided with normally open instrument circuits, traveling selectors for connecting with said lines, a line relay for each of said lines responsive to the closure of its associated normally open instrument circuit, multiple terminals of said lines at said selectors, and means controlled by the energization of the line relay of a calling one of said lines to alter the electrical condition of the terminals of said line, said means also including means for starting travel of a plurality of said selectors.

76. A telephone system including telephone lines provided with normally open instrument circuits, traveling selectors for connecting with said lines, a line relay for each of said lines responsive to the closure of its associated normally open instrument circuit, multiple terminals of said lines at said selectors, means controlled by the energization of the line relay of a calling one of said lines to alter the electrical condition of the terminals of said line, said means also including means for starting travel of a plurality of said selectors, and means for arresting the selector first to engage the terminal of said line in connection therewith.

77. A telephone system including telephone lines provided with normally open instrument circuits, traveling selectors for connecting with said lines, a line relay for each of said lines responsive to the closure of its associated normally open instrument circuit, multiple terminals of said lines at said selectors, means controlled by the energization of the line relay of a calling one of said lines to alter the electrical condition of the terminals of said line, said means also including means for starting travel of a plurality of said selectors, and means for

arresting the selector first to engage the terminals of said line in connection therewith and for preventing the other started selectors from stopping in engagement with the terminals of said line.

78. A telephone system including telephone lines, traveling selectors for connecting with said lines, multiple terminals of said lines at said selectors, apparatus operated responsive to initiation of a call over one of said lines to alter the electrical condition of the terminals of said line, said apparatus also including means for starting travel of a plurality of said selectors, means for arresting the selector first to engage the terminals of said line in connection therewith, and circuit connections for automatically restoring to normal the other started selectors.

79. A telephone system comprising telephone lines, suitable substation equipment, multiple jacks for said lines, a switchboard including a plurality of groups of operators' positions, manually controlled connecting means at said positions to connect with said multiple jacks, selective switches adapted to be operated on removal of the receivers at calling substations of said lines to select groups of operators' positions having idle connecting means, and other selective switches adapted to be thereafter automatically operated to extend the circuits of calling lines to said idle connecting means.

80. In a telephone call distributing system, the combination with a plurality of distributing switches each having stationary terminals and a movable switch member, of a plurality of telephone lines multiplied to symmetrically disposed stationary terminals on each switch, the movable members of said switch being dissymmetrically arranged with relation to the stationary terminals of any given line, a connecting cord circuit connected with the movable member of each switch, and electrically actuated mechanism responsive to the initiation of a call in any line adapted to effect the movement of said movable switch members, whereby the movable member of one of said switches is adapted to contact with the stationary terminals of any line after a relatively slight movement.

81. In a telephone call distributing system, the combination with a plurality of distributing switches, each having stationary contact terminals and a movable member, of a connecting cord circuit associated with the movable member of each switch, a plurality of telephone lines multiplied to the stationary terminals of the various switches, and electrically actuated mechanism responsive to the initiation of a call in any of said lines adapted to cause the movable members of said switches to traverse the stationary terminals thereof, the arrangement

of the line terminals with relation to the movable members of each switch being dissymmetrical, whereby the terminals of any line calling are "found" by the movable members of one of said switches in a relatively brief space of time.

82. In a semi-automatic telephone exchange system, the combination with a group of lines, finder switches to which said lines are multiplied, banks of multiple called terminals of said lines, manual switches for connecting therewith, means actuated in initiating a call from any of said lines for establishing an abnormal condition of its multiple calling terminals and for causing the simultaneous travel of all the switches to connect with said line, and means actuated upon the connection of the first arriving switch with its multiple terminal of said line for restoring the normal condition of its multiple calling terminals at the other switches, and establishing an abnormal condition of the multiple called terminals of said calling line in said banks of called terminals.

83. In a semi-automatic telephone exchange system, the combination with a group of lines, distributing finders to which said lines are multiplied, motor mechanism for moving said finders simultaneously, banks of multiple spring jacks of said lines, a group of connecting circuits each terminating at one end in one of said finders and at the other in a plug for insertion in said spring jacks, means actuated upon the initiation of a call from any line for establishing an abnormal condition of its multiple calling terminals and for causing the actuation of said motor mechanism, and means actuated by the first arriving switch in connection with a multiple terminal of the calling line for restoring the normal condition of its multiple terminals upon the other finders, and establishing an abnormal condition of the multiple spring jacks of said calling line.

84. In a telephone call distributing system, the combination with a group of lines, a group of finder switches to which said lines are multiplied, means actuated in initiating a call from any of said lines for establishing an abnormal condition of the multiple terminals thereof and for causing the movement of all said switches, and means actuated by the first arriving switch for stopping its movement and restoring the normal electrical condition of the multiple terminals of said line, whereby the travel of the remaining switches is not arrested.

85. In a telephone call distributing system, the combination with a plurality of distributing switches each having stationary terminals and a movable switch member, of a plurality of telephone lines multiplied to symmetrically disposed stationary terminals

on each switch, the movable members of
said switch being dissymmetrically ar-
ranged with relation to the stationary ter-
minals of any given line, a connecting cord
5 circuit connected with the movable member
of each switch, means for effecting the move-
ment of said movable members, and mech-
anism responsive to the initiation of a call
in any line adapted to cause one of said

switches to connect with the stationary ter- 10
minals of such line.

In witness whereof, I hereunto subscribe
my name this twenty-seventh day of Febru-
ary A. D., 1905.

FRANCIS W. DUNBAR.

Witnesses:

G. L. CRAIG,
LEON STROH.