

1,189,836.

Patented July 4, 1916.

2 SHEETS—SHEET 1.

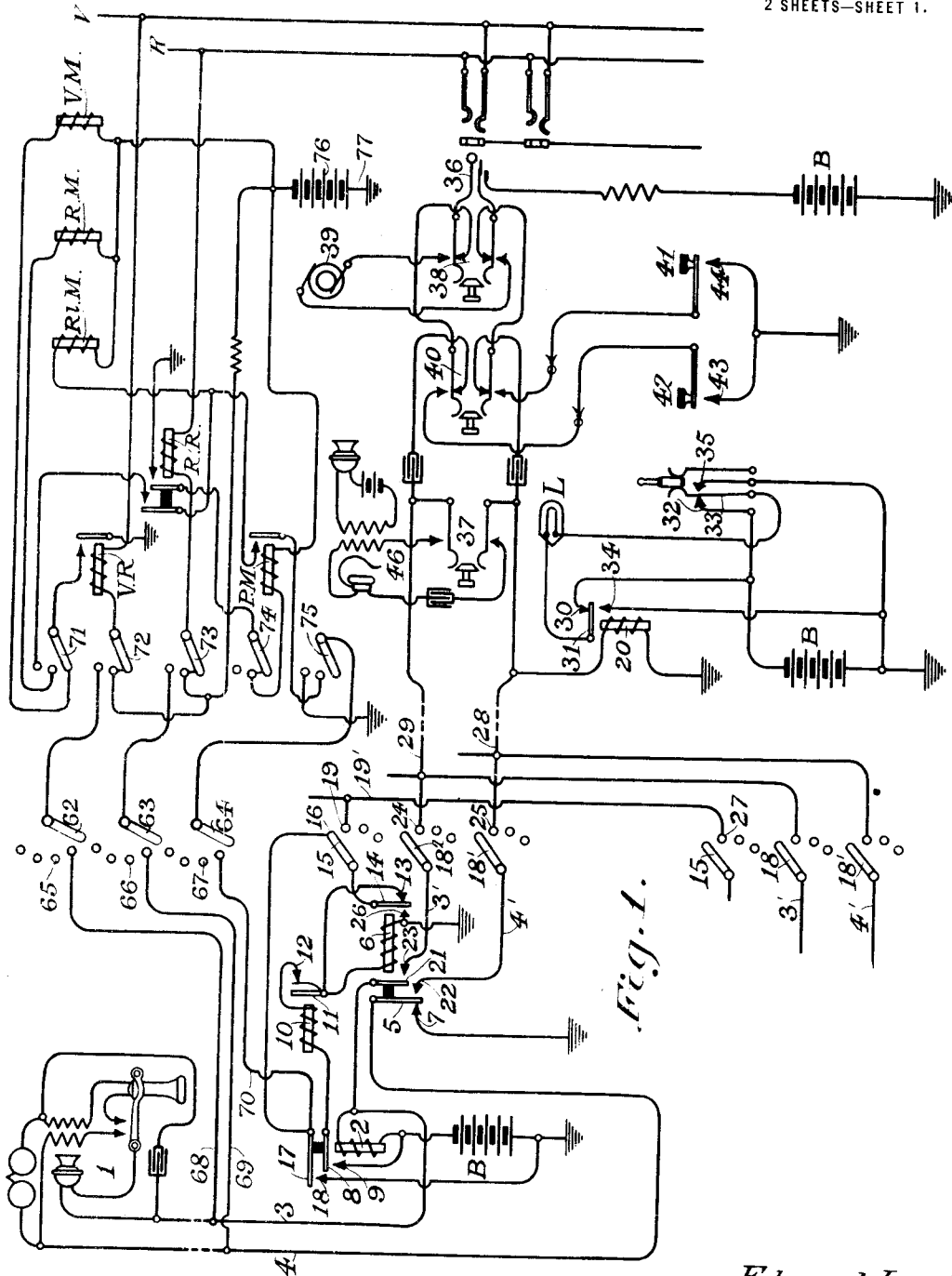


Fig. 1.

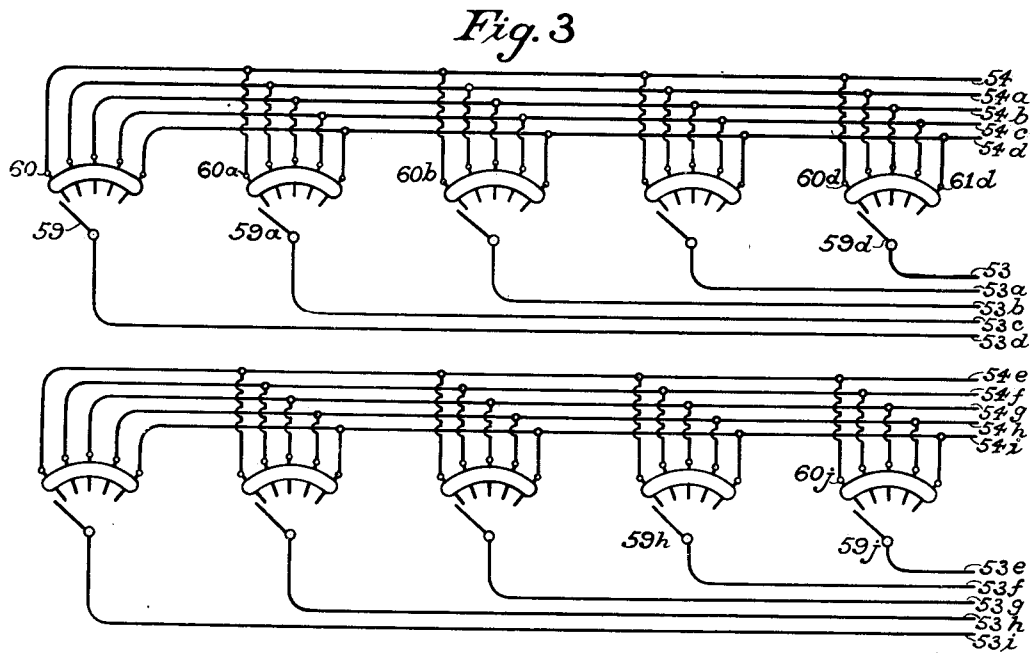
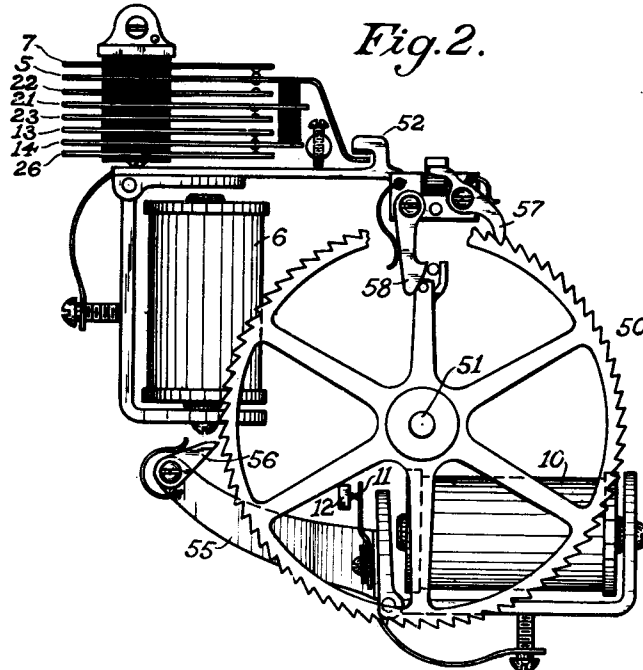
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TELEPHONE SYSTEM.
APPLICATION FILED JAN. 30, 1905.

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2 SHEETS—SHEET 2.



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UNITED STATES PATENT OFFICE.

EDMUND LAND, OF GRAND RAPIDS, MICHIGAN, ASSIGNOR, BY MESNE ASSIGNMENTS,
TO KELLOGG SWITCHBOARD & SUPPLY COMPANY, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

1,189,836.

Specification of Letters Patent.

Patented July 4, 1916.

Application filed January 30, 1905. Serial No. 243,329.

To all whom it may concern:

Be it known that I, EDMUND LAND, a citizen of the Dominion of Canada, and residing at Grand Rapids, in the county of Kent and State of Michigan, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to that class of telephone systems in which both manual and automatic switching appliances are utilized for the connecting of the lines from a subscriber's station to a central office, sometimes known as "semi-automatic" systems, and has for its object an improvement in the speed of making connections, a decrease in the expense caused by the ownership and maintenance of mechanism, with an attendant elimination of the operating disadvantages of excessive waiting on the part of the calling subscribers.

It is well known to those skilled in the telephone art that in systems utilizing manual switching equipments of the latest and most improved type, the multiple switchboard, even though of the central energy automatic signal type, possesses the great disadvantage of not permitting the total load of incoming calls from subscribers to be evenly distributed among the various operators seated before it. I recognize that effort has been made by other inventors in the direction of distributing the work to be done evenly among the operators, a notable example of such an effort being that of an inventor who arranged for changes in the terminals of the lines in the switchboard from time to time, as information might be gained with reference to their probable rates of calling. For instance, upon the establishment of a telephone exchange in a town, when only a limited number of subscribers for the service are secured, but a small switchboard will be installed, this being probably a part of a larger switchboard to be secured by extensions from time to time. It is natural that the subscribers first secured should be from among the busier industries and from among the residences of the wealthier citizens having wider social connections; and it is also the more likely that these early subscribers will retain telephone service, not dropping it through the exigencies of changing circumstance. It re-

sults, therefore, that the subscribers earliest secured and longest retained are those having the most need of the service and the greatest ability to pay for it, and that as the growth continues, by virtue of these reasons, and of the later making of lower rates attractive to the small user, a smaller and smaller calling rate per subscriber will accompany the latter conditions. As the older and busier lines are terminated on the earlier sections of the switchboard, it results that the additions will not furnish as much work per operator as the original portion, and that if the number of lines per position on the additions is not much greater than those on the earlier positions, the later operators will not work to economy. It is also true that with the growth of the exchange in total number of lines, the earlier operators having at one time a certain load at the busiest period of the day, will find that load so much increased as to eventually overburden them. These things being so, a means somewhat flexible has been devised by which, as information might be collected from time to time concerning the busier and less busy lines, there might be transpositions as to their terminal positions before the operators without causing an annoying and perhaps impossible change of the numbers by which the subscribers are known for calling purposes. But even such an improvement, important as it has been in the art, takes no account of and offers no relief in the matter of occasional rushes of business. These do occur, and are sometimes of so great a quantity as to cause local congestion in certain sections of the office. These result in a slower service to all calls in that section at that time, and occasionally in the delay in caring for certain calls. The production of good service, therefore, requires that the management provide so large an equipment, and so extensive a force of operators, as to care for the service in a satisfactory manner in even these occasional excessive though temporary rushes.

By means of my invention the investment and the corps of operators both may be kept at a reasonable minimum, amply sufficient for average work, without the necessity of providing in the form of constant expense, an insurance against temporary poor service.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 shows the circuits making up a complete connection; Fig. 2 the mechanism of the rotary switch; and Fig. 3 an arrangement of lines and trunks with relation to each other.

Referring to Fig. 1, 1 is a subscriber's telephone, being shown in these circumstances as of the central energy type adapted to receive a signal upon a bell, and to transmit one to the central office upon the removal of the receiver from its hook. In manual systems of the ordinary type, this removal of the receiver sets some form of visual signal before the operator at the particular position having a terminal for that line. In my system the removal of the receiver does other things, to the general end of setting in operation an automatic trunk selector which extends the line to such an operator as is not at the moment overburdened with work and there displays a signal.

2 is a relay adapted to be energized by current from the battery "B," through its winding over the limb 3 of the line, through the circuit of the telephone 1, to the central office over the limb 4 of the line to the armature 5 of the relay 6, and thence to ground via the contact 7. The relay 2 then effects contact of its armature 8 upon the point 9. Current will then flow from the battery "B," through this contact, through the winding of the relay 10, the contact point 12 and armature 11, through the contact of the point 13 engaging the armature 14 of the relay 6, thence to the contact wiper 15, its contact 16, from there to armature 17 of relay 2, to contact 18, and thence to opposite side of battery. The relay 6 does not receive current at this time as its winding is shunted by the direct path to ground just traced. The wiper 15 with its associated wipers 18² and 18' is mounted on a shaft more fully to be described with reference to Fig. 2. The three mentioned wipers move together in a rotary arc with this shaft, its rotary motion being accomplished by a pawl and ratchet mechanism associated with the armature 11, successive strokes of which rotate the shaft as indicated. These successive strokes will result immediately from the condition just described, as the armature 11, upon being attracted, breaks its contact with the point 12 at the end of its stroke, which stroke accomplishes the first step in the rotation of the shaft carrying the wipers. A result of such rotation is the carrying of the wiper 15 from the point 16, and if the next contact engaged by the wiper 15, as for example 19, is found to be grounded, a grounded circuit will exist and further rotation will ensue. If, however, the next contact, as 19, is found not to be grounded, the relay 10 will not execute further strokes and effect further rota-

tion as it will not be sufficiently energized through the only path for current, which is through the relay 6. In this connection it must be observed that the three batteries indicated as "B" are the same battery, and therefore the potentials of their ungrounded terminals are one and the same. I have shown them in this divided relation merely for the sake of clearness, and not with a view to indicating a plurality of sources of electric energy.

The relay 6 has a winding of much higher resistance than the relay 10, and in series with the winding of 6 the relay 10 will not be energized enough to attract its armature 11. The relay 6 will, however, be energized in series with the relay 10, so that unless the contacts successively engaged by the wiper 15 after leaving 16 are connected directly to the ground, the rotation will cease upon reaching the first one not so grounded as described. The relay 6 being so energized will attract all three of its armatures, 5, 14 and 21. The contact of 5 and 21 upon the respective points, 22 and 23, will extend the line wires 3 and 4, respectively, to the wipers 18² and 18'. Assuming that the ungrounded contact piece found by the wiper 15 is represented by 19 the extended line wires 3 and 4, will be placed upon the contact points 24 and 25, whose further path will be indicated shortly. The further act of relay 6 is to cause its armature 14 to engage the contact point 26, which is connected directly to ground. This places a ground immediately upon the wiper 15 and therefore upon the contact 19, thus placing a ground directly upon all contact pieces in other rotary switches belonging to other lines in so far as these have contact pieces connected directly to the wire 19'. As shown in this figure, the point 27 becomes so grounded as will all others connected directly to the point 19. When what has been described is considered, it will be seen that this placing of a ground upon point 27 and other similar points in other switches guards that wire and the wires of points 24 and 25 associated with 19 from the stoppage of the wipers of other rotary switches upon those points, and so effectively guards this trunk composed of wires 28 and 29 from being taken as an extension of another line while in use as an extension of the line formed of wires 3' and 4'. It will also be noted that had the contact piece 19 been previously grounded, this very condition would have caused the rotary switch to continue its onward movement until an ungrounded contact was reached and the switch thus arrested. The relay 20 was operated upon the stoppage of the rotary switch 10. The circuit which effects such operation may be traced as follows: from a grounded battery "B" through relay 2, subscriber's line 3, m-

strument 1, return line 4, armature 5 of relay 6, its forward contact 22, extension wire 4', wiper 18' contact piece 25, trunk line 28, to and through relay 20 and to ground. The operation of the armature 31 of relay 20, will make contact with point 34, thus connecting to one side of battery "B." The armature of the relay is connected in circuit with the lamp "L", which is in turn connected with spring 33 which engages spring 32; the latter being connected with the opposite side of the battery. The spring 32 and the points 33 and 35 are elements of a plug switch which is held in the position shown in Fig. 1 during the time the plug 36 is not in use, and is in its position in the shelf. The lighting of the lamp "L" will cause the operator to lift the plug 36 in readiness for making a connection and to operate her listening key 37. The lifting of the plug will extinguish the lamp "L" because the controlled spring 33 now breaks contact from 32 and makes contact with 35. The connection of the operator's telephone set 46 with the wires 28 and 29 in the key 37 enables the operator to speak to the subscriber whose signal has been given to her. Learning from him the number of the subscriber which he desires, the operator may make connection with the called line in a variety of ways, the particular method used depending upon the exact form of the other mechanism which is furnished for her use. One of these ways is to insert the plug 36, after a proper busy test has been made, directly in a jack of the called line as it appears in a multiple of the various lines before her. Another is for her to select one trunk from a number of exposed trunk jacks, the selected trunk leading to a distant office and an incoming trunk operator there, or to some division of the office in which she herself is located. Another alternative is for the plug 36 to be placed in a trunk jack associated with the trunk line leading to a selector in a properly organized automatic telephone switchboard of any existing type. Still another way is for the plug 36 to be placed in the jack of a special form of trunk distributing system as shown in my United States Letters Patent, S. N. 231,052, filed November 2nd 1904, Pat. No. 797,586.

In case it is the selection of a line in a multiple of lines, or the calling of the required subscriber over a trunk to a manual office which is desired, the provision of the ringing key 38 and the ringing generator 39 will enable the desired subscriber to be called. In case the connection is to be effected through an automatic switching equipment of, say, the widely used Strowger type, operation of the key 40 instead of the key 38 will connect the conductors of the plug 36 to the key levers 41 and 42, disconnecting

them from the line conductors 28 and 29. The levers 41 and 42 are intended to represent any suitable mechanism possessed by the operator to enable her to send signals over the trunk line for the purpose of setting up the desired connection with the called subscriber. In the automatic system to which I have referred, these connections are accomplished by successive ground contacts on two wires of the line. For instance, if the number called were 3421, the designation by the operator would be, assuming that the trunk conductors shown at the right of the sheet are respectively the "vertical" and "rotary" sides of the trunk, as they are known, three pressures on the lever 41, followed by one on 42, four on 41, followed by one on 42, two on 41, followed by one on 42, and lastly one on 41, followed by one on 42. This is exactly what happens in all four-digit connections in the system described. The key 38 controls the application of ringing current from generator 39 to the line of the called subscriber. In either of the conditions whereby the line is extended from the plug 36 to a distant called subscriber the duration of the conversation is under the complete control of the calling subscriber. This is by reason of the maintained contact of the relay 2, which in its operation has held the relay 6 energized. It will be recalled that the first act of the operation of the relay 6 was to break contact between the armature 5 and the grounded point 7, but as the conductor leading from the immediately taken point 22 has a path to ground through the relay coil 20, there is still a return path for current through the relay 2, so long as the receiver at the station 1 is not upon the hook. Current will thus flow through the telephone, providing it with energy for speech transmission, and, as stated, the relay 2 will be held through all this time. Upon the close of the conversation, however, this relay will release its armature 8, stopping further flow of current through relays 10 and 6 in series. The relay 6 will then release its armature, restoring the line to its original condition. As will be seen when more detailed reference is made to the details of mechanism of the rotary switch, the release of the armatures of the relay 6 accomplishes a further and mechanical result in that the shaft carrying the wipers 15, 18² and 18' is released to be restored to its normal position by the action of its spring. The contact engaged by the wiper 15 during conversation is therefore freed from ground by the de-energizing of relay 6 as is also the other contacts, such as 27, which have been held guarded by the existence of this ground. Restoring the switch-hook, deenergizes the relay 20, and the release of its armature 31 re-lights the lamp "L" by current from the battery "B" through the point 30, armature

31, lamp "L," spring 33, back contact 35 and to opposite side of battery. This re-lighting is a signal to the operator that the calling subscriber has hung up his receiver and released his rotary switch. The signal to remove the plug 36 from the trunk jack is therefore absolute to her, and she obeys it, returning the plug 36 to its seat, breaking the contact of the spring 33 with the point 35, extinguishing the lamp "L," and leaving all matters in readiness for the receipt of another call upon that particular trunk.

Referring to Fig. 2, the switch here shown is of the same general type as that shown in my United States Letters Patent, S. N. 231,052, filed November 2nd, 1904, Pat. No. 797,586. The switch as shown comprises the shaft 51 which carries a ratchet wheel 50. This shaft, with other parts of the switch having to do with the holding and release of the shaft 51 and with the support of the magnets 6 and 10, is supported in a base plate not shown in the drawing, and is further supported by an extension engaging the end not supported by the base plate. The magnet 10 is adapted to advance the ratchet wheel 50 by successive strokes of its armature through the agency of the extension 55 and the pawl 56. The contact point 12 by contact with the armature 11 is adapted to break the circuit of the magnet 10, as has been previously described with reference to Fig. 1. During the intervals between strokes of the armature of the magnet 10, the detent or pawl 57 holds the ratchet wheel 50 by engaging successive teeth.

The magnet 6 has been described with relation to the electrical switching which it performs, and the armatures and contacts which have to do with this switching are shown in further detail in Fig. 2. Through the agency of the arm 52 of the magnet 6 a relation is established between that magnet and the pawl 57, which is associated with the latch 58 and other parts, to the end of accomplishing a complete release of the ratchet wheel 50 from being held by the pawl 57. This release occurs only after the arm 52 has been attracted by the magnet 6 and again released at least once.

In the foregoing reference has been made to the parts 6 and 10 sometimes under the term "relay" and sometimes under the term "magnet." The distinction rests mainly upon the particular office which the electromagnetic device is performing, and this specification will be intelligible to those skilled in the telephonic art when it is understood that either term clearly describes the part under discussion.

The shaft 51 is rotated with the ratchet wheel 50 and it carries contact wipers of the type generally used in rotary switches for automatic exchange purposes. These contact wipers are adapted to engage contact

pieces arranged in circular arcs concentric with the shaft 51. Neither the contact pieces, their insulating supports, nor the contact wipers are shown in Fig. 2, as those elements of automatic switch construction are common to practically all of the various systems of automatic exchange working in telephony.

Referring now to Fig. 3, the ten conventionalized elements shown in the two portions of that figure are designed to represent in a simple manner rotary switches adaptable for use with my invention. The parts 59, 59^a, etc., to 59ⁱ, inclusive, are the respective contact wipers of rotary switches of the type shown in Fig. 2. The part 59, for example, is intended to stand for the entire group of contact wipers of a given switch. The wires 54, 54^a, etc., to 54ⁱ inclusive, are wires connecting the contact pieces in the various rotary switches, 54, for example, connecting to the points 60, 60^a, etc., to 60ⁱ, inclusive, in the various switches, so that similar contacts in various switches may be said all to be connected to each other so far as a given group of switches is concerned. The wires 53 53^a, etc., to 53ⁱ, inclusive, are the line conductors from the subscribers' telephones, each wire, as 53, being intended to represent both conductors of a line, or that line as a unit. If the subscriber using line 53 removes his telephone from its hook, the rotation of the shaft 51 of his rotary switch will cause the wipers 59^a to engage the contacts 60^a leading via the wire 54 to an operator at the switchboard. If the trunk 54 thus engaged is not already occupied in another switch by the contact wipers of another subscriber's line, the sequence following the engagement of a non-busy line will proceed as previously described. If the trunk 54 were in use by its engagement with another subscriber's line, the wipers 59^a would pass as described to some other set of contacts, as 61^a, and the line 53 would be extended over the non-busy trunk 54^a to another operator at the switchboard. If it be understood that a trunk, as 54, having its contacts in an early part of the circular arc of the rotary switches, leads to an operator's position at one end of the switchboard, that trunks, as 54^a, lead to an operator's position which is, say, the second on the switchboard, and so on, it will be seen that the first operators will have calls placed upon their trunks in preference to those operators at later sections of the switchboard, counting from that mentioned as being the first. The result of this will be that in a given amount of traffic, the operators nearer this first end of the switchboard will be given work to do to the full capacity of their trunks which appear in the rotary switches, and that for any existing traffic only a certain number of operators' groups of trunks

will be kept occupied. All operators beyond that number will be left without traffic upon which to occupy their energies. With this automatic distribution of the traffic, arrangements may be made for filling only the number of switchboard positions which experience has shown are required at a given hour of the day, and as the traffic increases or decreases, modifying that necessary number of employees as may be required.

In all the foregoing it is intended to make clear that in each rotary switch there are a number of trunk lines accessible, say sixty or more, so that the wipers in a given switch starting in a rotary search for an idle set of trunk contacts will have a strong probability of finding such a set before completing the entire arc of rotation. Further that each trunk so appearing in a given switch also appears in other switches to an extent to be predetermined. Further that it is not obligatory that each trunk appear in all the switches of an office, but only that such a number of appearances be made as will accomplish the necessities as I have outlined. Further, that the total number of trunk lines leading from the switches to the operators' positions is so subdivided among the various operators as to give each only such a number as when constantly occupied by successive conversations, will give her enough work to keep her reasonably busy.

It has been suggested that the operator may select the subscriber's line called for by means of any suitable automatic switching mechanism connected, for example, with the lines designated V R. In the upper part of the diagrammatic Fig. 1 I have shown in conventional form the circuits and relays of such a switching mechanism: this being substantially in conformity with the Strowger system and of the series type. The switch as shown is of the same general type as that shown in my United States Letters Patent S. N. 234,107 filed November 24th, 1904, Pat. No. 1,146,002. This patent shows the mechanical construction of the various parts of the automatic switch. In this part of the diagram 62, 63 and 64, respectively, designate a group of wipers connected to move together. These wipers are respectively arranged to cooperate with contacts, as 65, 66 and 67; one contact of each series 65 and 66 being connected with the corresponding limbs of the subscriber's line, while one of the others, 67, is connected with the armature 17 of the relay 2. The wipers are connected with the switching mechanism by extension conductors, as 68, 69 and 70, the latter being the private wire. The switch system referred to comprises the usual rotary magnet R M hereinbefore mentioned, vertical magnet V M, release magnet R¹ M, private magnet P M, vertical relay V R and rotary relay R R, and the several elements

of the side switch, indicated by the wipers 71, 72, 73, 74 and 75. The switch system comprises also battery and ground connections, as indicated at 76 and 77. The circuits and operation of this mechanism are well understood by those skilled in the art and need not therefore be detailed herein. It may, however, be noted that whenever the wipers 72 and 73 of the side switch have been moved into engagement with the third of their respective series of contacts the line connections will be extended from the subscriber's line through this switching mechanism to the called subscriber's line.

It is not essential to my invention that the specific circuit arrangements for the automatic connector switch as shown in Fig. 1, be used, as various other circuit arrangements may be used, such for example as shown in my hereinbefore mentioned United States Letters Patent S. N. 234,107, filed Nov. 24th, 1904, Pat. No. 1,146,002.

Should it happen that the called subscriber's line is busy, his relay 2 will, of course, be energized, and armature 17 in engagement with contact 18, which is connected directly to ground as shown. This direct connection to ground indicates that the line is busy; the "busy" test being marginal and distinguishable by the difference between the ground connection through the high wound relay 6 and the direct connection to ground.

I claim as my invention:

1. In combination with a plurality of subscribers' telephones and line circuits extending to each, a line relay connected with one of said subscribers' lines, a source of electrical energy, a relay-controlled motor, a switch mechanism operable by the motor, a series of trunk lines selectable by said switch mechanism, each terminating in a connection device, an operator's cord circuit including means for connecting it with said connection device, a manually-controlled permutation-switch mechanism accessible to the exchange operator, and an automatic switch connecting said last mentioned switch mechanism with a plurality of subscribers' lines.

2. In combination with a plurality of subscribers' telephones and line circuits extending to each, a line relay connected with one of said subscribers' lines, a source of electrical energy, a motor controlled by said line relay, a switch mechanism operable by said motor, a series of trunk lines selectable by said switch mechanism each terminating in a connection device and the several trunk lines terminating at various operators' positions, a plurality of operators' cord circuits, each including means for connecting it with a corresponding trunk line, a manually-controlled permutation-switch mechanism accessible to one or more of the operators, and

an automatic switch connecting said last mentioned switch mechanism with a plurality of subscribers' lines.

3. In combination with a plurality of subscribers' telephones and line circuits extending to each, a line relay connected with one of said subscribers' lines, a source of electrical energy, a motor controlled by said line relay, a switch mechanism operable by said motor, a series of trunk lines selectable by said switch mechanism each terminating in a connection device and the several trunk lines terminating at various operators' positions, a plurality of operators' cord circuits, each including means for connecting it with a corresponding trunk line, a manually-controlled permutation-switch mechanism accessible to one or more of the operators, and an automatic switch connecting said last mentioned switch mechanism with a plurality of subscribers' lines, said switch including test lines and means operable to indicate a "busy" condition of the called subscriber's line, when the latter is busy.

4. In combination with a plurality of subscribers' telephones and line circuits extending to each, a line relay connected with each of said subscribers' lines at the exchange station, a source of electrical energy, a relay-controlled motor accessible to each subscriber's line, a switch mechanism operable by each such motor, a series of trunk lines selectable by each switch mechanism and each terminating in a connection device, an operator's cord circuit including means for connecting it with a corresponding trunk line, a manually-controlled permutation-switch mechanism including means for connection therewith of the operator's cord circuit, and circuit connections including an automatic switch connecting said permutation-switch mechanism with a group of subscribers' lines.

5. In combination with a plurality of subscribers' telephones and line circuits extending to each, a line relay connected with each of said subscribers' lines at the exchange station, a source of electrical energy, a relay-controlled motor accessible to each subscriber's line, a switch mechanism operable by each such motor, a series of trunk lines selectable by each switch mechanism and each terminating in a connection device, an operator's cord circuit including means for connecting it with a corresponding trunk line, a manually-controlled permutation-switch mechanism including means for connection therewith of the operator's cord circuit, and circuit connections including an automatic switch connecting said permutation-switch mechanism with a group of subscribers' lines, said automatic switch including a test line extending to and controlled by the corresponding line

relay of each line, whereby the condition of the line is indicated when it has been taken.

6. In combination, a subscriber's telephone, a subscriber's line circuit normally extending from ground at the exchange station over one limb of the line to the subscriber's set and back to ground at the exchange station over the other limb, said line being normally interrupted at the subscriber's station, a source of current associated with the subscriber's line, a line relay at the exchange station included in the subscriber's line circuit and operable upon closing of the circuit at the sub-station, a motor relay controlled by said line relay, a switch mechanism operable by said motor relay, a plurality of trunk lines selectable by said switch mechanism, a subsidiary relay connected in a divided line branch of the circuit extending through the motor relay and of higher resistance than the latter, so as to be operable upon the selection of an idle trunk, switching devices controlled by said subsidiary relay and operating to remove the ground from one limb of the calling subscriber's line and to extend the subscriber's line to the trunk selected, an operator's cord system, means for connecting said cord system with a corresponding trunk line, a plurality of other subscribers' telephones and line circuits for each, and means including an automatic switch enabling the operator to connect her cord system with a called subscriber's line.

7. In combination, a plurality of subscribers' telephones and line circuits extending to each, a source of current associated with each subscriber's line, a line relay at the exchange station included in the subscriber's line circuit and operable upon closing of the circuit at the substation, a motor relay controlled by said line relay, a switch mechanism operable by said motor relay, a plurality of trunk lines selectable by said switch mechanism, an operator's cord circuit adapted for connection with a trunk, a manually-controlled permutation-switch system accessible for connection including an automatic switch with said cord circuit, circuit connections between said permutation-switch system and the several subscribers' line circuits, said automatic switch including test lines extended to and connected with circuit connections severally controlled by the line relays, for the purpose set forth.

8. In a telephone exchange system, the combination with telephone lines extending from sub-stations to an exchange, of a plurality of cord connectors at the exchange, each including a manually operated terminal plug at one end of the cord circuit, a traveling switching appliance at the other end of the cord circuit and constituting a

line terminal, a plurality of contacts for the plurality of cord circuits, with any of which the traveling terminal may make contact, means controlled by a subscriber for governing the traveling switching appliance to connect his line with a cord circuit, and means including an automatic switch for extending connection from said terminal plug to a called line.

9. In a telephone exchange system, the combination with a group of telephone lines extending from sub-stations to an exchange, of a plurality of cord connectors at the exchange, each including a manually operated terminal plug at one end of the cord circuit and having a traveling switch at the other end of the cord circuit and means serving to arrest the operation of a traveling switch and cause it to connect a cord circuit with the telephone line of a calling subscriber, a signal at the exchange controlled by said subscriber's apparatus to indicate the fact of his connection with a cord circuit, and means including an automatic switch for extending connection from said terminal plug to a called line.

10. In a telephone system a subscriber's telephone line, a selective switch associated therewith, a multiple switchboard having a plurality of operators' positions, selecting contacts for said selective switch normally disconnected from said line, stationary contacts for said selective switch, a series of trunk lines leading from said stationary contacts to several of the positions on said multiple switchboard, means for causing said selective switch to automatically move said selecting contacts into engagement with the stationary contacts of the first idle trunk line of said series, means for simultaneously connecting said selecting contacts with said subscribers' lines, and means including an automatic switch for extending a connection from a selected trunk to a called line.

11. In a telephone exchange system, the combination with a group of telephone lines extending from sub-stations to an exchange, of a plurality of link connectors at the exchange, each including a manually operated terminal at one end of the link circuit and having a traveling switch at the other end of the link circuit, means serving to arrest the operation of a traveling switch and cause it to connect a link circuit with the telephone line of a calling subscriber, and means including an automatic switch for extending connection from said manual terminal to a called line.

12. A telephone exchange system, including telephone lines extending from stations to an exchange, link circuits for uniting telephone lines in conversation, signal devices associated with said link circuits and operable by apparatus at said stations, automatic

selecting mechanism for connecting the answering ends of said link circuits interchangeably with different telephone lines, manually manipulated terminals for said link circuits serving automatically to change the indication of said signal devices, and means including automatic switches for extending connections from said terminals.

13. A telephone exchange system, including telephone lines extending from stations to an exchange, call signal devices at the exchange, automatic selecting mechanism for interchangeably associating said call signal devices with different telephone lines, link circuits having manually manipulated terminals serving to change the circuits of the signal devices to alter their indications, and means including automatic switches for extending connections from said terminals.

14. A telephone system including telephone lines, an automatic switch connected with each of said lines, multiplied waiting contacts in each switch adapted for selection thereby, means whereby each actuation of a switch to select idle contacts causes the contacts of said switch to be engaged in the same succession until an idle contact is reached, manually operated terminals and trunks, one connecting each terminal with contacts in all said switches, and automatic means controlled from said trunks for extending connections to called lines.

15. A telephone system comprising a plurality of telephone lines, a trunk line extending to an operator's position, a call signal individual to said trunk line operable from a calling substation, and automatic selecting and connecting switches for completing a connection to a called line.

16. A telephone system comprising a plurality of telephone lines, an operator's trunk, an automatically controlled switch at one end of said trunk to connect with a calling line, and selecting and connecting switches at the other end of said trunk to connect with called lines.

17. In a telephone system, a calling line, a trunk circuit provided with a calling signal, automatic means controlled from the calling substation for connecting said line to said trunk circuit and for operating said signal, and automatic means for extending a call from said trunk circuit, said automatic means being controlled from the central office.

18. A telephone system comprising telephone lines, operators' trunk circuits, selective switches controlled from calling substations to connect said circuits with calling lines, and electrically operated selective switches controlled by the operators to connect said circuits with called lines.

19. A telephone exchange system comprising telephone lines, operators' trunk circuits,

automatic means for extending connection from calling lines to said operators' trunk circuits, and automatic means for extending connections from said trunk circuits to called lines.

20. In a telephone system, a calling subscriber's line provided with an individual switch, trunk lines terminating at an operator's position, an automatic connector switch, means controlled by the calling subscriber for operating said individual switch to select an idle one of said operators' trunks, and means controlled by an operator for operating said automatic connector switch to extend a connection in the direction of a called line.

21. A telephone exchange system comprising telephone lines, trunks at the exchange for connecting said lines, call signals for said trunks common to a plurality of lines and operable from the substations thereof, and electrically controlled selective switches controlled from the exchange to connect with called lines.

22. A telephone exchange system comprising subscriber's lines, operators' trunk circuits, automatic means controlled by calling subscribers for extending connections to said operators' trunk circuits, and automatic electrically controlled switches controlled by operators for extending connections from said trunk circuits in the direction of called lines.

23. A telephone exchange system comprising a plurality of lines, an operator's trunk adapted for connection to said lines, a call signal for said trunk common to said lines adapted to be operated from a substation, and automatic selective and connective switches for extending a connection in the direction of the called line.

24. A telephone system comprising telephone lines, operators' trunk circuits, call signals for said trunk circuits, automatic means controlled by calling subscribers for connecting calling lines to said trunk circuits and for operating said call signals, automatic means controlled from the exchange for extending connections to called lines, and means controlled by said calling subscribers for disconnecting their lines from said trunk circuits.

25. A telephone system comprising a plurality of telephone lines, a trunk line extending to an operator's position and terminating in a plug, a call signal individual to said trunk operable from a calling substation, an automatic switch terminating in a jack, manual means for connecting said plug to said jack, and operator controlled means for operating said automatic switch.

26. In a telephone system, a calling line, an operator's trunk circuit, automatic means for connecting and disconnecting said line and said trunk circuit, said automatic means being controlled from the substation of said

calling line, and automatic means for extending a connection from said trunk circuit.

27. A telephone system including a plurality of lines, an operator's trunk having an automatic switch at one end to connect it with a calling line, automatic selecting and connecting switches associated with the other end of said trunk, and operator's controlling means intermediate said trunk for controlling said automatic switches.

28. In a telephone system, a calling line, an operator's trunk circuit provided with a call signal, automatic means controlled from the said calling line for connecting with said trunk circuit to operate said signal and for disconnecting from said trunk line for again operating said signal, and automatic means controlled from the central office for extending a connection.

29. A telephone exchange system comprising telephone lines, linking trunks for interconnecting calling and called lines, switches associated with said trunks, means under the control of a calling party for actuating one of said connecting switches to establish connection between his line and one end of a trunk, means under the control of an operator for actuating another connecting switch for extending the circuit of said calling line beyond said trunk.

30. A telephone exchange system comprising telephone lines, linking trunks for interconnecting calling and called lines, connecting switches associated with said trunks, means under the control of a calling party for actuating one of said connecting switches to establish connection between his line and one end of a trunk, means under the control of an operator for actuating other connecting switches to complete a connection between the other end of the said trunk and the called line.

31. A telephone exchange system comprising telephone lines, linking trunks for interconnecting calling and called lines, switches associated with said trunks, means under the control of a calling party for actuating one of said connecting switches to establish connection between his line and one end of one of the trunks, means under the control of an operator for actuating another connecting switch for extending the circuit of said calling line beyond said trunk, and a centralized source of operating and talking current.

32. A telephone exchange system comprising telephone lines, linking trunks for interconnecting calling and called lines, connecting switches associated with said trunks, means under the control of a calling party for actuating one of said connecting switches to establish connection between his line and one end of one of the trunks, means under the control of an operator for actuating other of the connecting switches to complete a con-

nection between the other end of the said trunk and a called line, and a centralized source of operating and talking current.

33. A telephone exchange system comprising telephone lines, trunks for interconnecting calling and called lines, a trunk selecting switch having access to a plurality of trunks, means under the control of a calling party for actuating said trunk selecting switch to establish connection between his line and an idle one of said trunks, other switches, and means under the control of an operator for actuating said other switches to extend the circuit of said selected trunk to include a desired called line.

34. A telephone exchange system comprising a calling subscriber's line, an automatic switch individual thereto, an operator's trunk circuit, means controlled from the said calling line for controlling the connection and disconnection of said trunk circuit with the said automatic switch, an automatic switch for connecting to a called line, and means controlled by an operator for operating said automatic switch to extend the connection to the called line.

35. A telephone system comprising a plurality of lines, a plurality of trunk circuits, automatic means for interconnecting said lines and said trunk circuits, and automatic means associated with said trunk circuits and controlled by a central office operator for extending connections from the said trunk circuits.

36. In a telephone system, a calling line, an automatic switch individual thereto, an operator's trunk circuit terminating in a plug terminal, means controlled from said calling line for operating said automatic switch to connect with said trunk circuit, an automatic connector switch terminating in a jack terminal adapted to receive the plug terminal of said trunk, and means controlled from the central office for operating said automatic connector switch for extending connection in the direction of a called line.

37. In a telephone exchange system, a plurality of telephone lines, trunk circuits, an automatic connector switch, means for automatically extending a call from a calling line to an idle one of said trunk circuits, manual means for connecting said trunk circuit to said automatic connector switch, and means for operating said automatic connector switch to extend connection to a called subscriber's line.

38. A telephone system comprising a calling subscriber's line, a trunk selecting switch individual thereto, operators' trunk circuits, electrically operative automatic switches, means controlled by said calling subscriber for operating said individual switch for connecting with an idle one of said trunk circuits, manual means for con-

necting the selected trunk circuit to one of said automatic switches, and means for controlling said automatic switch.

39. In a telephone system, a subscriber's line, a plurality of trunk circuits, automatic selective switches, means for automatically connecting said lines to idle trunk circuits, manual means for connecting trunk circuits to said automatic switches, and apparatus associated with said trunk circuits for operating the said automatic switches.

40. A telephone system comprising a plurality of subscribers' lines, operators' trunk circuits and automatic selective switches, automatic means for connecting a calling one of said lines to an idle one of said trunks, manual means for connecting the said connected trunk to one of said automatic switches, and apparatus at the exchange for controlling the operation of said automatic switches.

41. A telephone system comprising a plurality of telephone lines, operators' trunk circuits and automatic selective switches, automatic means for extending a calling one of said lines to an idle one of said trunk circuits, and operator controlled means for operating one of said selective switches to complete the connection to the line of a called subscriber.

42. A telephone system including telephone lines extending from substations to an exchange, trunk circuits, automatic switches for interconnecting the said lines and said trunk circuits, and operator controlled means associated with said trunk circuits for automatically extending connections to the line of a called subscriber.

43. In a telephone system, a plurality of telephone lines, a plurality of trunk circuits, automatic means for connecting said telephone lines to idle ones of said trunk lines, and operator controlled means for extending connections from selected trunks to called lines.

44. In a telephone system, a plurality of telephone lines, a plurality of trunk circuits terminating in a switchboard, automatic means for connecting calling ones of said lines to idle ones of said trunk circuits, and operator controlled means for automatically extending a connection from a selected one of said trunks to a called one of said lines.

45. A telephone system comprising telephone lines, connecting trunks, connecting switches associated with said trunks and operative to link them together to complete a circuit between a calling line and a called line, means under the control of a calling party for actuating one of said connecting switches to form a portion of said circuit, and means under the control of an operator for actuating other connecting switches to complete said circuit.

46. A telephone exchange system comprising

- ing telephone lines, linking trunks for inter-
connecting calling and called lines, connect-
ing switches associated with said trunks,
means under the control of a calling party
5 for actuating one of said connecting switches
to establish connection between his line and
one end of one of said trunks, means under
the control of an operator for successively
actuating other connecting switches to ex-
10 tend the circuit of said trunk, link by link,
to the called line.
47. In a telephone system, a plurality of
subscribers' lines, a plurality of operators'
trunk circuits, non-numerical switches for
15 interconnecting said lines and said trunk
circuits, operator controlled numerical auto-
matic switches for extending connections
from said trunk circuits to called subscribers'
lines.
48. In a telephone system, a calling sub-
20 scriber's line, a switch individual thereto, a
plurality of trunks terminating in different
operators' positions, means controlled over
the two sides of the calling line in series for
25 operating said individual switch for extend-
ing connection to an idle one of said trunks,
and automatic means for extending a call
from the selected trunk to the line of a called
subscriber.
49. In a telephone system, a calling sub-
30 scriber's line provided with a non-numerical
individual switch, a plurality of trunk lines
leading to different operators' positions, an
automatic connector switch associated with
35 said trunks, means controlled from the sub-
station of the calling line for operating said
individual switch to select an idle one of
said trunks, operator controlled means for
extending connection from a selected trunk
40 to said automatic switch, and means for op-
erating said automatic switch to extend con-
nection in the direction of a called subscriber.
50. In a telephone system, a subscriber's
line, a progressively movable step-by-step
45 trunking switch individual thereto provided
with only three magnets, a plurality of trunk
lines extending to an operator's board, means
for operating said switch to select an idle
one of said trunk lines, and means for ex-
50 tending connections from said operator's
board to the line of a called subscriber.
51. In a telephone system, a subscriber's
line extending from a substation to a tele-
phone exchange, a step-by-step switch indi-
55 vidual thereto provided with only three op-
erating magnets, trunk lines, means con-
trolled by the removal of the receiver at the
said substation for operating said auto-
matic switch to selectively pick out an idle
60 one of said trunk lines, and automatic means
for extending connection from said trunk
line, said means being controlled from the
central office.
52. In a telephone system, a subscriber's
line, a step-by-step motor driven trunk se- 65
lecting switch individual thereto for auto-
matically selecting an idle trunk line leading
to an operator's position, and automatic
means for extending a call from said op-
erator's position beyond said trunk line. 70
53. In a telephone system, a calling sub-
scriber's line, a non-numerical progressively
movable step-by-step trunking switch indi-
75 vidual thereto provided with only three mag-
nets, a plurality of trunk lines terminating
in an operator's position, means controlled
over the two sides of the said calling line
for operating said switch to connect with an
idle one of said trunk lines, and means for
80 disconnecting said automatic switch from
said selected trunk line.
54. In a telephone system, a subscriber's
line, a step-by-step motor driven switch indi-
vidual thereto provided with only three
85 wipers, a pair of line wipers and a test wiper,
trunk lines leading to an operator's posi-
tion, and means for operating said switch
to automatically pick out an idle one of said
trunk lines.
55. A telephone system comprising a plu- 90
rality of telephone lines, a trunk line ex-
tending to an operator's position, a call sig-
nal individual to said trunk line operable
from a calling substation, automatic select-
ing and connecting switches for completing 95
a connection to a called line, and a central-
ized source of operating and talking cur-
rent.
56. A telephone system comprising a plu-
rality of telephone lines, an operator's trunk, 100
an automatically controlled switch at one
end of said trunk to connect with a calling
line, selecting and connecting switches at
the other end of said trunk to connect with
called lines, and a centralized source of op- 105
erating and talking current.
57. In a telephone system, a calling sub-
scriber's line provided with an individual
switch, trunk lines terminating at an op-
erator's position, an automatic connector 110
switch, means controlled by the calling sub-
scriber for operating said individual switch
to select an idle one of said operator's trunks,
means controlled by an operator for operat-
ing said automatic connector switch to ex- 115
tend a connection in the direction of a called
line, and a centralized source of operating
and talking current.
58. In a telephone system, a calling line,
an operator's trunk circuit, automatic 120
means for connecting and disconnecting said
line and said trunk circuit, said automatic
means being controlled from the substation
of said calling line, automatic means for
extending a connection from said trunk cir- 125
cuit, and a centralized source of operating
and talking current.
59. A telephone exchange system compris-

ing telephone lines, linking trunks for interconnecting calling and called lines, connecting switches associated with said trunks, means under the control of a calling party
 5 for actuating one of said connecting switches to establish connection between his line and one end of a trunk, means under the control of an operator for actuating other electromagnetically controlled automatic connect-
 10 ing switches to complete a connection between the other end of the said trunk and the called line, and a centralized source of operating and talking current.

60. In a telephone system, a calling line,
 15 an automatic switch individual thereto, an operator's trunk circuit terminating in a plug terminal, means controlled from said calling line for operating said automatic switch to connect with said trunk circuit, an
 20 automatic connector switch terminating in a jack terminal adapted to receive the plug terminal of said trunk, means controlled from the central office for operating said automatic connector switch for extending
 25 connection in the direction of a called line, and a centralized source of operating and talking current.

61. In a telephone system, a subscriber's line, a progressively movable step-by-step
 30 trunking switch individual thereto provided with only three magnets, a plurality of trunk lines extending to an operator's board, means for operating said switch to select an idle one of said trunk lines, means for extend-
 35 ing connections from said operator's board to the line of a called subscriber, and a centralized source of operating and talking current.

62. In a telephone system, a calling sub-
 40 scriber's line, a non-numerical progressively movable step-by-step trunking switch individual thereto provided with only three magnets, a plurality of trunk lines termi-
 45 nating in an operator's position, means controlled over the two sides of the said calling line for operating said switch to connect with an idle one of said trunk lines, means
 50 for disconnecting said automatic switch from said selected trunk line, and a centralized source of operating and talking current.

63. In a telephone system, a subscriber's line, a step-by-step motor driven switch individual thereto provided with only three
 55 wipers, a pair of line wipers and a test wiper, trunk lines leading to an operator's position, means for operating said switch to automatically pick out an idle one of said trunk lines, and a centralized source of op-
 60 erating and talking current.

64. In a telephone system, a calling sub-
 scriber's line, a plurality of operators' trunks, an impulse transmitting device for controlling automatic switches associated

with said trunks, automatic means for con- 65
 necting an idle one of said trunks to said calling line, and means for connecting said device to said connected trunk

65. In a telephone system, a calling sub-
 scriber's line provided with an individual 70
 selective switch, a group of operator's trunk circuits, an operator's impulse sending device for controlling automatic switches as-
 sociated with said trunk circuits, means con-
 75 trolled over the two sides of the calling line in series for operating said selective switch to connect said calling line with an idle one of said trunks, and means for connecting
 said device to said selected trunk.

66. In a telephone system, a calling sub- 80
 scriber's line, a plurality of operators' trunk circuits, a calling device adapted to be connected to any of said trunk circuits, auto-
 matic means for connecting said calling sub-
 scriber's line with one of said trunk circuits, 85
 and means controlled by said calling device for extending a connection to a called sub-
 scriber's line.

67. A telephone system comprising call-
 ing subscribers' lines, operators' trunks, 90
 called subscriber's lines, automatic means for interconnecting said calling subscribers' lines and said trunks, and automatic means
 controlled by an operator for interconnect-
 ing the said operators' trunks and said called 95
 subscribers' lines.

68. A telephone system comprising calling
 subscribers' lines, operators' trunks, called
 subscribers' lines, automatic means for in-
 100 terconnecting said called subscribers' lines and said trunks, automatic means controlled by an operator for interconnecting the said
 operators' trunks and said called subscribers' lines, and a centralized source of operating
 105 and talking current.

69. In a telephone system, a calling sub-
 scriber's line, a switch individual thereto, an
 operator's trunk circuit, means responsive to
 the removal of the receiver at the subscrib-
 er's substation for operating said switch to 110
 connect said line to said trunk circuit, and automatic means controlled by an operator
 for extending a connection from said trunk
 to the line of a called subscriber.

70. In a telephone system, a calling sub- 115
 scriber's line, a plurality of operators' trunk circuits, means responsive to the removal of the receiver at the calling subscriber's sub-
 station for connecting his line to an idle
 one of said trunk circuits, and automatic 120
 means controlled by an operator for extending connections from a connected trunk
 circuit to a called subscriber's line.

71. A telephone system comprising a sub-
 scriber's line, an automatic switch individ- 125
 ual thereto provided with only three wipers, a pair of line wipers and a test wiper,
 trunk lines leading to an operator's posi-

tion, and means controlled over the subscriber's line for operating said switch to automatically pick out an idle one of said trunks.

72. A telephone system comprising a subscriber's line, an electromagnetically driven step-by-step trunking switch individual thereto provided with only three magnets, trunk lines, means for operating said switch to select an idle one of said trunk lines, and means for extending the connection from said selected trunk line to the line of a called subscriber.

73. In a telephone system, a subscriber's line extending from a substation to a telephone exchange, an electromagnetically driven step-by-step switch individual thereto provided with only three operating magnets, trunk lines, means controlled over the said subscriber's line for operating said automatic switch to selectively pick out an idle one of said trunk lines, and means for extending a connection from said selected trunk line to a called subscriber's line.

74. In a telephone system, a subscriber's line extending from the substation to an exchange, a switch individual thereto provided with only three operating magnets and with only three wipers, trunk lines, means controlled by the removal of the receiver at the substation for operating the said automatic switch to selectively pick out an idle one of said trunk lines, and means for extending connection from said selected trunk lines.

75. A telephone system comprising a subscriber's line, an electromagnetically driven step-by-step switch individual thereto provided with only three wipers, a pair of line wipers and a test wiper, operators' trunk lines terminating in bank contacts accessible to said wipers, means for moving said wipers over said bank contacts, means for preventing the operative connection of said subscriber's line to said line wipers until an idle one of said trunk circuits is selected, and a centralized source of operating and talking battery.

76. In a telephone system, a subscriber's line, an automatic step-by-step switch individual thereto provided with only three wipers, a pair of line wipers and a test wiper, operators' trunk lines terminating in the bank contacts of said switch, means for advancing said wipers over said bank contacts, means for releasing said wipers from an advanced position, and means for prevent-

ing the operative connection of said line wipers to said subscriber's line during the advance and the release of said automatic switch.

77. A telephone system including a calling telephone line and a called telephone line, operators' trunk circuits, automatic means for extending a connection from said calling line to an idle one of said operators' trunk circuits, and automatic means for extending a connection from said selected trunk circuit to said called subscriber's line.

78. A telephone system including a subscriber's line, a step-by-step motor driven switch individual thereto provided with only three wipers, said wipers being a pair of line wipers and a test wiper, trunk lines extending to a manual switchboard, and means for operating said switch to automatically pick out an idle one of said trunk lines.

79. A telephone system including a subscriber's line, an automatic switch individual thereto provided with only three wipers, said wipers being a pair of line wipers and a test wiper, trunk lines extending to a manual switchboard, and means controlled over the two sides of the subscriber's line in series for operating the said switch to pick out an idle one of said trunk lines.

80. A telephone system including a subscriber's line, an electromagnetically driven step-by-step trunking switch individual thereto provided with only three magnets, trunk lines, means controlled over the subscriber's line for operating the said magnets whereby said switch operates to select an idle one of said trunk lines, and means for extending connection from a selected trunk line to the line of a called subscriber.

81. A telephone system including a subscriber's line extending from a substation to a central exchange, an electromagnetically driven step-by-step switch individual thereto provided with only three operating magnets, trunk lines, means controlled over the two sides of the said subscriber's line in series for operating the said magnets whereby said switch operates to selectively pick out an idle one of said trunk lines, and means for extending a connection from the selected trunk line to a called subscriber's line.

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