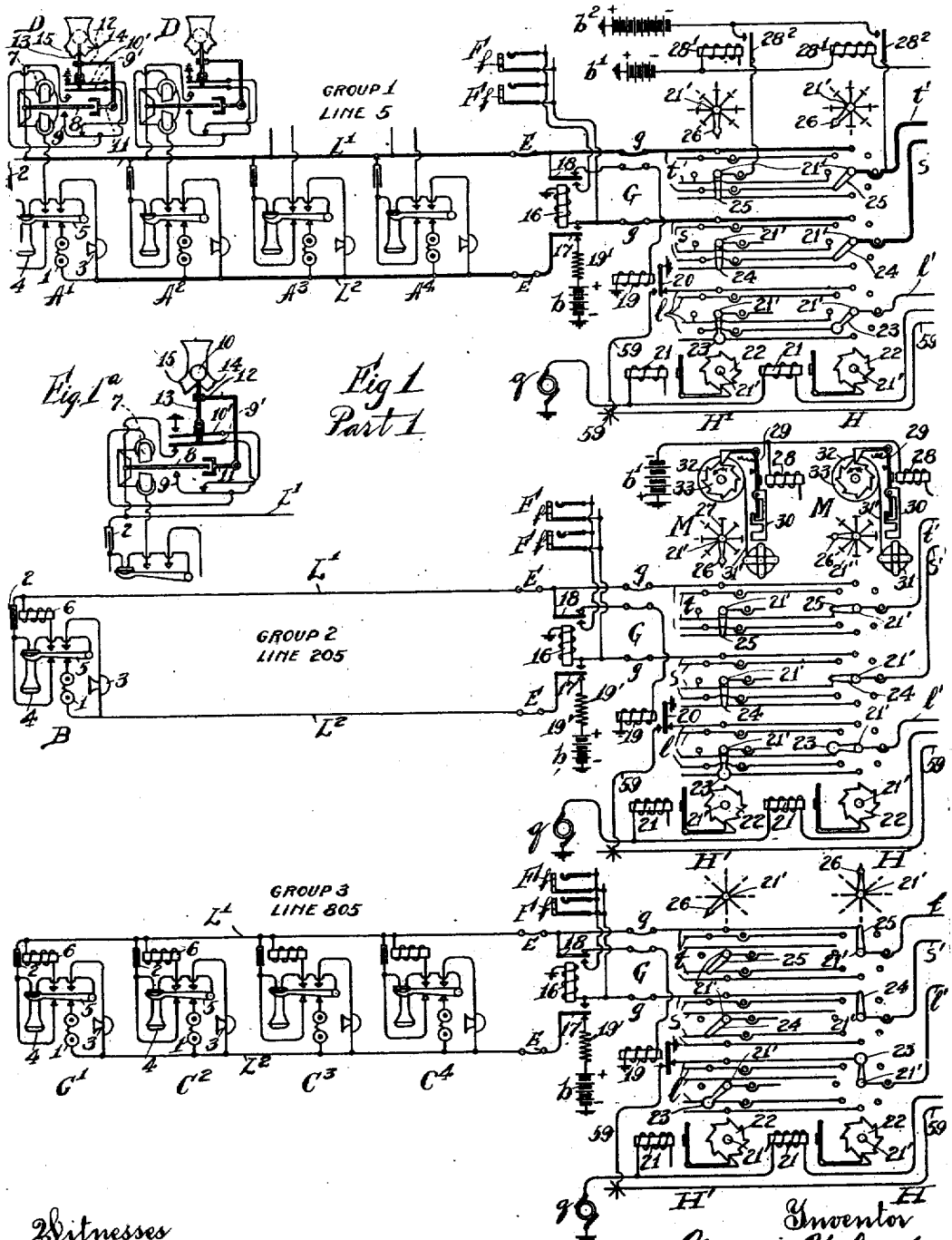


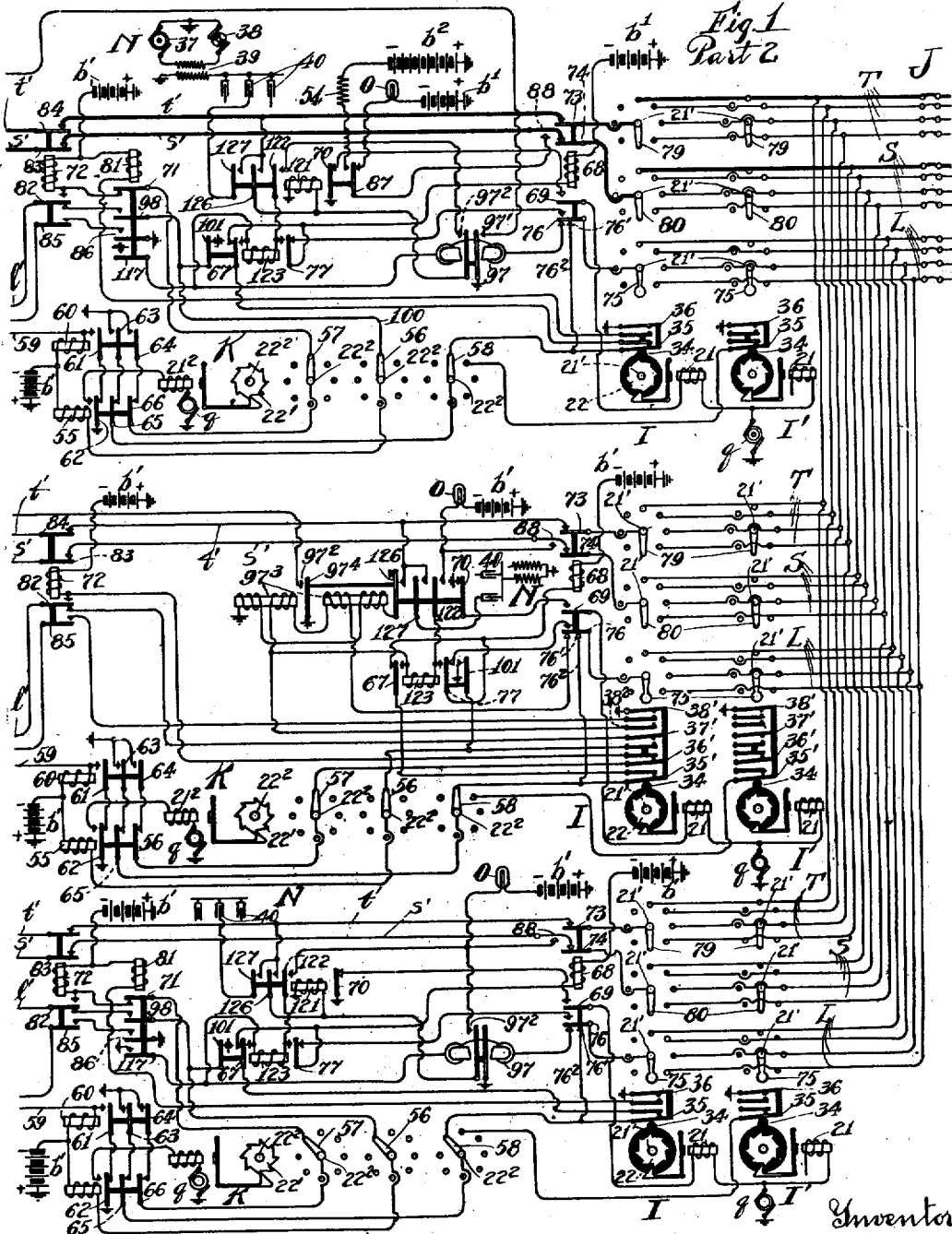
1,133,113.



Witnesses
Geo. E. Mueller.
H. C. Christie.

Inventor
Francis W. Dunbar
by Thomas A. Ferguson
Attorney

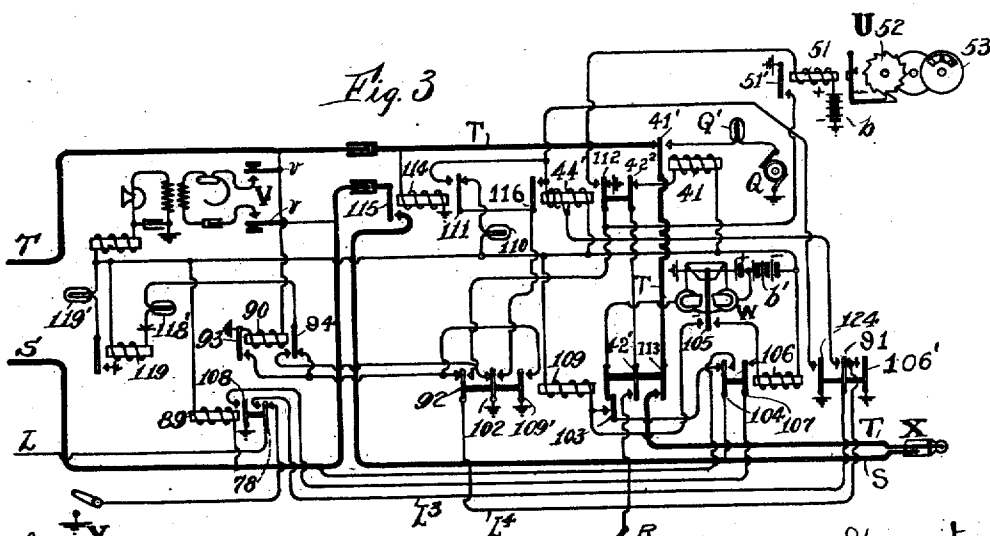
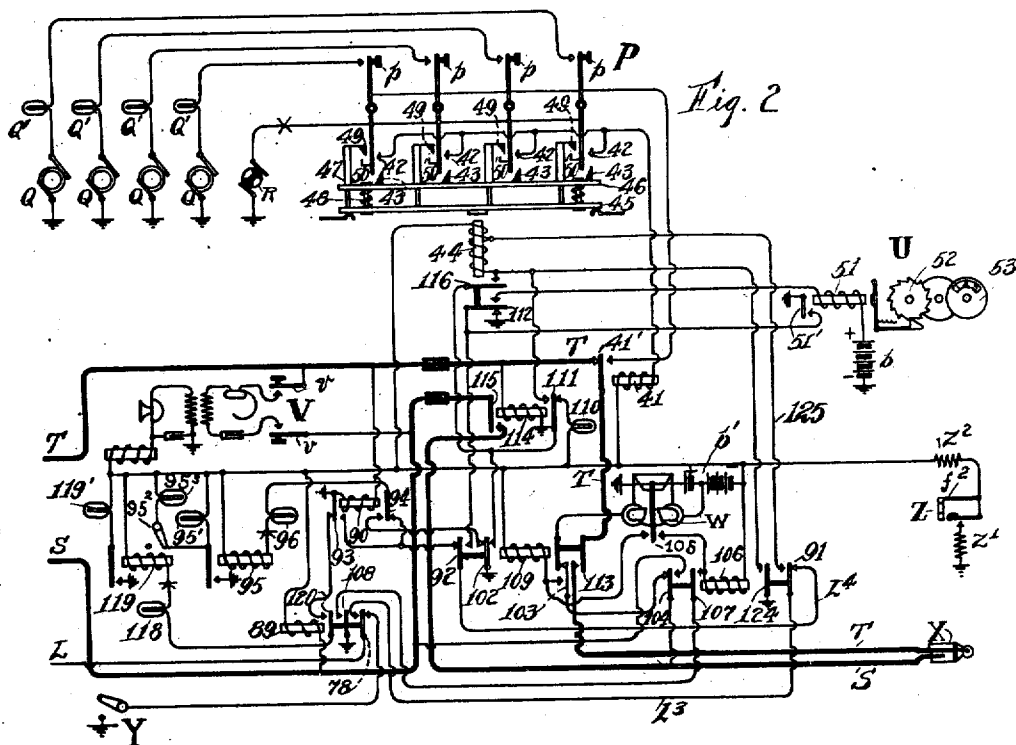
1,133,113.



Witnesses
Geo. C. Mueller.
H. C. Olmsted.

Inventor
Francis W. Dunbar
by Thomas H. Ferguson
Attorney

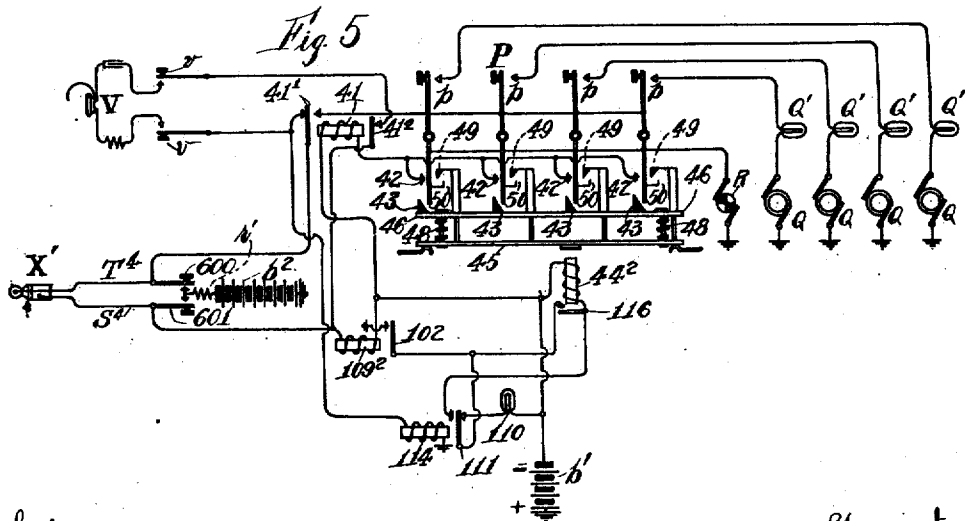
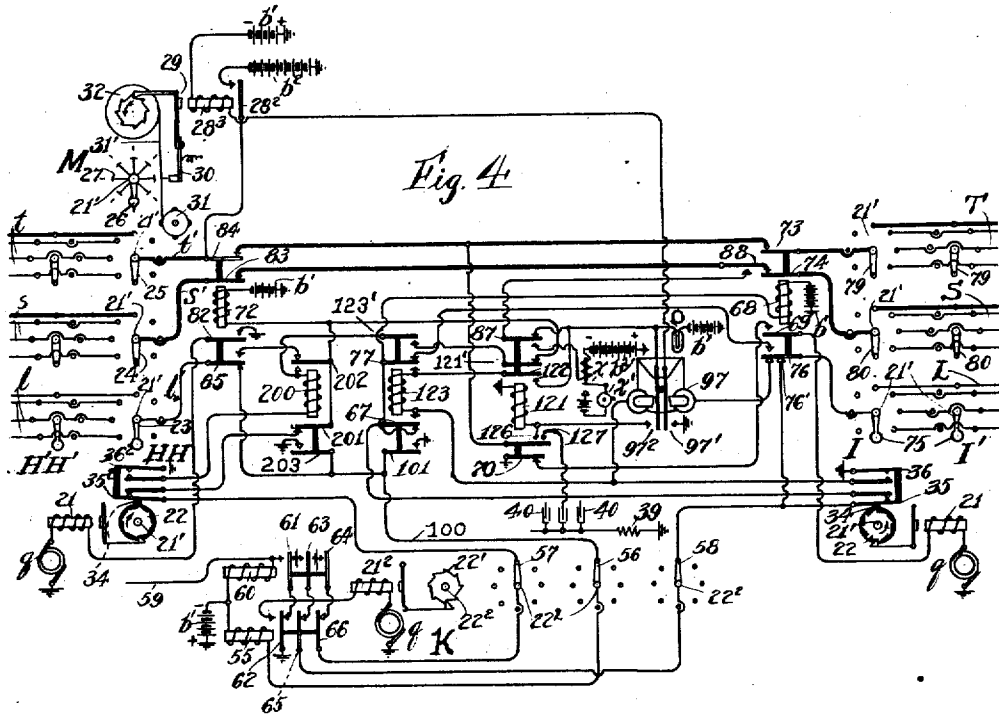
1,133,113.



Witnesses
Geo. E. Mueller.
H. C. Okmstead

Inventor
Francis W. Dunbar
by Thomas H. Ferguson
Attorney

1,133,113.

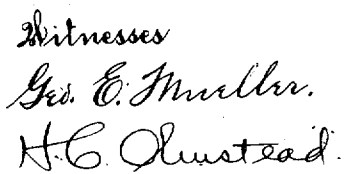


Witnesses
Geo. C. Mueller.
H. C. Olmstead.

Inventor
Francis W. Dunbar
by Thomas H. Ferguson
Attorney

1,133,113.

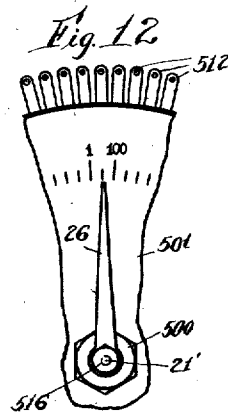
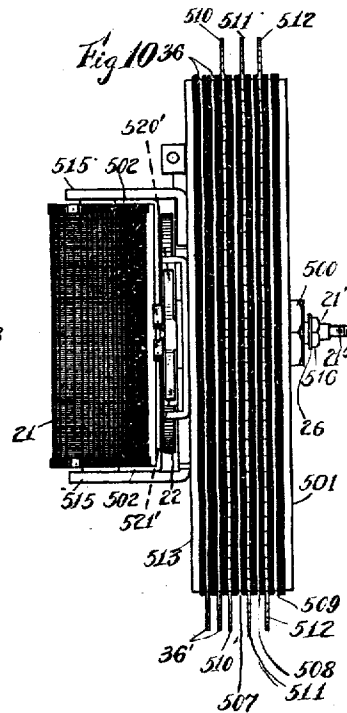
7 SHEETS—SHEET 5.



Inventor
Francis W. Oumbar
by Thomas H. Ferguson
Attorney

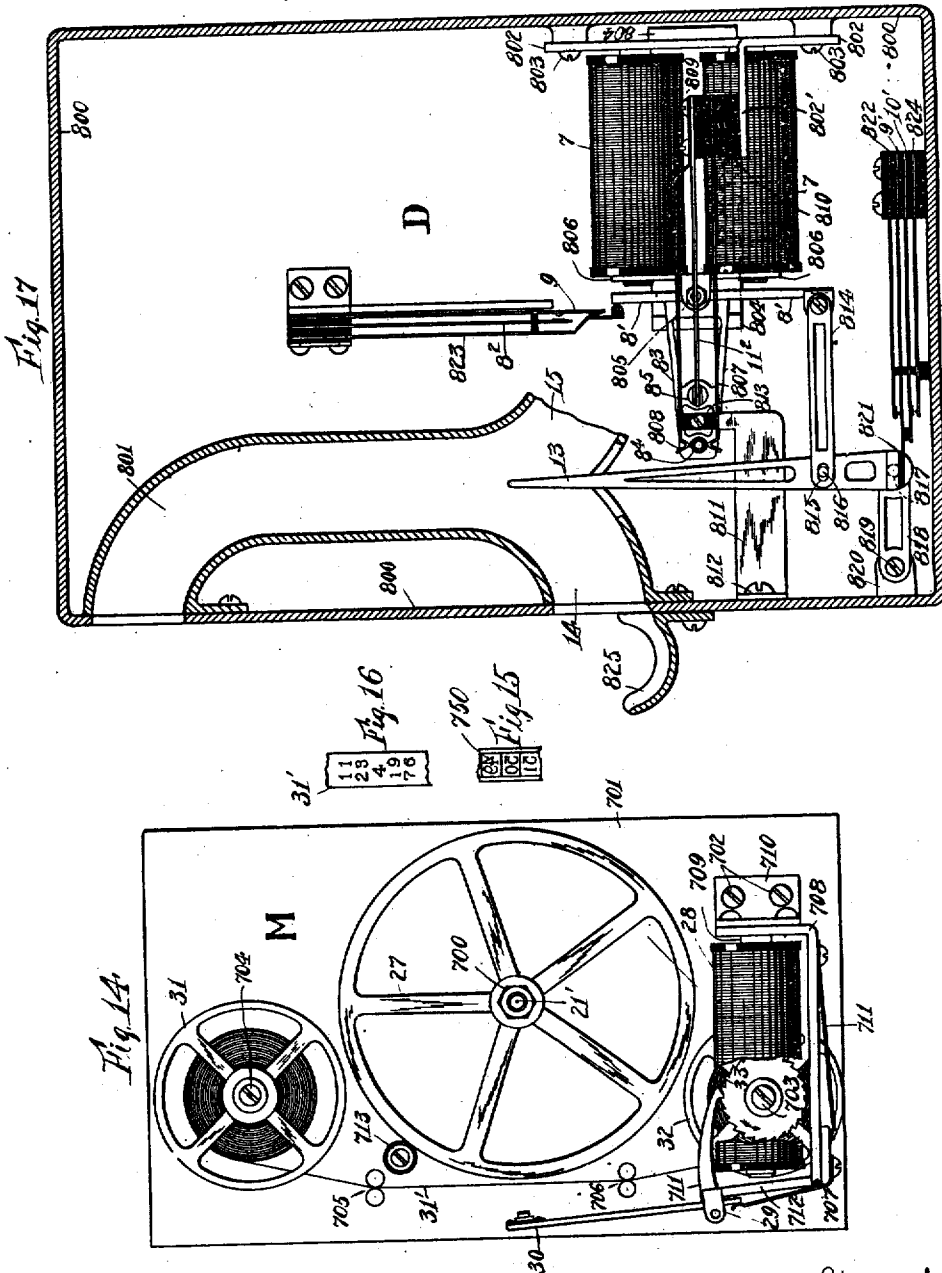
1,133,113.

7 SHEETS—SHEET 6.



Inventor
Francis W. Dunbar
by Thomas H. Ferguson
Attorney

1,133,113.



Witnesses
Geo. E. Mueller.
H. C. Olmstead.

Inventor
Francis W. Dunbar
by Thomas H. Ferguson
Attorney

UNITED STATES PATENT OFFICE.

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

TELEPHONE SYSTEM.

1,133,113.

Specification of Letters Patent.

Patented Mar. 23, 1915.

Application filed October 11, 1906. Serial No. 338,417.

To all whom it may concern:

Be it known that I, FRANCIS W. DUNBAR, a citizen of the United States, and resident of Chicago, county of Cook, and State of Illinois, have invented new and useful Improvements in Telephone Systems, of which the following is a specification.

The present invention relates to telephone exchange systems generally and more particularly to that class of such systems in which the subscribers' calls are automatically distributed before various operators at the central office in a pre-determined order. In such systems, switch mechanism at the central office, set in motion by the removal of the calling party's receiver from its hook, automatically establishes connection between the calling line and an idle link-circuit terminating in a plug or in other manually operated connecting means, before an operator, and extends a call signal thereto. The operator thereupon may receive the order from the calling subscriber through the agency of her telephone set and connect his line either directly with the line of the desired party or to a trunk line, which may then be connected to the line of the desired party.

The present invention is an improvement over the systems of this nature described in several of my applications for United States Letters Patent filed heretofore. In one of my said applications, I have provided service meters individual to the subscribers' lines adapted to automatically count completed called-for connections. In my present invention, I provide a group of service registers for a larger group of subscribers' lines. Thus, ten of said registers may be provided for a group of one hundred lines and will conjointly automatically register completed called-for connections made by each of the said one hundred subscribers.

Another feature of my present invention consists in providing means for automatically collecting a coin or "token" deposited in a coin-box at a subscriber's set, upon the completion of the desired connection and for automatically returning said coin or "token" in case the desired subscriber be busy.

Another feature of my invention consists in the provision of means whereby the various classes of service—such as "unlimited,"

"measured," "pay-station" and "slot machine" service—may be handled in a uniform manner by the call-receiving operators, and whereby the correct data upon which charges are based, may be automatically registered, or the deposited coins automatically collected.

Another feature consists in the provision of means whereby the business originating in any particular group of lines may be distributed among a plurality of groups of switches thereby making uniform the originating business handled by each group, of switches and securing the highest efficiency from the installed automatic selecting apparatus.

Another feature consists in providing means for interconnecting subscribers' lines provided with individual answering terminals with lines provided with means for automatically selecting idle link-circuits and in providing means for readily changing subscribers from one class of service to another.

My invention also comprises still other features which result from or are incident to the main features above enumerated.

These, and other features including certain details of construction of parts and other advantages resulting from the employment of my invention will be more fully understood upon reference to the following detailed description taken in connection with the accompanying drawings, and the scope of the general features of the invention will be apparent from the appended claims, while the more specific features, having been divided out, will be made the subject matter of divisional applications.

In the drawing, Figure 1 comprising parts 1-2, illustrates diagrammatically one preferred arrangement of the subscribers' circuits and selecting switches applied to one well known type of telephone exchange system; Fig. 1* illustrates diagrammatically one position of the contacts of a coin-box or pay-station apparatus; Fig. 2 illustrates diagrammatically a preferred arrangement of the operator's link-circuit in which party line selective signaling mechanism is employed; Fig. 3 illustrates a modified link-circuit arrangement; Fig. 4 illustrates diagrammatically a modified circuit arrangement for the line and link-circuit selector

switches which may be used in place of the corresponding similar arrangements of Fig. 1; Fig. 5 illustrates diagrammatically an operator's circuit for use in placing two parties on the same party-line in communication with each other; Fig. 6 illustrates diagrammatically a trunk circuit adapted to interconnect subscribers in different central offices; Fig. 7 illustrates diagrammatically one arrangement of subscribers' circuits for securing interconnection between subscribers having individual answering terminals and those provided with means for automatically selecting idle link-circuits; Fig. 8 illustrates diagrammatically a link-circuit for completing connections when calls are received over individual answering terminals illustrated in Fig. 7; Fig. 9 is a front elevation, partially cut away, of a link-circuit selector switch of the character diagrammatically illustrated in Fig. 1; Fig. 10 is a side elevation of the same switch viewed from the right; Fig. 11 is a partial vertical section of the same switch taken on the plane indicated by the line 8, 8, (Fig. 9); Fig. 12 is a detail of a pointer and scale associated with said selector switch; Fig. 13 is a diagram of the contacts adjacent to the zero position of the switch; Fig. 14 is a side elevation of a register for use in the systems illustrated in Figs. 1 and 4; Figs. 15 and 16 are detail views of the periphery of the type wheel and tape respectively of Fig. 14, and Fig. 17 is a front elevation of a coin-box or pay-station mechanism, the inclosing casing and coin chute being shown in section.

A brief description of the general arrangement of apparatus and circuits illustrated in Figs. 1 and 2, is given as follows: The subscribers' lines are divided into groups, say, of one hundred lines each. The operators' link-circuits are also preferably divided into groups of, say, one hundred each. Each group of one hundred link-circuits provides ample facilities for handling the originating calls from say fifteen hundred lines—that is, from fifteen groups of one hundred lines each, or perhaps from a larger number of groups, as it would seldom occur in practice that any group would be completely filled with operatively connected lines. I then provide a proper number of pairs of selector switches for each group of lines, say, ten pairs of such switches for each group of one hundred lines, one switch, H, of a pair I term a line selector and one, I, a link-circuit selector. If the lines and link-circuits be thus grouped in hundreds, I preferably employ selector switches having one hundred operative stationary positions or "points," each "point" comprising the necessary number of contact members required for each line or link-circuit. Each switch is provided with movable contact members or wipers, and two of the said wipers of a

pair of switches are electrically connected to complete the talking circuit. The conductors uniting the said movable wipers may be properly termed a "link," an "intermediate link" or a "link-circuit." The lines of each group of one hundred are multiply connected to the stationary points of the ten line selectors belonging to the group and the one hundred link-circuits are multiply connected to the stationary points of the link-circuit selectors of the entire fifteen groups, in the example chosen as an illustration. It therefore follows in the illustration assumed, that the one hundred link-circuits will be multiplied one hundred and fifty times—that is, will be connected to one hundred and fifty link-circuit selectors, thus rendering their use common to fifteen groups of one hundred lines each.

As an example, assume an exchange consisting only of fifteen hundred subscribers' lines, divided into fifteen groups of one hundred lines each. Each of said groups of lines would be provided with ten line selectors and ten link-circuit selectors, whereby each subscriber in the exchange would have access to any one of the one hundred link-circuits, although facilities are furnished for establishing only ten simultaneously existing calling connections in any group of one hundred lines.

It will be understood that my invention is not limited in the number of pairs of switches which may be provided for the common use of a group of subscribers' lines for originating calls, but that a sufficient number of pairs of such switches will be provided to accommodate and properly handle the originating business from any group of subscribers' lines. I provide for each such group of lines an additional switch which I will term a "master switch." The said master switch is for the common use of the subscribers in its allotted group and its function is, upon the initiation of a call by any subscriber in its group, to start the rotation of an idle pair of switches allotted to said group, whereby the line selector may select and make connection with the calling subscriber, and the link-circuit selector may select and make connection with the first idle link-circuit apportioned to the common use of the fifteen groups of one hundred subscribers' lines. The said master switch is not included in circuit with the completed connection, but on the contrary is freed the instant it has caused the line selector to connect with a calling subscriber, and will then move forward. In case there be at this time no other calling subscriber in the same group the said switch will stop in engagement with the contact points of the next idle pair of selector switches. In case there be at this time another calling subscriber in the same group, the said master switch will

immediately start a second pair of selector switches for the purpose of completing the connection between said subscriber's line and the next idle link-circuit in the group apportioned to the said fifteen hundred lines, chosen as an illustration. It is apparent that if the exchange be limited to the said fifteen hundred lines, chosen as an example, each calling subscriber's line will be automatically connected to the first idle link-circuit in the exchange. Suppose, however, that three thousand subscribers' lines be connected with the single central office now under consideration, thus, presumably, requiring two groups of one hundred link-circuits each to handle the originating business from each major group of fifteen hundred lines. In this case, the subscribers would still be divided into minor groups of, say, one hundred lines each, and the link-circuits for each of the two major groups would be preferably alternately terminated at each operator's position, so that link-circuits 1, 3, 5, 7, etc., of each operator's position would be accessible to the first major group of fifteen hundred lines and link-circuits 2, 4, 6, 8, etc., of each operator's position would be accessible to the second major group of fifteen hundred lines. In case forty-five hundred subscribers' lines were led into the same exchange, thus requiring, in the example chosen, three groups of one hundred link-circuits each, each operator's position would be provided with link-circuit terminals, of which each third one, in numerical order, would be preferably accessible to one only of the three major groups of subscribers' lines.

In the present case I also provide means whereby the number of operatively connected link-circuits terminating at each or any operator's position may be varied at the discretion of a chief operator or traffic manager or similar executive. In order to preferably provide the maximum facilities at each operator's position, I employ a greater number of link-circuits terminating at each operator's position than will be operatively required on the average. Each link-circuit is preferably provided with a switch under the control of the said executive whereby its corresponding link-circuit may be temporarily placed in an inactive or artificially busy condition, and whereby the said executive may apportion the number of operatively connected link-circuits terminating at each operator's position in accordance with the efficiency of the operator then present at said position.

Referring now particularly to Fig. 1, three subscribers' lines are indicated, each supposedly in a different group and each group preferably comprising subscribers of a separate service class. Thus the group including "line 205" is equipped with sub-

scribers having limited or measured service; a charge being made for each completed connection, or for each completed connection in excess of a fixed number. Preferably each line is equipped with but one subscriber. One such subscriber's set is shown at B and consists of a well-known arrangement of apparatus, including bell 1, condenser 2, transmitter 3, receiver 4, hook 5, and retardation coil 6. No further description is required of this apparatus, nor is my invention limited to any particular type or arrangement of telephone set. The group including "line 805" is equipped with subscribers having unlimited service, no charge other than the fixed service charge being made. Each line may be equipped with one or more subscribers. Four such subscribers' sets for "line 805" are shown at C', C², C³, and C⁴. The sets may be similar to those shown at B, except that where several are included on the same line their bells are preferably adjusted to different rates of current, so that they may be selectively signaled. Thus, for example, the four bells shown at 1 may be tuned respectively to respond to twenty, forty, sixty and eighty alternations per second. The group including "line 5" is equipped with slot-service or coin-box subscribers; a coin or token being required deposited for each call made, said coin being returned if the desired called line be busy and collected if connection be completed. Each line may be equipped with one or more subscribers. Two of such subscribers' sets for "line 5" are shown at A', A², and two others suggested at A³, A⁴. The sets are similar to those shown on lines 205 and 805, with the exception of the added coin depositing and collecting device diagrammatically shown at D and illustrated in mechanical detail in Fig. 17. The retardation coil 6 of the regular set is preferably replaced by a polarized relay 7 whose winding is normally extended to ground via normal contacts of springs 9 and 10'. The position of the deposited coin is shown by the dotted circles in Fig. 1 while in Fig. 1^a, the coin itself is indicated by the full line circle 10. As shown in said latter figure, the deposit of the coin will by its weight cause the pivoted arm 13 to depress contact springs 10' and 9' so as to close contact 9' and open contact 10' thereby interrupting the normal ground connection via 10', and extending the winding of relay 7 to the line limb L' via 9. The diagrammatically illustrated bifurcated pivoted arm 11 arrests the armature 8 and limits its movement in either direction, except when a heavy current from a special high potential source of current b², located at the central office, is passed through the winding of relay 7. When said current is passed through the relay in a direction to cause a complete upward attraction of its

armature, the extension 12 of arm 11, which freely slides along the upright arm 13 pivoted to springs 10' and 9', will tilt the said arm 13 to the right, thus dropping the coin into the coin-box via chute 15. When, however, said heavy current is passed in a contrary direction through the relay, the complete attraction of the armature in a downward direction will cause the arm 11 to tilt arm 13 to the left and return the coin to the subscriber via chute 14. A flow of current of the ordinary value from the regular low voltage talking common battery *b'* will cause the relay to attract its armature only sufficiently to contact with 9 and open it from its normal ground contact, via 10', thus causing the same circuit changes as are caused by the deposit of the coin. Current from the normally connected low voltage signaling battery *b*, of reversed potential with respect to *b'* will cause the armature 8 to be elevated until stopped by the arm 11.

At the central office, the subscribers' lines extend through a main distributing board diagrammatically shown at E, whereby the lines may be distributed to their multiple spring-jacks F in regular numerical order. Each line is provided with a cut-off relay 16 and a line relay 19. A protective resistance 19' is preferably employed between the live pole of the battery *b* and its normal connection to the line. The extensions of the line wires and the conductors extending to the line relays are preferably carried through an intermediate distributing board G, whereby any line may be extended to any group of selector switches without altering the number of the subscriber's line or multiple spring-jacks. Thus suppose subscriber 203 desires to change the character of his service, say, from measured to unlimited. The short "jumper" wires *g* may be re-run to connect his line with a different group of selector switches comprising unlimited service subscribers, without altering the connection to his multiple jacks or changing his catalogue number. Similarly, the intermediate distributing board G may be utilized for regulating the number of subscribers connected to a given group of switches and for regulating the calls originating in any group of switches. Thus it will necessarily happen that certain groups of lines originate more calls than other groups unless the grouping be arranged with reference to the average business actually transacted. The intermediate distributing board affords facilities, by the re-running of the said jumper wires *g*, for thus equalizing the originating calls in the various groups.

In Fig. 1, the three lines are indicated as belonging to three separate groups arranged according to the classes of business; each group being provided with a plurality

of line selectors H, H', etc., sufficient in number to handle the originating calls of the group. I, I', etc., are the corresponding link-circuit selectors; I being the mate of H; I' the mate of H', etc. Selectors H, I, are indicated in full with their associated relays and switching mechanism, whereas H', I', are only partially shown. Conductors T, S and L represent the conductors extending to the link-circuits at the operator's positions, each complete link-circuit comprising a conductor T, a conductor S and a conductor L. As previously described, these conductors are multiply connected to the various stationary points of all the link-circuit selector switches I, I', etc., of a major group of lines. J represents diagrammatically an intermediate distributing board through which the link-circuit conductors are extended and by means of which the said link-circuits may be variously distributed to the operators' positions. The distribution is preferably such that the manually operated terminals of the various link-circuits occur in the same numerical order at the switchboard as on the stationary contacts of the link-circuit selector switches, the first point of the link selector switch being carried to the first link-circuit terminal, the second point to the second terminal etc., when there exists but one group of link-circuits. If there be a plurality of groups of link-circuits, then the distribution would preferably be that heretofore described wherein each operator's position is provided with link-circuit terminals accessible to each major group of lines, and in which said link-circuit terminals of each group occur in the same numerical order at the switchboard as on the stationary contacts of the link-circuit selectors. Furthermore, instead of having this equal distribution of link-circuits for each group at each operator's position, I may by means of the jumpers of the said distributing board J, distribute the link-circuits corresponding to any major group of subscribers' line, unequally in any preferred manner, before the different operators. For example, it may happen that one particular major group of fifteen hundred lines originates the greater part of the calls during a certain period of the night. It would therefore be preferable to provide the first operator's position with a greater number of link-circuits accessible to this particular group—and with fewer link-circuits from the other groups; thereby enabling one operator to handle all calls from that group from one position. It thus appears that through the agency of the various distributing means above described, I am able to equalize the load among the various groups of selector switches, whereby the greatest efficiency of the installed apparatus is obtained, and am able to most

efficiently distribute the load among the various groups of link-circuits and at the various operators' positions.

Each group of subscribers' lines is provided with a master switch K, the said switch having preferably as many stationary contact points as there are pairs of selector switches, or even multiples thereof, in the group. Each point is electrically associated with its corresponding pair of selector switches. The selector switches are diagrammatically illustrated in Fig. 1. As therein shown, the line selector comprises a shaft 21' capable of being rotated step-by-step by the magnet 21 driving the ratchet-wheel 22 fixed to said shaft; the said shaft carrying also, the insulated wipers 23, 24, 25, adapted to contact with fixed contacts multiply connected to the line conductors *t*, *s*, and *l*. In addition, the shaft carries a pointer 26, bearing a fixed relation to the said wipers and rotating over a graduated dial, the graduations corresponding to the fixed contact points of the switch and being preferably numbered in numerical order from 1 to 100. The line selectors provided for groups of lines containing measured or limited service subscribers are provided with a printing mechanism or register M. This register is shown in detail in Fig. 14, but may be described as consisting essentially of a type-wheel 27 fixed to the same shaft 21' carrying the wipers and pointer; said type-wheel being preferably provided with removable type-plates carrying numbers corresponding to the subscribers' lines, and occupying positions corresponding to the fixed contact points.

28 is the printing magnet which, on the attraction of its armature 29, causes the hammer 30 to print the opposing number on the paper strip 31' carried between the type and hammer; said paper strip being unrolled from bobbin 31 and rolled up on bobbin 32. The retraction of the armature 29 will drive the ratchet-wheel 33 one tooth in the direction shown by the arrow, so as to unwind the paper from one bobbin and wind it on the other bobbin, thus bringing a new space between the hammer and the type-wheel.

The link-circuit selectors are essentially of the same construction as the line selectors. Each link-circuit selector is adapted, however, to automatically return to its normal or zero position at the time of release, and in this position the insulated projection 34, carried by the revolving shaft 21', is adapted to raise certain contact springs. In the case of the selectors 1, 1', etc., in groups 1 and 3, the projection 34 in its normal position closes contact 35 and opens contact 36 while in any but the normal or zero position, contact 36 will be closed and contact 35 opened. In the case of the link-circuit

selectors of group 2, the contact springs 35', 36', 37' and 38' are raised so that contacts 35' and 36' are closed while contacts 37' and 38' are opened. In any but the normal or zero position, contacts 35' and 36' are open and contacts 37' and 38' are closed. A pointer 26 may be also supplied to the link-circuit selectors, if desired. Likewise the master-switches are of practically the same construction as the other selector switches. Each master-switch is provided with a step-by-step magnet 21² actuating a ratchet wheel 22' fixed to a shaft 22² which carries wipers 57, 56 and 58, electrically insulated from each other and adapted to make connection with the fixed contacts, respectively associated with, and electrically connected to, the pairs of selector switches provided in the group controlled by the master-switch under consideration.

*b*² indicates a source of relatively high electrical potential and is adapted to fully operate the polarized relay 7 at the coin-box subscriber's station set.

b' represents a source of current of the same polarity as *b*², but of lower potential.

b represents a source of current of relatively low potential with respect to *b*², but having its opposite pole grounded. It will be understood that each of the several batteries marked "*b*" may be, and preferably are, one and the same battery, and the same statement is true with respect to the various batteries *b*' and true also with respect to the several batteries *b*².

g represents a source of pulsating or alternating current to which magnets 21 and 21² are responsive and it will be understood that one such source may be employed for all of the separate sources diagrammatically illustrated. The arrangement of circuits and apparatus associated with the intermediate link electrically uniting a pair of selector switches is substantially the same in each of the three groups of lines indicated, differing however in certain minor points which will be described later on.

N represents a "busy back" source of current and is adapted to give a characteristic signal to a calling subscriber if the line for which he calls is busy. It may consist of a variable source of current 37 carried through an interrupter 38 and the primary of induction coil 39; the secondary of said induction coil being led to condensers 40, one such condenser being preferably provided for each pair of selector switches.

O represents a signal—preferably of incandescent lamp—which will be continuously lighted under certain conditions of trouble to give a visual indication of such trouble to an attendant. Each pair of selector switches is preferably provided with such a signal and the attendant, by referring to the pointer 26 is enabled to determine the

number of the subscriber's line on which trouble may exist.

P (Fig. 2) diagrammatically indicates a party line selective ringing key, whose operation may be described as follows: p, p, p, p , represent the four ringing buttons which, when completely depressed, are adapted respectively to extend ringing current from the corresponding generator Q via resistance lamp Q' to the alternate contact 41' of relay 41. Each button has two positions in addition to its normal position. In its fully depressed position, the interrupter R is electrically connected to the winding of relay 41 via contact 42. The button is retained in its fully depressed position by an associated beveled stop 43 carried by a bar 46, and is retained in such position until said stop is withdrawn. As the button is depressed, the end of the lever adjacent to the stop slips over the beveled face of the stop into engagement with its opposite face. Upon the energization of the magnet 44, its armature 45 and the connected bar 46 are drawn downward to remove the stops 43 from their engaging positions, whereupon the previously depressed lever will return to its intermediate indicating position. It is held in its intermediate position by the engagement of stops 49 and 50. The stop 49 is carried by a pin 47 secured to the armature 45 and it remains in its engaging position so long as the said armature remains in its attracted position. As soon, however, as the magnet 44 is deenergized, its armature 45 returns to the position illustrated and the stop 49 is moved from its engaging position, thereby allowing the actuated key and its lever to return to normal. From this description, it will be seen that the depression of any button will, by the engagement of its lever with its associated stop 43, move the bar 46 so as to move other stops 43 out of engaging position and thereby release other buttons which have been previously depressed.

U represents a counter adapted to record completed connections. Each link-circuit may be provided with such a counter.

51 represents the counting magnet which, when energized, will cause the ratchet-wheel 52 to make one step and, by a suitable train of gears, will cause the next consecutive number to appear on the dial 53.

V represents the customary operator's telephone set adapted to be included in circuit by the depression of the listening-in keys v, v .

W represents a polarized relay connected to an intermediate point of battery b' at about one quarter of the total potential of the battery above the ground. The said relay is adapted to move its armature 105 in one direction when the connecting plug X is inserted into the jack of a busy line, and

in the opposite direction when inserted into the jack of an idle line.

Y is a switch preferably placed before the manager or chief operator, there being preferably one such switch for each link-circuit. Each switch, when in its normal position (that shown), permits the selection of the corresponding link-circuit; but when the said switch is moved to its alternate or grounded position, the corresponding link-circuit is rendered incapable of selection by calling subscribers,—in other words, is rendered artificially busy. Switches Y thus supplement the functions of the distributing board J by providing ready and rapid means for distributing the load among the operators' positions and for proportioning the number of calls received at any position in accordance with the ability of the operator then present at the position. As an example, the operator at the first position may be highly skilled while the operator at the second position may be less skilled and capable of handling efficiently only a relatively small number of calls. The traffic manager or chief operator may then by means of the switches Y render artificially busy all link-circuits at these positions in excess of the number capable of being efficiently handled. When all actively connected link-circuits at these two positions are in use, the calls will of course pass on to the third or subsequent positions and the business at these positions may be similarly regulated by the switches Y. It is apparent that in the event of a sudden or unexpected rush of business, which would otherwise extend calls to positions beyond the last one, at which an operator is then present, the said manager may by the manipulation of the switches Y, place one or more of the artificially busy link-circuits at one or more operators' positions, in service, thereby distributing the unexpected additional load among the operators. For the purpose of indicating to the said manager the existence of this unexpected load suitable indicating means are provided which may be preferably located at his desk and which preferably consist of the lamps 95², one for each operator's position, connected between battery b' and the armature contact of the pilot call relay 95. Said relay 95 is necessarily energized whenever a call extends to the operator's position at which it is located. Therefore whenever manual switch 95² (preferably also under the control of the said manager) is closed and said relay 95 energized, lamp 95³ will be lighted. By means of the several switches 95² the lamps 95³ corresponding to the positions at which operators are present may be cut-out, while the remaining lamps 95³ are left in circuit. Under these circumstances, calls which may be extended to oper-

ator's positions beyond those at which operators are present, will be at once indicated to the manager, whereupon he may, as above described, distribute this additional unexpected load among the present operators.

Z represents a busy back jack, of which several may preferably be provided at each operator's position. It is used for the purpose of permitting the release of a selected link-circuit either when trouble exists upon the selecting line or when it is desired to restore a deposited coin or token to a calling subscriber who cannot secure connection to his desired party. In either event the plug X is inserted, by the operator, into the said jack Z.

Having pointed out the essential characteristics of the principal apparatus employed in establishing connection, I will now trace in detail the operation of the apparatus of my invention as illustrated in Figs. 1 and 2, assuming one of the subscribers on "line 5" desires a connection with some other subscriber in the exchange. Referring first to the master-switch K of group 1, it will be noted that whenever the magnet 55 is energized, circuit will be completed through the motor magnet 21² and the master-switch will advance. It is also true that magnet 55 will be energized whenever wiper 56 is in engagement with a contact point associated with a busy intermediate link as will appear from subsequent description. It necessarily follows, therefore, that the wiper 56 (and consequently wipers 57 and 58) will be normally at rest and in engagement with contacts extending to an idle pair of selector switches. I will assume that subscriber A' removes his receiver 4 from its hook for the purpose of initiating a call. I will also assume that the said subscriber neglects to deposit a coin. The removal of his telephone from its hook, therefore, merely includes battery *b* in closed circuit with protective resistance 19', line limb L', transmitter 3, polarized relay 7, and contacts 9 10', to ground and the return side of battery *b*. The resulting flow of current is of a direction and potential to cause armature 8 to be merely elevated until stopped by arm 11. Consequently, no operative signaling mechanism is affected. In other words, the subscriber is unable to make a call until he has deposited a coin. Upon the deposit of a coin, however, arm 13 causes contact 10' to open and 9' to close, to include battery *b* in closed circuit via 19', L', 3, 7, 9', L' and line relay 19 to the grounded terminal of the said battery *b*; whereby the line relay 19 is energized to remove the ground from conductor *l* of "line 5" and to establish a flow of current from ground via armature spring 20 and its alternate contact, conductor 59, (common to the sub-

group of one hundred subscribers), relay 60 of the master-switch of that group, to battery *b*'. Relay 60 is thus energized and would be energized via the same common conductor 59, were any other subscriber in the same sub-group to remove his telephone from its hook and deposit a coin for the purpose of making a call. The energization of relay 60 locks its own circuit via alternate contact of spring 61 and normal contact of spring 62, thus preventing the deenergization of said relay 60 until relay 55 is energized. In addition, the energization of relay 60 extends the ground connection via spring 63 through normal contact of spring 65, wiper 58, normal contact 35, normal contact of spring 67, through private relay 68 to battery *b*'. Relay 68 is thus energized to cause the operation of link-circuit selector magnet 21 from source *g*, said magnet 21, contact 69, contact 70 to ground. Simultaneously spring 64 is closed to ground, completing circuit through contact 66, wiper 57, contact 71 and private magnet 72 to battery *b*'. The energization of relay 72 may or may not complete the circuit of the step-by-step magnet 21 of the line selector H, depending upon the position of the local wiper 23 of said selector switch. It may happen that the line selector H, when last used, had left its wipers (23, 24, 25) in engagement with the contacts of the line now calling. This, however, is an exceptional condition and would result in preventing any further movement of the said wipers, as will presently appear, because they are already in engagement with the contacts of the calling line. Reverting to the further conditions established by the energization of relay 68, it will be seen that the circuit of the intermediate link *l'*, *s'*, will be opened at springs 73, 74, and that the local wiper 75 of the link-circuit selector will be extended via alternate contact of spring 76, normal contact of spring 77 to said relay 68, whereby the energization of the said relay 68 is placed under the control of said wiper 75 as soon as the normally closed contact 35 is opened by the first step of the motor magnet 21 of the said link-circuit selector I. In other words, the private relay 68 is initially energized via wiper 58 of the master-switch K and normal contact 35, but its continued energization is dependent upon ground connections via wiper 75 after the first step of said link-circuit selector I. After the first step of wiper 75 (which is preferably provided with an enlarged contact member capable of bridging from one stationary contact point to another so as not to interrupt the circuit established there through in its passage from one grounded contact to another), relay 68 will only remain energized as long as said wiper encounters contact points connected with local conductors

L of link-circuits then grounded. It will subsequently appear that local conductor L of each link-circuit will be either directly grounded or grounded through a battery *b* of reversed potential (an effective ground) at all times when the said link-circuit is busy. When, however, the said wiper 75 encounters a contact point connected with a local conductor L of an idle link-circuit, the circuit through relay 68 will be entirely opened. This will appear on referring to Figs. 2 and 3, which represent the normal or idle condition of a link-circuit. Conductor L is normally extended via spring 78 to switch Y. Said switch in its normal position is free from ground. Therefore, if said link-circuit be both idle and in a condition to be selected (that is, if switch Y be in its normal position and not thrown to ground), relay 68 will be deenergized, thereby interrupting the current through motor magnet 21 and continuing the intermediate link *t'*, *s'* via wipers 79 and 80 to the link-circuit conductors T, S. The opening of the circuit of magnet 21 prevents the further operation of the link-circuit selector switch. Meanwhile, the line selector switch H has been selecting the calling subscriber's line (unless its wipers were already in engagement therewith).

It will be noticed that the circuit of the step-by-step magnet 21 of line selector H can only be initially closed by the simultaneous energization of relays 72 and 81; its circuit being normally open at 85 and 86. Relay 81 may be termed an "off-normal" relay because it can only be energized when the corresponding link-circuit selector I is off its normal or zero point, thereby closing circuit from battery *b'* through said relay 81 and contact 36 to ground, thus causing the energization of said relay 81 as long as the switch I remains "off-normal." The first step of the link-circuit selector I will necessarily energize said relay 81. Relay 72 (initially energized via 71, 57, 66 and 64) will be released simultaneously with the energization of relay 81, unless a ground be then present upon the conductor *l* then in engagement with wiper 23. If the said wiper 23 be then in engagement with the conductor *l* of the calling line, no such ground will be present, for spring 20 of line relay 19 is then in engagement with its alternate contact. Therefore, the step-by-step magnet 21 cannot be energized and no movement of the line selector switch H will take place. The more general case, however, results when the wipers 23, 24, 25 are not resting on the contacts of the calling subscriber's line. In such case, the initial energization of private relay 72 locks the said relay via alternate contact 82, conductor *l*, wiper 23 and normal contact 20 of the relay 19 of that line then engaged by wiper 23, to

ground. Relay 72 therefore remains energized after the energization of relay 81 and thereby causes the energization and operation of motor magnet 21 of line selector H, until wiper 23 encounters a conductor *l* not connected to ground—i. e., until the wipers 23, 24, 25 encounter the conductors *l*, *s*, *t*, of a calling line. Relay 72 will then be deenergized and will open the circuit of 21 to prevent further movement of the line selector. During the rotation of the said line selector H, the wipers 24, 25 were electrically opened at 83, 84. Wipers 23 of the line selectors H, H', etc., are also preferably provided with contact faces capable of bridging from one contact point to another. It has appeared that the closure of contacts 63, 64 of the master-switch caused the operation of both selectors of the idle pair then engaged by said master-switch, to cause, on the one hand, the selection of the first idle link-circuit and, on the other hand, the selection of the calling subscriber's line; also that the deenergization of the private relays 68 and 72 unites the calling line with the selected link-circuit via the intermediate link *t'*, *s'*. It is also apparent that as both selector switches H, I, are started practically simultaneously, each to seek out a certain circuit, either one may first complete the selection. For example, during the idle hours of the day, the probabilities are that the link-circuit selector I will on the average first complete its selection; but during the busiest hours of the day, the probabilities are that the line selector will on the average first complete its selection. While both selectors are in motion, both sets of contacts 83, 84, and 73, 74 are on open circuit. Should H complete its selection prior to I, thereby closing contacts 83, 84 before 73, 74, it will be seen that cut-off relay 16 will be operated from battery *b'*, via O, normal contact 87, alternate contact 88, link *s'* including contact 83, wiper 24, *s*, 16 to ground, thus causing springs 17, 18 of said cut-off relay to leave their normal resting contacts and engage their alternate contacts, whereby the calling apparatus 19, 19' is disconnected and the test rings *f*, *f'*, of the multiple jacks F, F are connected to battery *b'*, thus rendering "line 5" busy. The instant however, relay 68 is released, upon the selection of the first idle link-circuit, circuit from battery *b'* will be closed simultaneously through relays 89 and 90 (Fig. 2), via 89, S, 80, 74, *s'*, 24, *s*, 17, L', substation A', L', *t*, 25, *t'*, 73, 79, T, 90 to ground; whereby both of said relays 89 and 90 will be simultaneously energized and will immediately ground conductor L (Fig. 2) via alternate contact 78, normal contact 91, normal contact 92 and alternate contact 93. On the contrary assumption that the link-circuit selector I completes its selection prior to the line selector H, it will be seen

that the cut-off relay 16, will not be operated until H has completed selection and that upon the release of relay 72 the said cut-off relay 16 will be energized from battery b' via relay 89 (Fig. 2), S, 80, 74, s' , 24, s and said relay 16 to ground, prior to the extension of the circuit through the substation and relay 90 (Fig. 2), S, 80, 74, s' , 24, s and said relay 16 to ground, prior to the extension of the circuit through the substation and relay 90 (Fig. 2), above traced. Should, therefore, relay 89 be so adjusted as to close alternate contact 78 prior to the opening of normal contact 94 of relay 90, it would close battery b' (Fig. 2) to conductor L, via pilot relay 95, call lamp 96, normal contacts 94, 92, 91, and alternate contact 78; but the said conductor L is then closed to ground via 75, normal contact 76, 76', conductor 76', wiper 58, normal contact 65 and alternate contact 63, whereby the polarized relay 97 is short circuited and thereby deprived of current which would otherwise flow through it and cause its operation at this time. Upon either assumption, therefore, with respect to the order of complete selection by switches H and I, it is apparent that conductor L will be grounded to prevent the operation of the polarized relay 97 and to prevent any other link-circuit selector from stopping in engagement with the link-circuit now selected and consequently busy.

Upon the operation of the cut-off relay 16 (which, as we have seen, will be operated the moment the line selector H has selected the calling subscriber), it is apparent that the disconnection of the line relay 19 will result in the reestablishment of the ground on L, whereby a circuit is completed from battery b' , via relay 55 of master-switch K, its wiper 56, contact 98, normal contact 82, conductor L', wiper 23, normal contact 20, to ground; thereby operating said relay 55 to unlock relay 60 and to energize the motor magnet 21' via alternate contact 62 to ground. The master-switch thus advances one step, thus bringing wiper 56 into engagement with the next pair of selector switches in its group. Should this pair be busy, ground would be present on the conductor 100 either at a contact 20 of a calling line via contacts 98, 82, conductor L', wiper 23, conductor L and normal contact 20, or, in case the parts were then being restored to normal, ground would be present at contact 101, (as will later on appear);—thus causing in either case the continued attraction of relay 55 and advance of the master-switch, until an idle pair of switches is encountered; at which time, conductor 100 being open, relay 55 will be deenergized and will cause the master-switch to stop in engagement with the said idle pair of switches. During rotation, the circuits of wipers 57,

58, are open at 66, 65, respectively. If there had been at this time more than one calling subscriber in the group containing "line 5", then, as above described, relay 55 would cause the advance of the master-switch to the next idle pair of switches, and upon the deenergization of 55 (relay 60 being now energized by the second or simultaneously calling subscriber), the said idle pair of switches would be started to pick up the calling subscriber in the manner set forth above; and upon the selection of the said calling line, (entirely irrespective of whether or not the corresponding link-circuit selector has previously selected the link-circuit), the master-switch would again advance and finally come to rest in engagement with an idle pair of selector switches after attending to all calls then being initiated in its group. The master-switch, therefore, is normally in engagement with an idle pair of selector switches, as previously stated. It is also apparent that the stepping forward of the master-switch has removed the previously existing short circuit of relay 97 via conductor 76', wiper 58, contacts 65 and 63, to ground; whereby said relay 97 is now operatively connected to the conductor L extending to the link-circuit and will respond to current which will at a later time be sent back over said conductor L. Relays 89 and 90 (Fig. 2), being now energized, close circuit from battery b' , through pilot relay 95, call lamp 96, alternate contact 94 and normal contact 102 to ground, thus lighting said call lamp 96 to advise the operator that a subscriber is awaiting attention on this particular link-circuit. Pilot call lamp 95' is simultaneously lighted for the well-known purpose of supplying a pilot call signal common to all the link-circuits at the operator's position. If at this time switch 95' be closed, lamp 95' will be also lighted for the purpose previously described. The * indicates the common point of the group of link-circuits. The operator now communicates with the calling subscriber and finds out his wants by the use of the well known apparatus indicated at V, v, v. Returning to the substation A', it is apparent that the reversal of current through the relay 7 at the time battery b' was included in circuit with relays 89 and 90 has merely altered the position of armature 8 without altering the effective electrical connections. Assuming the subscriber desires a line in the same exchange, (all which lines I preferably provide with multiple spring-jacks F), the operator will preferably first depress a button p of the selective ringing key P, corresponding to the adjustment of the bell of the party on the line desired (whether said line be an individual or a party line) and will then insert plug X into a jack F cor-

responding to the line of the subscriber desired, without first "testing" said jack. The depression of any ringing button *p* establishes a flow of current from battery *b'*, through relay 41, contact 42 of said ringing button *p*, through the common interrupter R to ground, whereby said relay 41 is intermittently energized and deenergized to cause its armature 41' to alternately contact with its normal and alternate contacts. Depending upon whether said line is idle or busy, or whether or not the subscriber answers, three conditions arise which will be separately discussed.

First, called subscriber's line idle.—In this case, the sleeve rings *f* of the jacks F will be at the potential of ground, for each such ring is connected thereto via cut-off relay 16 without connection to battery. Consequently when the plug is inserted, a flow of current will result from the intermediate point of battery *b'* (Fig. 2), through polarized relay W, normal contacts 103 and 104 to sleeve strand S, plug X, sleeve ring *f* of the jack F of the called line, cut-off relay 16 to ground; thereby causing armature 105 of relay W to move to the left and close circuit from battery *b'*, through supervisory relay 109, and said armature 105 to ground, whereby said relay 109 is energized and establishes the following circuit conditions:—Said relay 109 locks itself up via alternate contact 103, normal contact 104, sleeve conductor S, plug X, sleeve ring *f*, cut-off relay 16 of the called line to ground; whereby said relay 109 can only be deenergized by the removal of the plug from the jack. In addition, alternate contact 103 is broken (preferably subsequent to the establishment of its alternate contact, although this is not necessary with the slow-acting relay W) to disconnect polarized relay W. In addition, alternate contact 102 is closed to illuminate supervisory lamp 110 by current from battery *b'*, through said lamp, normal contact 111 and said alternate contact 102 to ground. Said indication remains until the called-for party responds by removing his telephone from its hook, thereby giving a visual indication to the operator at the response of the called-for party. The opening of normal contact 102 extinguishes the calling lamp 96. Also, alternate contact 92 is closed to extend conductor L to ground at contact 112, via alternate contact 78, conductor L², normal contact 91, conductor L¹, alternate contact 92 and normal contact 112; thereby maintaining the busy condition of the selected link-circuit, and throwing its point of control under the influence of relay 44. Also, contact 113 is closed to extend alternately the tip conductor of the called subscriber's line, first, to the ringing generator Q, and second to the tip supervisory relay 114, depending upon the position of the armature 41' of relay 41

now under the control of the interrupter R, as described. Ringing current (from the proper source Q) is thus intermittently extended to the bell of the called subscriber's line via tip strand T, alternate contact 18 of his cut-off relay, line limb L', condenser 2, bell Z, line limb L², alternate contact 17 of his cut-off relay (one return path to ground being provided through said cut-off relay), jack contact *f*, plug X, sleeve conductor S, normal contact 104, alternate contact 103, supervisory relay 109 to battery and ground. The said bell Z at the called subscriber's station will thus intermittently ring and the tip conductor will be intermittently and alternately extended to the tip supervisory relay 114, whereby, when said subscriber removes his telephone from its hook and the armature 41' of relay 41 is in its normal position, a closed path for the flow of current from battery *b'* will be established via supervisory relay 109, alternate contact 103, normal contact 104, sleeve conductor S, line limb L², transmitter 3, polarized relay 7 (if the called subscriber be a coin-box subscriber) to ground at normal contacts 9 and 10'; the current through said polarized relay 7 being of a direction to immediately cause its armature to move contact 9 to its alternate position and thereby continue the flow of current via said polarized relay 7, alternate contact 9, armature 8, line limb L', tip conductor T, contact 113, normal contact 41', through said tip supervisory relay 114 to ground. The removal of the telephone from its hook at the called station will, therefore, operate polarized relay 7 (if it be a coin-box subscriber) to establish the talking circuit through said station and to cause the operation of relay 114 at the central office. If the called subscriber were not provided with a coin-box set, but were provided with a set such as shown either at B or C', the removal of the telephone from its hook would directly close the circuit through said relay 114 to cause its operation. With any arrangement of apparatus at the called station, therefore, the removal of the telephone energizes relay 114, resulting in the following circuit changes: Contact 115 is closed to continue the sleeve strand S from the calling to the called subscriber, normal contact 111 is broken to extinguish the supervisory lamp 110 (thus notifying the operator of the response by the called party) and alternate contact 111 is closed to extend current from battery *b'*, through relay 44 and said alternate contact 111 to ground at alternate contact 102, whereby said relay 44 is energized to effect the following circuit changes: Contact 116 is closed to lock the said relay 44 via its winding and said contact 116 through said alternate contact 102 to ground, whereby said relay 44 can only be released by the removal of the plug from its jack. Also,

armature 45 is attracted and restores the depressed ringing button *p* to its intermediate or indicating position, as previously described, simultaneously opening connection to the ringing generator *Q* and interrupting the circuit of relay 41 at contact 42, thereby preventing the further attraction of its armature 41'. In addition, conductor *L*⁴ is extended via alternate contact 112 to counting magnet 51 and battery *b* of reversed potential. A closed path for the flow of current is thus established from said battery *b*, via counting magnet 51, alternate contact 112, alternate contact 92, conductor *L*⁴, normal contact 91, conductor *L*³, alternate contact 78, conductor *L*, wiper 75 (Fig. 1), normal contact 76, polarized relay 97 and contact 117 to ground, thereby energizing the said counting magnet 51 and the polarized relay 97. The direction of flow of current from battery *b*, through said polarized relay 97, is such as to close contact 97', thus energizing magnet 28' from battery *b*', through said relay 28' and contact 97' to ground. Relay 28' attracts its armature 28² to close circuit from the battery *b*² of relatively high potential, through the polarized relay 7 at the calling subscriber's station over the following circuit: battery *b*², said contact 28², wiper 25, line limb *L*¹, contact 9', through said polarized relay 7, transmitter 3, line limb *L*², alternate contact 17 and cut-off relay 16 to ground. This flow of current is in a direction opposite to that previously flowing through the said polarized relay 7 at the subscriber's station and of greater value. It will therefore elevate armature 8 and engage arm 11, causing the extension 12 to draw arm 13 to the right thus depositing the coin in chute 15 as previously described. Reverting to counting magnet 51, it will be seen that, upon the complete attraction of its armatures, it will step ratchet-wheel 52 one step to register one additional completed connection, as previously described, and will cause its armature 51' to close its contact and thus ground the extension of conductor *L*⁴; whereby a locking circuit is provided for said relay 51 and polarized relay 97 is deprived of current (due to the short circuit thus imposed thereon), to cause its armature 97' to open the circuit of relay 28', thereby opening the circuit of the special high voltage battery *b*², whereupon the polarized relay 7 at the substation again receives low potential current in the former direction to again complete the conversational circuit via line limb *L*¹, transmitter 3, said relay 7, alternate contact 9, armature 8, and line limb *L*². The conversational circuit is thus completed between the calling and the called subscribers, the coin has been collected and deposited, and the counting magnet 51 in the link-circuit has recorded the completed connection on the counter *U*. The circuit of said

counting magnet 51 is under the control of relay 44, which relay is locked up under the control of relay 109, which latter relay can only be deenergized when the plug *X* is removed from the spring-jack, whereby the movement of the hook-5 at either the calling or the called subscriber's station can have no effect either upon the counter *U* or upon the collecting magnet 28'.

During conversation, the calling subscriber has under his individual control the supervisory lamp 118. Said lamp, as usual, will be illuminated by the calling subscriber replacing his telephone upon its hook, thereby including said lamp in circuit from battery *b*', pilot supervisory relay 119, said supervisory lamp 118, contact 120, normal contact 93 to ground. Pilot supervisory lamp 119' is at the same time lighted, due to the energization of the common pilot relay 119. Similarly, during conversation, the supervisory lamp 110 is under the individual control of the called subscriber and will light when the said subscriber replaces his telephone upon its hook; the circuit thus established being that previously traced. Upon the conclusion of conversation and when both subscribers have replaced their telephones upon their hooks, thus causing both supervisory lamps 110 and 118 to light, the operator will withdraw the plug *X* from its spring-jack, thereby releasing supervisory relay 109, which in turn releases relay 44. The release of relay 44 releases counting magnet 51 and restores the party line selective signaling key to its normal condition, as previously described. The release of relay 109 extends conductor *L* to the source of current *b*', thereby causing a flow of current over the following path: battery *b*², pilot relay 95, lamp 96, normal contact 94, normal contact 92, conductor *L*⁴, normal contact 91, conductor *L*³, alternate contact 78, conductor *L*, polarized relay 97, contact 117 to ground. This flow of current energizes relay 97 in a direction opposite to its previous energization when included in circuit with battery *b*, whereby its contact 97² is closed to effect release as follows: A flow of current from battery *b*² is first established via lamp *O*, contact 97², relay 121 to ground, thereby energizing said relay 121 to extend battery *b*² via lamp *O*, contact 122, release relay 123 and contact 117 to ground, thereby energizing said relay 123. The energization of said relay 123 establishes an additional path for the flow of current from battery *b*², via private relay 68, alternate contact 77, said relay 123, to the said contact 117 and thence to ground, whereby said private relay 68 and said release relay 123 are locked via contact 117; said contact being under the control of the normal switch contact 36. The energization of private relay 68 disconnects wipers 79 and

80 at contacts 73—74 preparatory to release, and in addition, opens normal contact 76, whereby polarized relay 97 is released and will release relay 121, if the calling subscriber's telephone be then upon its hook, as assumed. In addition, wiper 75 is disconnected at normal contact 77 preparatory to the said release. Due to the release of relay 121, as above described, the motor magnet 21 of the link-circuit selector I will be energized from pulsating or alternating source g , via said magnet 21, contact 69 and contact 70 to ground, thereby causing the continued rotation of the said link-circuit selector switch until it reaches its zero or normal point. When this point is reached, relays 68 and 123 are deenergized by the opening of contact 117, due to the release of relay 81, caused by the opening of its circuit at normal switch contact 36. All apparatus has therefore resumed its normal position. The wipers of the line selector H remain in engagement with the contact points associated with the last subscriber calling. During the release, as above described, it is apparent that contact 101 of relay 123 will be continuously closed whereby the ground is maintained on conductor 109 of a pair of switches not in their normal position and hence not ready to receive new calls. Upon the deenergization of relay 68, alternate contact 88 will be opened, thereby interrupting the circuit through cut-off relay 16 of the calling line to again operatively connect the calling apparatus belonging to that line to the said line.

Second, called line busy.—If the called line be busy, the sleeve rings f of the jacks F will be at a potential different from the ground and always as great as or greater than one half the potential of battery b' . This arises from the following conditions: If the busy line be one that is then initiating a call, battery b' (Fig. 1, Part 2) may be momentarily closed through the cut-off relay 16, via lamp O, normal contact 87, alternate contact 88, conductor s' including contact 83, wiper 24, conductor s , and said cut-off relay 16 to ground. The resistance of lamp O will not be greater than the resistance of relay 16, whereby the potential in the circuit above traced, at s , electrically connected to the sleeve rings f , will not be less than one-half the potential of b' . As soon as selection is completed, battery b' (Fig. 2) is closed through said cut-off relay 16, via relay 89, S, wiper 80, normal contact 88, s' including contact 83, wiper 24, conductor s , where the current divides, a part returning to the ground side of battery b' via the cut-off relay 16, and a part continuing over the subscriber's circuit and back through t , wiper 25, t' including contact 84, contact 73, wiper 79, conductor T to ground through relay 90 (Fig. 2). The joint resistance of the cut-off

relay 16 and the combined line, substation and relay 90, will not be less than the resistance of relay 89; whereby, as before, the potential of the rings f (connected to the intermediate point s of the above circuit) will not be less than one-half the potential of battery b' . Should the busy line be one receiving the busy back indication, then a circuit would exist from battery b^2 (Fig. 1, Part 2), through protective resistance 54, alternate contacts 87 and 88, conductor s' including contact 83, wiper 24, conductor s , where the current divides, a part returning via cut-off relay 16, and a part continuing over the subscriber's circuit and back through t , wiper 25, t' including contact 84, contact 126, relay 121 to ground. The resistance of 54 is relatively low and the potential of battery b^2 relatively high with respect to b' , whereby the potential of the rings f (connected to the intermediate points s of the above circuit) will not be less than one-half the potential of battery b' . It might of course be much greater. In case the busy line be one which has been connected to at a jack F, then its cut-off relay 16 would be operated by current from battery b' (Fig. 2), via relay 109, alternate contact 103, normal contact 104, conductor S, plug X, jack F, sleeve ring f , where the current divides, one part returning via cut-off relay 16, and the other continuing over the subscriber's circuit and back via alternate contact 18, plug X, conductor T, contact 113, normal contact 41' to ground via relay 114. The joint resistance of relay 16 and the combined line, substation and relay 114, is not less than the resistance of relay 109, whereby the intermediate point f (the said sleeve rings) is maintained at a potential not less than one-half of battery b' . It is obvious that should the busy subscriber replace his telephone on its hook, it would increase the potential of the test rings f to a value nearer the total potential of b' . In all conditions of a busy line, this relation between the potential of the test rings f and battery b' holds true—that is, the said rings f are at a potential not less than one-half the potential of b' . It therefore necessarily follows that the insertion of the plug X into a jack of the busy line will cause a flow of current through relay W in a direction opposite to the flow previously traced when the plug was inserted into the jack of an idle line. The flow may be traced as follows: Starting with either the source b' or b^2 , and following either one of the various paths above traced in detail until the conductor s is reached, the current will continue via the test ring f of the jack into which plug X is now inserted, said plug X, sleeve conductor S, normal contact 104, normal contact 103, said polarized relay W, to the intermediate point of battery b' . It will be remembered

that said intermediate point is preferably about one-quarter the total potential, thus leaving, as a minimum effective potential for the operation of W, a potential about one-quarter of the total potential of b' . Armature 105 of said polarized relay W will therefore move to the right and close circuit from battery b' , through "busy" relay 106 and armature contact 105 to ground, whereby said relay 106 will be energized to establish the following circuit conditions: Said relay will lock itself up from battery b' via contact 107 and contact 108 of relay 89 to ground, whereby its release is dependent upon the release of relay 89; said relay 89 is locked up by current flowing from battery b' through said relay, alternate contact 104, sleeve conductor S, sleeve ring f of the jack, cut-off relay 16 of the busy called line to ground; whereby the release of both relays 106 and 89 is placed under the control of the inserted plug. In addition, polarized relay W has its circuit opened at normal contact 104, thus releasing and restoring its armature. In addition, contact 124 is closed to energize relay 44 from battery b' via said magnet winding and said contact 124, to ground; whereby the release of said relay 44 is also placed under the control of the inserted plug. The operation of said relay 44 cannot at this time extend battery b via counting magnet 51 and alternate contact 112 to the conductor L, because (the called line being busy) relay 109 then is deenergized. It is, therefore, impossible at this time to either operate the counting magnet 51 at all, or to operate the relay 97 in a direction to collect the coin at the subscriber's station. Moreover, it is impossible to extend ringing current to the busy subscriber's line because of the open contact 113 now existing. It is also apparent that with the exception of a possible single slight "click", due to the re-adjustment of the current in the busy called line at the time relay W caused relay 89 to be locked up via the cut-off relay of said busy line, no disturbance of the called line will result; it being apparent that the conversational circuit of the selected link-circuit now connected with the calling line is interrupted at said contact 113 on the tip side and at contact 115 on the sleeve side.

The operation of relay 106 has also extended current from battery b' to polarized relay 97 via the following circuit: said battery b' , the upper portion of the winding of relay 44 (preferably of relatively low resistance), conductor 125, alternate contact 91, conductor L^3 , alternate contact 78, conductor L, wiper 75, said relay 97, and contact 117 to ground. The said relay 97 is therefore energized in a direction to close its contact 97² and to operate relay 121, which in turn, causes the energization of re-

lays 68 and 123, as previously described. It will be observed, however, that relay 121 will not in the present case, be released by the opening of contact 97² at the time relay 68 is energized, but will, on the contrary, be locked up over the calling subscriber's line via the following circuit: high voltage battery b^2 , alternate contact 87, alternate contact 88, conductor s' , wiper 24, line limb L^2 , transmitter 3, polarized relay 7, alternate contact 9, line limb L' , wiper 25, conductor t' , contact 126, said relay 121, to ground. The heavy flow of current from high voltage battery b^2 will cause the complete downward attraction of armature 8 to engage arm 11 and cause arm 12 to move arm 13 to the left, thereby releasing the coin 10 to the subscriber via chute 14. Arm 13 will therefore be free to slide through the projection 12 and allow contacts 9'-10' to return to their normal positions; but as armature 8 maintains the circuit condition above traced through the relay and transmitter, the said circuit conditions will be maintained. In addition to the return of the coin, the subscriber is notified of the busy condition of the line by a flow of current from the busy back apparatus N (previously described), via condenser 40, contact 127, conductor t' , wiper 25, line limb L' , the calling subscriber's telephone set, line limb L^2 , alternate contact 17 and to ground through cut-off relay 16, or the other ground returns then present. The subscriber is thus advised that the desired line is busy, his coin has been returned, but the link selector I has not as yet returned to normal, owing to the continued energization of relay 121, due to the assumption that the calling subscriber has not as yet replaced his telephone upon its hook. Referring again to the link-circuit (Fig. 2), it is apparent that relay 90 has been released by the opening of contact 73 of relay 68, (Fig. 1), thus causing the illumination of supervisory lamp 118 (and pilot supervisory lamp 119') over the circuit previously traced, and that supervisory lamp 110 is now illuminated over the following path: battery b' , said lamp 110, normal contact 111, contact 116, contact 124 to ground, whereby the operator receives the complete disconnecting signal. In other words, the instant the operator inserts the plug into the jack of a busy line, she receives the complete disconnecting signal, entirely irrespective of whether or not the calling subscriber replaces his telephone upon its hook. The calling subscriber meanwhile has been advised that the called line is busy. The operator in obedience to the disconnecting signal removes the plug from the jack, thus unlocking relay 89 and restoring the entire link-circuit apparatus to its normal position. It is apparent that the energization of relay 44 and its subsequent deenergization

restores the depressed ringing key, first, to its intermediate, and second, to its normal position, just as though the connection had been made to an idle line, as previously described. The link-circuit is thus immediately placed in an idle condition so that it is available to any other subscriber in the entire major group, entirely irrespective of whether or not the calling subscriber has as yet, in response to his busy back signal, replaced his telephone upon its hook. When the calling subscriber does hang up, relay 121 will be released, thus energizing the motor magnet 21 of the link circuit selector I and causing the release of the said switch in the manner previously described at length.

Third, called subscriber does not answer.—The circuit conditions, previously traced with respect to the first condition, apply to this condition up to the point when the called subscriber, not responding, the operator advises the calling subscriber that the desired party does not respond, or until the calling subscriber notifies the operator that he does not care to wait longer and desires the return of his coin. The operator, thereupon, removes the connecting plug X from its jack and preferably inserts it into a special spring-jack Z, provided for this and other purposes as previously stated. The sleeve ring f^2 of said jack is connected to battery b' via a protective resistance z^2 whereby the polarized relay W is energized upon the insertion of the plug in a direction such as to move its armature 105 to the right to cause the circuit conditions explained at length with respect to the insertion of the plug into a jack of a busy line. Resistance coil z' is connected to the said sleeve ring f^2 upon the complete insertion of the plug into the jack to provide a closed path for the flow of current from battery b' , just as is present in a busy line through the cut-off relay. The subscriber's coin is thus restored to him in the same manner as though he had called for a busy line; the link-circuit is immediately freed so as to be available to other subscribers; and the selector switch I is restored to its normal position as soon as the calling subscriber has replaced his telephone upon its hook, just as described with respect to a busy call.

If at any time in the operation of the system, the calling subscriber should neglect or refuse to replace his telephone upon its hook, or in case an accidental cross between the two limbs L' , L^2 should otherwise occur, thus in either case extending a call to an operator by the selection of an idle link-circuit in the manner previously traced, the operator, upon finding that no call is intended, would insert the plug X into the spring-jack Z as previously described, thereby releasing the link-circuit and placing it

in a condition to be selected by other subscribers, and establishing the same condition upon the subscriber's line as results before a calling subscriber has replaced his telephone upon its hook after having received the busy back signal. Referring to Fig. 1, it will be seen that under this condition, lamp O is continuously lighted by a flow of current from battery b' , via said lamp, contact 122, relay 123 and contact 117 to ground. The continued illumination of the said lamp, as distinct from its intermittent illumination at other times, indicates to the central office attendant the existence of trouble upon the circuit then associated with the corresponding line selector, as previously described. The attendant will thereupon open the subscriber's line thus releasing the link selector switch in the same manner as described when the subscriber replaces his telephone upon its hook, whereby the pair of selector switches are made available to other calling subscribers. The number of the particular line in trouble is found by the attendant consulting the "jumper list" and the pointer 26 of the line selector at which the signal is displayed; the "jumper list" is a table connecting the numbers on the pointer dials with the subscribers' numbers. In case accidental ground should occur on either limb of a subscriber's line, the following circuit conditions would exist: assuming, first, a low resistance ground on limb L^2 , the removal of the telephone from its hook would fail to initiate a call. A low resistance ground on limb L' would similarly prevent the initiation of a call. Should, however, a ground of relatively high resistance be present upon limb L^2 (say, a ground of two or three hundred ohms resistance), or should a similar high resistance ground be present upon limb L' , it would not prevent the receipt of a call upon the removal of the subscriber's telephone from its hook, because such ground would not short circuit either line relay 19 or tip supervisory relay 90 (Fig. 2); nor would it prevent the operation of tip supervisory relay 114 in case of a connection to a called line upon which such ground might be present. It thus appears that the arrangement of line relay 19 and protective resistance 19' is such that the presence of extraneous grounds will not interfere with the proper operation of the apparatus at the central office, except when said grounds are of such low resistance that they would interfere with conversation passing over the line.

The conductors of the talking circuit of "line 5" Fig. 1, the similar conductors of Fig. 4, and the talking strands of the operator's link-circuits of Figs. 2 and 3 are shown in heavy lines. I will now assume that a subscriber on "line 205", or any other line,

equipped with limited or measured service subscribers, initiates a call. The removal of the receiver from its hook will initially close circuit through line relay 19, as retardation coil 6 is now immediately placed in metallic circuit with the line limbs L', L². Subsequent to the initiation of the call, the operation with respect to a subscriber in the group represented by "line 205" is substantially the same as that described with respect to "line 5", with the exception that relay 28' (group including "line 5") is replaced by a relay 28 provided with an armature 29 acting upon the printing recording mechanism M, as previously described. In other words, magnet 28 (now acting merely as a printing magnet) is controlled by contact 97² of polarized relay 97³, (diagrammatically illustrated as having two linearly arranged cores), just as relay 28' was controlled by the operation of polarized relay 97 in group 1. In addition, the polarized relay 97 of group 1 and the magnet 121, controlled thereby, are replaced in group 2 by the said polarized relay 97³, whose armature 97⁴ is so arranged as to complete the circuit of magnet 28 when attracted in one direction (as previously described in connection with polarized relay 97 and magnet 28' of group 1), and to operate contacts 126, 127, 122 and 70 when attracted in the opposite direction—that is, at the time battery b', (Fig. 2) is thrown on to conductor L for the purpose of effecting the release as previously described. In addition, the off-normal magnet 81 (group 1) and the contacts 71, 98, 86 and 117 carried thereby, are replaced respectively by contacts 36', 37', 38' and 38², of the normal switch shown directly controlled by projection 34 of link-circuit selector switch I of group 2. It is apparent, therefore, that in the same way magnet 28' of group 1 was energized, as described with respect to calling subscriber A' of "line 5", the corresponding printing magnet 28 of group 2 will be energized to print the number of the calling subscriber upon the tape when the subscriber, whom he has called for, removes his telephone from its hook. All other conditions recited with respect to a calling subscriber in group 1 are pertinent to a calling subscriber in group 2, save those concerned directly with the collecting or returning of the deposited coin.

With respect to a calling subscriber in group 3, the same circuit arrangements exist as described with reference to group 1, with the exception that no coin collecting magnet 28' need be provided; the subscribers in said group being those having unlimited service, no contact need be provided on polarized relay 97, corresponding to contact 97'.

Referring now to Fig. 4, I have indicated

a circuit arrangement whereby subscribers included in all of the service classifications previously described may be included in a single group; and whereby the correct charges or collections may be automatically accomplished at the central office without requiring special instructions given to, or operations performed by, the operators at the switchboard. In other words, relay 28³ (Fig. 4) acts not only as a printing magnet, as is required of magnet 28 in group 2, but also as a coin collecting magnet, as is required of magnet 28' of the group including "line 5". In addition the line selector switches H H, H' H', etc., of Fig. 4 are so arranged as to automatically return to their normal positions upon the release of the corresponding link-circuit selectors I, I', etc. For this purpose they are provided with contact members 35², 36², operated by insulated projections 34 carried by the wheels 22 as described with respect to the link-circuit selectors I, I', etc. Fig. 4 may be properly considered as an alternative arrangement of the apparatus of Fig. 1, between the line conductors t, s, l, and the link-circuit conductors T, S, L. The conductors t, s, l, and 59 at the left of Fig. 4 correspond to the similarly lettered conductors of Fig. 1, part 1, and the conductors T, S, L, at the right of Fig. 4, correspond to the similarly lettered conductors of Fig. 1, part 2. The operation of the apparatus of Fig. 4 differs, however, in certain respects, from that of Fig. 1. Thus a release relay, 200, is provided for each line selector in Fig. 4 which will operate at the time of release. The motor magnet 21 of each line selector of Fig. 4 has its circuit controlled wholly by relay 72 at its contact 82. The circuits of private relays 72 and 68, are, as before, normally open at contacts 64 and 63 respectively of the master-switch K and will be closed upon the initiation of a call as previously described,—conductor 59 being then grounded at contact 20 of the line relay of the calling line. Relay 68 will therefore operate to cause the selection of the first idle link-circuit just as described with respect to Fig. 1. Relay 72 will be operated from battery b' via said relay 72, contacts 201 and 35², wiper 57 and contacts 66, 64 to ground, thereby closing the circuit of the motor magnet 21 to cause the advance of the line selector switch H H. Contacts 83 and 84 are held open during rotation, as before. The first step of the switch opens contact 35² thereby opening the circuit over which relay 72 was initially energized, but a new path for its continued energization is immediately provided from battery b' via said relay 72, normal contact 202, alternate contact 85, conductor l', wiper 23, conductors l connected to the contacts successively engaged by said wiper, to the ground contacts

20 of those lines not then calling. Relay 72 will therefore, remain energized until a calling line is reached. It will then be released (on account of the opening of the circuit at normal contact 20 of the calling line) and will open the circuit or motor magnet 21 at contact 82 thus stopping the switch in engagement with the calling line. Contacts 83, 84, also close to extend the line to the link-circuit as previously described with respect to Figs. 1 and 2. Upon the response of the called line, relay 97 will operate as before described to momentarily close contact 97' and cause one operation of relay 28³. If the calling subscriber be one provided with a coin-box instrument, he will have previously deposited his coin or token and the closing of contact 28², thus momentarily closing the circuit of battery *b*² through his station apparatus as previously described, will collect the said coin or token. If the calling subscriber be one having measured or limited service, his number will be printed once on the tape 31' by the hammer 30 engaged by the armature 29 of magnet 28³ as previously described. The type wheel 27 may be provided with removable type whereby numbers may be inserted only for the subscribers having limited or measured service and whereby the tape record will then indicate charges for such subscribers only. On the other hand, the type numbers may be inserted for all points whereby each completed connection will be charged against the correspondingly calling subscriber—those connections charged to unlimited service subscribers may then be disregarded; those charged to limited or measured service subscribers would be billed, and those charged to coin-service subscribers may be charged against the collectors, thus insuring accurate returns from the collectors. Should the called line be busy, or should the operator insert the plug X into a jack Z after determining that the called subscriber does not answer, relay 121 will be operated via contact 97² of polarized relay 97, and will close its locking circuit from battery *b*² via alternate contacts 87 and 88 over the subscriber's line and to ground via said relay 121 and its alternate contact 126, just as described with respect to Fig. 1, whereby (if the calling subscriber be provided with coin-box service) the coin or token will be returned. As relay 28³ will not be operated under the above conditions because of the failure of contact 97' to close as described with respect to Fig. 1, no record will be made of such calls on the tape 31'. It therefore appears that if desirable, the various classes of service previously enumerated may be properly handled in one group by the circuit arrangement of Fig. 4, or, in several groups by that of Fig. 1, or that

two or more classes may be handled in the same group, and that in all cases the method of handling the calls is made uniform at the switchboard irrespective of their service classifications.

Relay 97 responds to the releasing current just as in Fig. 1 and closes contact 97² to operate relay 121, which in turn operates relay 123 which in its turn operates relay 68 and locks said relay 68 and itself through the off-normal contact 36 to ground as previously described in full with respect to Fig. 1. As before, relay 121 upon its release (which as previously described occurs immediately upon the energization of relay 68 unless the calling subscriber has not replaced his telephone upon its hook), completes the circuit of motor magnet 21 of the link-circuit selector thus rotating the switch to its zero or normal position as previously described at length. In the arrangement of Fig. 4, however, I provide an extra contact 121' for relay 121 and an extra contact 123' for relay 123, whereby when relay 123 is energized and relay 121 is de-energized as above described, upon the release of the link-circuit selector, circuit will be established from battery *b*' through relay 72, said contacts 121' and 123', relay 200 and off-normal contact 36² to ground, thus operating said relays 72 and 200. Relay 200 closes its alternate contact 202 to shunt contacts 121' and 123' thus locking relays 72 and 200 up through off-normal contact 36² to ground, whereby motor magnet 21 of the line selector switch H H, is energized from the pulsating or alternating source *q* via contact 82 to ground, thus causing the rotation of the said switch to its zero point. At this point projection 34 open contact 36² thus releasing relays 200 and 72 and causing the switch to remain in its normal or zero position. During the release of said switch, contact 203 of relay 200 maintains conductor 100 grounded just as does contact 101 of relay 123 during the release of the link-circuit selector I, as previously described at length. Upon the return of both selector switches to their normal positions all grounds are removed from conductor 100, thus allowing the master-switch K to remain in engagement with any pair of idle switches which it encounters, as previously described at length. It will be understood that no line conductors are connected to the normal or zero contact buttons of the line selectors in Fig. 4 although in Fig. 1 all points may be connected to line conductors. In addition I have illustrated in Fig. 4 at *x* a resistance heat coil controlling a local circuit including a battery and a signal *x*', which may be employed in place of or in addition to the lamp signal O. It will be noticed that said heat coil is only placed

in circuit during the energization of relay 121 and that its circuit is then completed through the cut-off relay 16 of the calling line and also through the line limbs and said relay 121 as previously described. Should therefore a calling subscriber fail, in response to his busy back signal, to replace his receiver upon its hook, or should he leave his telephone set with the receiver off its hook, or should a cross occur between the two line limbs, then, in either event, after the operator has released the link-circuit thus selected as previously described, the said heat coil would at the end of a proper time melt the fusible connection which normally holds open the local circuit thus causing the said local circuit to close and operate the signal α' . The attendant is thereby notified of the existing trouble and will free the pair of selector switches as previously described.

In Fig. 3, I have illustrated one preferred arrangement of a link-circuit which may be employed when it is not required that each link-circuit be provided with a set of party line selective ringing keys. In addition, I have illustrated a circuit arrangement in which the calling lamp 96 and supervisory lamp 118 of Fig. 2 are replaced by a single signal 118' having a double function. Referring first to the arrangement of the ringing circuit it will be noticed that whereas in Fig. 2 I have arranged the magnet 41 so that it will be operated as soon as any one of the selective keys p is depressed, I have in Fig. 3 connected the said magnet 41 in circuit with the battery b' and interrupter R through a normally closed contact 42' of relay 44' and a normally open contact 42'' of relay 109, whereby said relay 41 will be operated only after the plug X has been inserted into a jack of a called line, thereby, if the line be idle, operating said relay 109 as described with reference to Fig. 2. Relay 44' (Fig. 3), performs all the functions of relay 44 (Fig. 2) except that of controlling the ringing buttons, and is initially operated, when connection is made to an idle line, by the operation of tip relay 114 upon the response of the called subscriber, just as described with respect to Fig. 2, thereby opening the circuit of relay 41 at contact 42' to disconnect the source of calling current Q from the link-circuit via contact 41'. Relay 44' is locked up during the remainder of the connection via its contact 116 and alternate contact 102 of relay 109, just as in the arrangement of Fig. 2. The operation of relay 44' also extends battery b via relay 51, alternate contact 112, alternate contact 92, conductor L', normal contact 91, conductor L'', alternate contact 78, conductor L, wiper 75 (Fig. 1) normal contact 76 to relay 97 and ground at 117, for the purpose

of operating said relay 97 and thereby cause the operation of the coin collecting or recording mechanism, just as described with respect to Fig. 2.

Referring to the arrangement of lamp 118' of Fig. 3, it will be seen that upon the initiation of a call, relay 90 will be operated just as described with respect to Fig. 2, thereby closing circuit from battery b' through pilot relay 119, said lamp 118', alternate contact 94 and normal contact 102 to ground, to illuminate said lamp as a call signal. Said lamp will be extinguished upon the operation of relay 109 just as in Fig. 2. It will however, again light should the calling subscriber replace his telephone upon its hook after the insertion of the plug X into the jack of an idle line, by reason of the circuit then closed from said battery b' through said relay 119 and lamp 118' via normal contact 94 and contact 109' of relay 109 (then closed) whereby said lamp gives the supervisory indication previously provided by lamp 118 of Fig. 2. Moreover, should plug X be inserted into a jack of a busy line, thus causing the continued operation of relay 89, the operation of relays 106 and 44' and the release of relay 90 as previously described with reference to Fig. 2, the said lamp 118' will remain lighted owing to its inclusion in the following circuit: battery b' , relay 119, said lamp 118', normal contact 94, normal contact 92, conductor L' and closed contact 106' to ground. Lamp 110 is of course also illuminated at this time by current from battery b' flowing through said lamp 110, normal contact 111, closed contacts 116 and 124 to ground as described with reference to Fig. 2. The operator therefore removes plug X in response to this disconnecting signal as previously described. In fact, with the exception above described, the link-circuit of Fig. 3 operates in the same manner as that of Fig. 2.

In Fig. 5 I have illustrated a special cord-circuit, one or more (as may be found necessary) of which may be provided at each operator's position or at each section of switchboard. It sometimes happens—although infrequently—that a calling subscriber desires connection with another subscriber who may be located on the same line. It is at once apparent that if the calling subscribers be divided into groups and if such groups contain subscribers of the same service classification only, that all party line subscribers may be included within a certain range of numbers and that the link-circuits available to such subscribers may terminate in distinctly colored plugs or cords, whereby an operator receiving a call for a party line subscriber (as determined by said number falling within the limits of said party line

numbers) from a party line subscriber (as determined by the distinctive coloring of the selected link-circuit), will request from the calling subscriber his own number in order to determine whether or not the subscriber desired be located upon the same line. As an alternative, each party line subscriber may be provided with a list of all other subscribers on his own line and with instructions accompanying said list to inform the operator, should such subscriber have occasion to call any one of said parties from his own instrument, that the desired party is on his own line. For instance, such instruction may be given by any characteristic designation as "party line" 5— or "private" 5—. The operator being advised in either of the above manners, or in any other manner, that the desired subscriber is located upon the same line as the calling subscriber will proceed as follows: She preferably first requests the calling subscriber to replace his telephone upon its hook, thereby releasing the selected link-circuit and the selected pair of selector switches, as previously described. In addition she informs said calling subscriber that she will call him upon the response of the called subscriber. The operator after the calling subscriber hangs up, inserts X' into a jack of the called party's line (the same line as the calling party's line) and, either before or after such insertion, depresses the selective key *p* of key P, corresponding to the desired party. Relay 41 is thereby intermittently energized from battery *b'* as before described and extends ringing current intermittently from the selected ringing source Q through the bell of the desired subscriber via key *p*, alternate contact 41', plug X', line limbs L' L², to ground through cut-off relay 16 and sleeve supervisory relay 109²,—in both of said relays 16 and 109² being then operated by current from battery *b'* via said relay 109², plug X' and said relay 16 to ground. Supervisory lamp 110 is at this time lighted by a flow of current from battery *b'* via said lamp 110, normal contact 111 and closed contact 102 of relay 109² to ground.

The response of the called party will cause the energization of tip relay 114 just as described with reference to Fig. 2, thereby extinguishing the supervisory lamp 110 to notify the operator of said response. In addition, relay 44² will be energized by current from battery *b'*, via said relay, alternate contact 111 and contact 102 to ground, just as described with reference to the similar relay 44 of Fig. 2. Relay 44² locks itself up via contacts 116 and 102 and releases button *p* to its intermediate or indicating position. The operator will then momentarily depress another key *p* corresponding to the

calling subscriber and cause current from another source Q to ring his bell. Relay 44² being now energized will prevent the locking of key *p* in its ringing position, whereby on the release of the key by the operator it will immediately assume its indicating position. The operator may at the same time depress her listening keys *v*, *v*, to determine if the calling party at once responds to his "all ready to talk" signal. For this purpose I preferably provide an additional contact 41² on relay 41, whereby only upon the deenergization of relay 41 will the operator's circuit V be connected to the talking strands T⁴, S⁴, via contacts 41' and 41², thus preventing ringing current passing through the operator's circuit. Upon the response of both parties the operator will momentarily depress key 600 thus closing battery *b'* momentarily to the tip side of the line circuit via resistance *r'*, T⁴, and X', whereby current is passed through the substitution circuit of the calling subscriber in a direction and of a magnitude to collect the deposited coin, if said party line subscriber be provided with a coin-box set. Conversation may now take place, the operator leaving plug X' in the jack of the line to prevent the initiation of a false call that would obviously otherwise occur. Upon the conclusion of conversation, both subscribers will replace their telephones upon their hooks, thus causing the illumination of supervisory lamp 110 by the deenergization of tip relay 114 as described previously. The operator will then remove plug X' from its jack leaving all apparatus in its normal condition. In case the desired party did not answer, the operator would ring the calling subscriber and so inform him and then momentarily depress key 601, whereby battery *b'* would be tapped to the sleeve side of the line via resistance *r'* and S⁴ to restore the deposited coin. Upon the calling subscriber again hanging up, the operator would disconnect in response to the supervisory lamp 110.

Fig. 6 illustrates one arrangement of a trunk circuit which I may employ in the connection of a subscriber's line in one central office with a subscriber's line in another central office, or with a subscriber's line in another part of the same central office. Multiple spring jacks F' are provided at the "out-going" end of each trunk line, 300, located within the convenient reach of a plurality of operators. Each trunk is preferably provided with a distributing board 301, at its "out-going" end and with a similar distributing board 301' at its "incoming" end, whereby each manually operated terminal X² may be distributed to a proper operator's position and whereby each outgoing trunk may be distributed to its proper central office. Each plug X² may normally rest

in a seat so as to force spring 302 out of contact with stop 303, thus preventing the normal illumination of lamp 304. Each trunk is also provided with a relay 305, serially connected in its sleeve conductor having a normally closed contact 306 controlling the said lamp circuit at a second point. Should an operator receive a call for a desired subscriber in another central office, she would communicate with the operator at that central office capable of establishing the desired connection, by means of the customary "order wire circuit" extending between the operators, and inform said operator of the number of the desired subscriber. Said operator would then elect the trunk to be employed (300 in this case) and would inform the first operator of this election. The first operator would then insert the plug X (Fig. 2) into a jack F' (Fig. 6) and the second operator would insert the plug X² into a jack F (Fig. 1) of the desired line, thereby extending the circuit of the calling line through the link-circuit of Fig. 2 to the line of the called subscriber. Relay W of said link-circuit would then operate to move its armature 105, in either one direction or the other depending upon the busy or idle condition of the desired line, just as explained at length with respect to Fig. 2. In fact, the entire operation of the apparatus will from this time on, be the same as previously described with respect to Fig. 2, except in the following additional particulars: Relay 305 at the distant central office is energized by the flow of current from the battery b' (Fig. 2) via either relay 89 or 109 (depending upon the busy or idle condition respectively of the called line) sleeve strand S, plug X, jack F', sleeve side of trunk 300, through said relay 305, plug X², jack F of called line, its cut-off relay 16 to ground; whereby the circuit of lamp 304 is maintained open at contact 306, although now closed at contact 302-303, by reason of the removal of the said plug X² from its seat. Condenser 307 is provided to secure a talking circuit free from the impedance of relay 305. Upon the receipt of the disconnecting signal by the first operator (whether said signal be automatically and immediately received as would be the case if the called line were busy, or whether it be received at the conclusion of conversation, as previously described at length) the said operator will withdraw plug X from jack F' thus de-energizing relay 305 and causing lamp 304 to light, as its circuit is now closed both at contact 306 and at contacts 302, 303. The second operator, in response to this disconnecting signal, withdraws plug X² and returns it to its seat, thus extinguishing lamp 304 and leaving all apparatus in its normal position.

It is apparent that a sufficient number of

such trunk lines, 300, may be provided between each central office and each other central office to provide for all calls between subscribers in different central offices, and that the operators handling the incoming ends of these trunk circuits preferably handle no other calls. It will also be apparent to those generally skilled in the art of telephony that many different arrangements may be employed for trunking between the several central offices or the several sections of the same central office and my invention is not limited to the use of any particular method of trunking or arrangement of circuits, but comprehends means for establishing connection directly to the jack of a called line as described with respect to Fig. 2, or indirectly thereto by means of an auxiliary link as described in connection with Fig. 6.

I have hitherto confined the description of my invention to lines, which, when calling, are automatically connected to manually operated link-circuits. It may happen that in addition to lines of the above character, other lines provided with individual fixed calling terminals, will be brought into the same central office. As an illustration, it may be required in an existing exchange system in which all lines are provided with individual answering jacks to change over all or a part of the exchange so that those changed will operate in accordance with my invention as heretofore described. The change must be made so as not to interrupt the ready interconnection of all subscribers lines. Figs. 7 and 8 illustrate one adaptation of my invention to meet either such temporary or permanent conditions. In Fig. 7, I have shown two subscribers' lines, one line 605, extending via the intermediate distributing board G, to a group of line selectors H, H', etc., as previously described with respect to Fig. 1, and the other, line 705, extending via the said distributing board G to an answering jack F' and line relay 400. The said relay 400, controls by its contact 401, the individual call lamp 402 in the well-known manner. Relay 403 is a pilot call relay common to a group of call lamps and controls by its contact 405, the pilot call lamp 404 in the well-known manner. In fact the general arrangement of line 705 is well-known in the art and needs no further explanation.

Fig. 8 illustrates an operator's link-circuit adapted to operate with lines of the character illustrated at line 705, Fig. 7, and provided with party line selective ringing keys diagrammatically illustrated at 410. 412 represents the operator's set controlled by keys 411. 413 represents the "busy test" relay, which when operated, will short circuit the impedance coil 413' to cause an induced busy test "click" in the

operator's receiver. 414 and 415 are respectively the sleeve and tip supervisory relays controlling the supervisory lamp 420 associated with the calling end of the link-circuit. 416 and 417 are respectively the sleeve and tip supervisory relays controlling supervisory lamp 419 associated with the answering end of said link-circuit. 418 and 421 are respectively the pilot supervisory relay and pilot lamp associated only with calling lines. X^4 is the answering plug adapted for insertion into the jacks F^4 , and X^2 is the calling plug adapted for insertion into the multiple jacks F , (Figs. 1 and 7). Should now a subscriber on line 705 remove his receiver from its hook for the purpose of initiating a call, relay 400 would be operated by current from battery b' flowing through relay 19^a, normal contact 17, line limbs $L^2 L'$, normal contact 18, jumper wire g , said relay 400 to ground. The operation of relay 400 lights call lamp 402 and the operator in response to the signal, inserts plug X^4 into answering jack F^4 , thereby energizing both supervisory relays 416 and 417 and the cut-off relay 16 of the calling line. She then depresses the listening key 411 and inquires the number of the desired subscriber. Should a similarly equipped subscriber's line be called for, or should a subscriber's line having no individual calling terminal be called for, the operator would proceed to test the spring jack F of the desired line by touching its test ring f with the tip of the plug X^2 . In case the desired line be equipped for automatic distribution as described in Figs. 1 and 2, we have already found that the said test ring f will be altered in potential from ground. A flow of current will result therefore from said test ring through the tip of the plug X^2 , normal contact of relay 414 to ground through the test relay 413, thereby energizing it and short circuiting coil 413' to cause the busy test "click".

In case the desired line be equipped with answering jacks, that is, if its equipment be similar to line 705, and if said line be busy, either an answering plug X^4 will be already inserted in its answering jack F^4 , or a calling plug X^2 will be already inserted in one of its multiple jacks F , whereby, in either case, battery b' will be connected to the test rings f of all its jacks, either via relay 416, in the one case, or via relay 414 (or resistance coil 414') in the other, thus causing a similar flow of current through the test relay 413 and causing such line to test busy. In case the desired line be idle, no flow of current will result through the test relay 413, because the test rings f of lines similar to 705 are normally connected to earth only, just as pointed out with respect to the test rings f of lines equipped as in Fig. 1. Consequently the line will

test idle and the operator will insert the plug into the jack and proceed to ring the desired subscriber. The insertion of the plug X^2 into any jack F of any line energizes the cut-off relay 16 of that line to remove the normally associated signaling apparatus from the line and extend the line to the multiple spring jacks. The energizing path is as follows, before a ringing key 410 is depressed: battery b' , relay 414, plug X^2 , jack F , cut-off relay 16 to ground. During the operation of a ringing key, the path through relay 414 is replaced by the path through resistance coil 414'. At the same time, circuit from ringing generator Q is sent over the called line via plug X^2 , jack F , line limbs $L^1 L^2$, returning to ground via cut-off relay 16 and via coil 414' to battery b' and ground. The conversational circuit is completed as usual upon the removal of the called subscriber's receiver from its hook and relay 415 is energized by current over the line limbs thereby extinguishing lamp 420 and indicating the response to the operator. When both telephones are replaced upon their hooks, thus causing the illumination of both lamps 419 and 420, the operator will disconnect both plugs from their jacks thus releasing both cut-off relays 16 and leaving all apparatus in its normal position. In case a subscriber on line 605, (Fig. 7) initiates a call, it will be received on an automatically selected link-circuit in the manner described with respect to Figs. 1 and 2. Should said subscriber desire connection to a similarly equipped subscriber, the operator would proceed as already described with respect to Figs. 1 and 2. Should the subscriber call for a subscriber whose line is equipped similarly to line 705 (Fig. 7) then the operator would proceed just as previously described with reference to Figs. 1 and 2 and would not necessarily know the character of the line with which she makes connection. The insertion of plug X (Fig. 2) into a multiple jack F of line 705 (Fig. 7) causes relay W of the link-circuit to move its armature 105 either to the right or to the left, depending upon the busy or idle condition of the called line with the results previously set forth at length and also causes the energization of cut-off relay 16 of line 705 for the same purposes and with the same results previously described. The response of the called subscriber will collect the deposited coin or register the completed call or both, just as previously described. Conversation and disconnection is secured in the same manner as before. It thus appears that my invention in one of its phases includes means for interconnecting lines provided with individual stationary answering terminals and lines equipped with means for automatically extending calls to the idle link-circuits.

I will now assume that it is desired to change line 705 from one provided with an individual answering jack to one provided with means for automatically extending calls to the idle link-circuits. The group of three jumper wires *g* may be disconnected from the terminals of the distributing board G extending to jack F⁴ and relay 400 and may be connected to a group of terminals extending to conductors *t*, *s*, and a relay 19—just as are the jumpers *g'* of line 605 now extended to similar conductors. Line 705 will therefore be immediately transformed from one class to another. In changing over an exchange system, the lines may thus be transferred singly or in groups without delay or impairment of the service. Similarly an existing system may be extended by the addition of lines and connecting apparatus of the same or different class without the impairment of service.

It will be understood that I have illustrated in Fig. 7 but one of many known types of line circuits having individual answering terminals, and in Fig. 8, but one of many available types of link-circuits and that the same or similar means may be employed either to change over other existing systems of telephony to operate in accordance with my invention or to allow mutual interconnection between subscribers some of whose lines may be provided with individual answering terminals and others with means for automatically extending their calls to the idle link-circuits.

In Fig. 7 I have also illustrated a heat coil arrangement which I preferably employ when the line relay 19 (or 400) is connected to that line limb (L') opposite the limb (L²) connected to the battery *b*. I have already pointed out in the description of Figs. 1 and 2, that the grounding of either line limb L' or L² will not result in the improper operation of a pair of selector switches, and that if said cross to ground be of sufficiently low resistance, relay 19 will fail to respond. In order that the exchange attendants may be advised of the existence of such a ground on say line 605, I provide a relay 19³ controlling a local circuit at contact 19³ including a heat coil having a pin 19⁴ soldered or fused at 19³ to a spring 19⁵ which when released by the heating of the coil will close a local circuit containing a source of current *b*, a signal 19², or alarm 19⁵, or both. Said heat coil and its local circuit may be common to a plurality of lines—say 10 or more. Should now a ground of low resistance occur on limb L², thus operating relay 19³, a continuous flow of current would result through the heat coil via contact 19³, causing it, after a proper interval, to heat sufficiently to melt the solder or fusible metal and close the local circuit through the said signal and alarm. The attendant may then readily locate the

line in trouble from operated relay 19³ and report or remove the trouble. The momentary operation of relay 19³ at the time a call is made is insufficient to cause the operation of the heat coil. Should now a low resistance ground occur on limb L' and should a subscriber remove his telephone to initiate a call, relay 19³ would again, as long as the telephone is kept off the hook, continuously operate to cause the operation of the heat coil and thus notify the exchange attendant of trouble as before. Each of the lines illustrated in Fig. 1 may be similarly equipped if desired; so may the lines 705.

A preferred form of switch adapted for use either as a link-circuit selector, line selector or master-switch is mechanically illustrated in Figs. 9, 10, 11 and 12. This switch consists essentially of a shaft 21' adapted to be rotated step-by-step by the motor magnet 21, and carries four wipers, 504, which make contact successively with the various stationary contact members. The wipers are shown in their normal or zero position in Figs. 9 and 11. Fig. 13 is a diagram of the contact members on each side of the said zero position and adjacent thereto. The wipers 504 are again shown in their zero position. At this position the upper wiper makes electrical connection between the individual contacts 35 but when in any other position, closes connection between the contact strips 36 which extend around the entire circle except at the zero position. The second wiper closes connection between the common strip 507 and one of the individual contact points 510 in its zero position and between said common strip and some other point 510 in each other position. Similarly the third wiper closes contact between common strip 508 and contact points 511, and the fourth or lower wiper closes contact between common strip 509 and contact points 512. Insulating rings 506 separate and electrically insulate the various layers of contact points from the common strips and from each other. Thus, upon the metallic base plate 501 is placed an insulating ring 506, upon that a common contact strip 509 provided with a connection terminal 509', then an insulating ring 506, then a layer of one hundred and one individual contact points 512, another ring 506, another common contact strip 508 provided with a soldering terminal 508', another ring 506, a second row of one hundred and one individual contact points 511, another ring 506, a common contact strip 507 provided with a terminal 507', another ring 506, another row of one hundred and one individual contact points 510, another ring 506, then a common contact strip 36 provided with a soldering terminal 36'; said strip being cut away at the zero point to provide an individual contact 35 at this point, then another ring 506, a similar

contact strip 36, terminal 36', and individual contact 35, then a last insulating ring 506. The top metallic plate and support 513 is screwed by means of screws 514, extending through insulated bushings, to the bottom plate 501 whereby all groups of contacts and contact strips are held firmly in place and at fixed separating distances. The shaft 21' is shouldered at both ends and is held in place at its lower end, by a hollow bolt 500 threaded into the base plate 501, and is held at its upper end by the bridge or support 502. Said bridge is fixed to the pole pieces 515 of the motor magnet 21, which pole pieces are in turn fixed to the said top plate 513. Said shaft rotates freely in the bearings provided in said supports and carries the wheel 22 keyed thereto and provided with one hundred and one square cut teeth. Each wiper 504 is made up of two spring metallic strips suitably curved at their outer or contact ends, as shown in Fig. 13, to readily slide over and contact with the stationary contact members and perforated at their inner ends to slip over an insulating sleeve provided on the metallic hollow bushing 505, which in turn is slipped on the shaft 21' and secured thereto by a set screw 505². Insulating washers 503 are used to properly space the wipers and insulate each from the other. The metallic bushing 505 is provided at its lower end with a thread upon which nut 505' is screwed to clamp the wipers and hold them in a fixed position with respect to the shaft 21'. The two spring strips forming each wiper are given a permanent "set" to insure proper contact with both the upper and lower stationary contact members between which the wiper terminals rotate.

26 is the pointer which may be attached to the lower end of shaft 21' by nut 516 and which thus has a fixed position with respect to the wipers. A graduated scale may be stamped on the base plate 501 (Fig. 12) whereby the reading of the pointer will correspond to the position of the wipers. The irregularly shaped armature 517 for motor magnet 21 is centrally pivoted on shaft 21' by a sleeve 518 to which said armature is fixed. The pole pieces 515 of said magnet 21 are suitably shaped to attract, upon the energization of said magnet, both ends of the armature 517. A retracting spring 519 fixed at one end to the frame 513 and acting upon the armature 517 at its free end, serves to retract said armature upon the deenergization of the magnet. The said armature carries two pawls 520 and 521, pivotally mounted thereon and provided with customary engaging springs 520' and 521'. Fixed stops 520² and 521² are provided for said pawls by projections of piece 522 screwed to the top plate 503. Upon the energization of the magnet 21, armature 517 will be attracted to cause pawl 521 to rotate

wheel 22 in the direction of the arrow, and consequently wipers 504. Stop 521² limits the motion to a little more than one tooth or division and forms a forward stop to the armature throw. Pawl 520 during said throw rides upon pin 523 fixed to the plate 513, thereby disengaging itself from wheel 22. Upon the deenergization of magnet 21, the armature is restored by spring 519 and pawl 520 engages the preceding tooth of wheel 22 and forces said wheel backward a fraction of one division, the net forward movement of the complete energization and deenergization being one complete tooth. Should magnet 21 become deenergized after starting the motion of its armature but before completing its stroke, thereby carrying the wipers forward less than one complete step, pawl 520 would upon the said energization engage the same tooth with which it was in previous engagement and carry the wheel back the same amount it had advanced, thereby leaving the wipers on the same contact members they were previously engaging. This is an important feature of my switch. It sometimes happens that the ground is removed from the local conductor controlling the busy condition of a circuit at just the moment the said circuit is engaged by the wipers of a selector switch then rotating and seeking an idle circuit. Thus, referring to Figs. 1 and 2, it may happen that just as a link-circuit selector I, while rotating to select the first idle link-circuit, is in engagement with the contacts of a busy link-circuit, the said link-circuit will be freed from its existing connection. The release of its relay 89 by opening the circuit of the local conductor L at switch Y via normal contact 78, as previously described at length, should then cause the link-circuit selector I to remain in engagement with the said link-circuit, for it is now idle. Private relay 68 of the said link-circuit selector I has however been previously held up by current from battery b' via said relay 68, normal contact 77, alternate contact 76, wiper 75, said conductor L and the ground present on said conductor prior to the release of said relay 89. The release of relay 89 opens this circuit at switch Y thus causing the release of relay 68 and the opening of the circuit of motor magnet 21 at contact 69. Said motor magnet may however have already started the attraction of its armature to cause the wipers to advance. In such event, unless means were provided to the contrary, the said wipers might remain in an intermediate position between two sets of contact points due to the retraction of the armature 517 by spring 519 before the completion of its stroke. The arrangement of the pawls 520 and 521 is however such as to cause the return of the wheel 22 and wipers 504 to 130

their preceding position should the armature 517 prematurely be released and retracted as above described. I preferably construct one set of contact points such as 510 with a
 5 broader contact surface than the two other sets 511 and 512 whereby the wiper traveling over contacts 510 may establish connection with one contact before breaking circuit with the preceding—or may approxi-
 10 mate such condition, and whereby the wipers traveling over contacts 511 and 512, will break circuit with one contact before making contact with the next. I preferably utilize contacts 510 for the local conductors
 15 and contacts 511 and 512 for the talking conductors.

It will be understood, that whereas in my diagrammatic drawings of the various selector switches in Figs. 1 and 4, I have represented conductors directly connected to the wipers, such conductors are in the switch
 20 illustrated in Figs. 9 to 13, attracted to the common contact rings 507, 508 or 509, with which said wipers are constantly and respectively in contact.

It is also evident that the zero contact points 35, 35 and the off-normal contact rings 36, 36 of Figs. 9 to 13 are the equivalent of the similarly numbered contact mem-
 30 bers illustrated diagrammatically in Figs. 1 and 4. Also that where additional contacts of this nature are required as illustrated at 37', 38' in switches I, I' of Fig. 1, part 2, group 2, they may be added to the switch of
 35 Figs. 9 to 13 by merely duplicating the contact points and common contact rings 35, 36 and providing wipers therefor similar to those already provided.

It is also evident that when it is desired to
 40 use such switch for the line selectors H, H', etc., of Fig. 1, no conductors will be connected to contacts 35, 35,—the zero point then becoming similar to all other points.

Again it is evident that should certain switch points be left unconnected to circuits,
 45 that is, should there be more points than circuits in a given group, the unused local contact points 510 would be connected to ground thereby rendering them busy and
 50 causing the wipers to advance beyond them.

It is also evident that the switch of Figs. 9 to 13 may be employed for the master switch K and that the unused points with
 55 which wiper 56 (Figs. 1 and 4) engage, may be grounded or that the various contacts may be multiplied in groups depending upon the number of pairs of selector switches provided for a group of lines—
 60 thus if there be 10 such pairs of selector switches and if the master-switch be provided with one hundred and one points or divisions, each group of selector switches could be multiplied 10 times and the 101st point 510 grounded.

It will also be apparent that my intention

is not limited to the use of the switch construction shown in Figs. 9 to 13 or to any particular form or size of switch but that many other switch constructions might be employed. Likewise the switch construction
 70 herein disclosed is capable of use in other relations than those mentioned.

In case there be more than one subscriber calling at the same time, it is apparent that there will be a plurality of motor magnets
 75 21 simultaneously operating and in multiple circuit with each other from the common source *g*. If the said source be a source of pulsating current as from a machine generator, or be from a source of direct current
 80 provided with a pole-changer, and if there be a difference of inductance between the several motor magnets 21, the release of the armatures of certain of said motor magnets will be delayed owing to the discharge path
 85 provided by the motor magnet or magnets of relatively low inductance. The speed at which the switches can be properly and reliably operated, will therefore be lowered by the presence of unequal inductance
 90 among the various motor magnets, unless means be provided for positively causing the quick discharge and consequent release of each and every motor magnet. I therefore, preferably use a source of alternating
 95 current at *g* whereby the magnetization of all motor magnets which may be operating at the same time will be positively and quickly reversed twice each complete cycle. Two complete strokes of the armature are
 100 thus positively obtained for each cycle, and I have found in practice that with a switch of the preferred construction shown in Figs. 9 to 13, and by the use of alternating current at the source *g*, a speed of seventy and even
 105 more steps of the switch wipers per second may be readily obtained.

Fig. 14 illustrates mechanically a preferred form of printing register M. It consists essentially of a type wheel 27, and a
 110 printing magnet 28 adapted on its energization to attract its armature 29 and thereby cause hammer 30 to print on the paper strip or tape 31', carried by the drum 31, 32, the opposing number then presented by
 115 the type wheel. Said type wheel is adapted to be mounted on, and carried by, the projecting end 21' of the shaft 21' of the selector switch shown in Figs. 9-13. The end of said shaft 21' may be shouldered and
 120 threaded and the type wheel 27 secured thereto by nut 700 (Fig. 14). The printing magnet 28 and drums 32, 31 are suitably mounted on a supporting base 701 in fixed relation to the said shaft 21' and type wheel
 125 27 by means of screws 702, 703 and 704. The tape is unwound from drum 31 and wound up on drum 32. By means of the said screws, 703 and 704, the drums may be removed to permit the removal of a record
 130

for auditing and the substitution of a full for an exhausted roll of tape. Friction rollers 705, 706 suitably guide and hold the tape 31' either side of the printing hammer.

5 Printing magnet 28 is partially cut away to disclose the step-by-step driven wheel 33 fast to the drum 32, which advances the tape one division at each release of the armature 29. Said armature is pivoted at 707 to the
10 angle iron 708 which in turn is fast to the core 709 and angle mounting frame 710. Spring 711 is fast to said angle iron at one end and rests on the under surface of armature 29 at its free end whereby said armature
15 is retracted when the magnet is deenergized. Pawl 711 is pivoted to the armature and on its retraction advances the wheel 33 one step. The hammer 30 is carried by armature 29 and pivotally secured
20 thereto, whereby spring 712 acting on the lower end thereof will cause the hammer to rebound from the type wheel, the blow being struck as a result of the momentum of the hammer during the attraction of the armature 29. A suitable ink roller is shown at
25 713 engaging removable type 750 mounted in the periphery of the wheel 27. I have shown in Fig. 15 a portion of the periphery of the type wheel 27 with the removable
30 type 750 mounted thereon, and in Fig. 16 I have shown a section of the printed tape record. The numbers indicate that subscribers 11, 23, 4, 19 and 76 belonging to the particular group to which the line selector
35 and register M are assigned, have each in the above order, secured one completed connection to a called subscriber. If desired, the type 750 may bear the actual numbers of the calling subscribers. If this be done,
40 then each time a new subscriber is added to a group, the corresponding type will be inserted into each type wheel of the group; or each time a subscriber is transferred from one group to another by means of the jumpers
45 g, as previously described, corresponding changes in the type will be made so that the true number of each calling subscriber who has secured a completed connection will be recorded. On the other hand, the
50 type may be numbered consecutively from 0 to 100, in the example chosen, and arranged consecutively in each type wheel. In this case, the true number of the calling subscriber would be determined by reference to
55 the "jumper" list. Thus in case the number actually printed were 59 and the record were taken from a type wheel in the 16th group of line selectors, the said list would be consulted to determine the actual number of the subscribers whose line is carried
60 via the jumpers g to the 59th points of the line selectors of group 16. In either arrangement it would only be necessary, in the example chosen as an illustration, to consult the records of ten registers in order to

correctly bill the number of completed calls, or those in excess of a fixed number, to each such measured service subscriber.

If it be desired to supply registers for groups of subscribers other than those having limited or measured service, it may obviously be done by merely adding the registers M to the line selectors as described. Thus, if such registers be provided for the slot-service or pay-station subscribers, the
70 records made up for each line would indicate the number of nickels which should be returned by the collector for that line, thus providing a check on the collectors. Similarly if it be desired, the unlimited service
75 subscribers may be provided with registers whereby the number of completed connections initiated by any line may be automatically recorded. When different classes of
80 business are combined in one group as described with reference to Fig. 4, it is obvious that the type may be either arranged to print the true numbers of the calling lines or may be arranged consecutively as above described,
85 or that if it be desired to record completed connections from the measured service subscribers only of that group, the type corresponding to other subscribers may be left blank.

Fig. 17 illustrates mechanically a preferred form of coin-box or pay station device
90 D for use at the subscribers' stations. It comprises a box having walls 800 supporting the polarized relay 7, coin-chute 801 and their associated parts and contact springs. The polarized relay 7 is fastened to the iron
100 mounting strip 802, which in turn is fastened to the box by screws 803 and carries the bent permanent polarizing magnet 804 extending forward and terminating in front
105 of the armature 8'. Said armature is pivoted at 805, to a brass strap 806 fast to and encircling the free ends of the magnet cores. Said armature is provided with a projecting
arm 8" provided with a pin 8' adapted to be engaged by the restoring springs 807, 808, which are mounted by screws 809 and blocks
110 810 to a projection 802' of the mounting strip 802. Arm 811 mounted on the front of the box by screws 812, is provided with a spacing stop 813 against which said restoring
115 springs 807, 808 normally press, whereby said armature 8' is normally held in a fixed intermediate position. In said position spring contact 9 is closed to spring 823 but open from 8². When the upper end of the armature moves to the left, spring 9 breaks from
120 823 and contacts with 8². The armature arm 8' also carries a slotted post 8⁵ into which slot projects a stiff spring 11² fixed at its opposite end to the same projecting support
125 802', whereby the motion of the armature in either direction is checked after a certain limited movement fixed by the width of said slot, unless the relay coils be then traversed
130

by current in one direction or the other from the source of high electromotive force b^2 (Figs. 1 and 4). The armature also pivotally carries a connecting rod 814 provided with a slot 815 engaging a pin 816 carried by the upright arm 13 which arm in turn is pivoted at 817 to a connecting rod 818 pivoted at 819 to the mounting block 820 fast to the box. Slot 815 is so proportioned as not to engage pin 816 when armature 8' is moved in its lesser degree, in either direction as limited by slotted post 8⁵, but so as to engage said pin and move said arm 13 either to the right or to the left upon the greater energization of relay 7. Arm 13 is provided at its lower end with an insulated stop 821 normally resting lightly upon spring 9' which normally maintains contact with spring 822. When a proper coin or token is deposited in chute 801 it will strike the top of arm 13 and cause spring 9' to open its contact and spring 10' to close its contact,—the coin being prevented by arm 13 from passing out either chute 14 or 15. The complete movement of armature 8' under the influence of current from said high voltage battery b^2 , will, however, cause arm 13 to move either to the right or left thereby allowing the deposited coin to be either returned to the subscriber via chute 14 and holder 825, or to be deposited in the box via chute 15. The wiring of the contacts will be obvious from Figs. 1 and 1^a. In other words, spring 9 is to be connected to 9' and to one terminal of relay 7; spring 8² to line limb L' and to spring 822; spring 823 to 10', and spring 824 to ground.

From a consideration of the invention and the embodiment of it disclosed herein, it will be apparent that many modifications and alterations may be made in the matter disclosed without departing from the spirit and scope of the invention, and that many of its features and details are capable of use in other connections. I therefore, do not wish to be limited to the specific matter disclosed, but aim to cover by the terms of the appended claims all such alterations, modifications and adaptations.

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

1. A telephone exchange system comprising a telephone line, a plurality of associated link-circuits, means including electrically controlled switches for extending the circuit of said telephone line to an idle one of said link-circuits, and means for causing the substantially simultaneous operation of the switches required in extending said line circuit.

2. A telephone exchange system comprising a subscriber's telephone line, a plurality of associated link-circuits, means including electrically controlled switches for extending the circuit of said telephone line to an

idle one of said link-circuits, and means under the control of the subscriber for causing the substantially simultaneous operation of the switches required in extending said line circuit.

3. A telephone exchange system comprising a telephone line, a plurality of associated link-circuits, manually actuated means for extending the circuit of each of said link-circuits, means including electrically controlled switches for extending the circuit of said telephone line to an idle one of said link-circuits, and means for causing the substantially simultaneous operation of the switches required in extending said line circuit.

4. A telephone exchange system comprising a subscriber's telephone line, a plurality of associated link-circuits, manually actuated means for extending the circuit of each of said link-circuits, means including electrically controlled switches for extending the circuit of said telephone line to an idle one of said link-circuits, and means under the control of the subscriber for causing the substantially simultaneous operation of the switches required in extending said line circuit.

5. A telephone exchange system comprising a telephone line, a plurality of associated link-circuits, a plurality of electrically controlled switches associated with the answering ends of said link-circuits and operative to establish connection between said telephone line and an idle link-circuit, another electrically controlled switch for extending the circuit of a selected idle link-circuit, and means for causing the substantially simultaneous operation of the required switches.

6. A telephone exchange system comprising a subscriber's telephone line, a plurality of associated link-circuits, a plurality of electrically controlled switches associated with the answering ends of said link-circuits and operative to establish connection between said telephone line and an idle link-circuit, another electrically controlled switch for extending the circuit of a selected idle link-circuit and means under the control of the subscriber for causing the substantially simultaneous operation of the required switches.

7. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated link-circuits, an electrically controlled switch associated with the answering end of each of said link-circuits and operative to establish connection between its link-circuit and a calling telephone line, another electrically controlled switch for extending the circuit of a selected idle link-circuit, and means for causing the substantially simultaneous operation of the required switches.

8. A telephone exchange system comprising

ing a plurality of subscribers' telephone lines, a plurality of associated link-circuits, an electrically controlled switch associated with the answering end of each of said link-circuits and operative to establish connection between its link-circuit and a calling telephone line, another electrically controlled switch for extending the circuit of a selected idle link-circuit, and means under the control of the calling party for causing the substantially simultaneous operation of the required switches.

9. A telephone exchange system including an interconnecting link-circuit terminating at its opposite ends in movable switch contacts, a plurality of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, means for causing the substantially simultaneous operation of said movable contacts to automatically select and connect definite conductors to the ends of said link-circuit.

10. A telephone exchange system including an interconnecting link-circuit terminating at its opposite ends in movable switch contacts, a plurality of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, a single control device, and means responsive to the operation of said device to cause the substantially simultaneous operation of said movable contacts to automatically select and connect definite conductors to the ends of said link-circuit.

11. A telephone exchange system including an interconnecting link-circuit terminating at its opposite ends in movable switch contacts, a set of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, means for changing the normal relative condition of each set of passive contacts and automatic means dependent upon the changed condition of said passive contacts for causing the practically simultaneous operation of said movable contacts to select and connect definite conductors to the ends of said link-circuit.

12. A telephone exchange system including an interconnecting link-circuit terminating at its opposite ends in movable switch contacts, a set of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, means for changing the normal relative condition of the contacts of each set of said passive contacts, a single control device, and means responsive to the operation of said device and dependent upon the changed condition of said passive contacts to cause the substantially simultaneous operation of said movable contacts to automatically select and connect definite conductors to the ends of said link-circuit.

13. A telephone exchange system comprising

a plurality of telephone lines, passive switch contacts for said lines at the exchange, an interconnecting link-circuit, a plurality of switch contacts associated with the ends of said link-circuit, one of said movable contacts cooperating with said passive contacts, other passive contacts associated with said other movable contacts, conductors leading from said other passive contacts, and means for causing the substantially simultaneous operation of said movable contacts to select and connect a calling line to one end of said link-circuit and an idle conductor to the other end of said link-circuit.

14. A telephone exchange system comprising a plurality of telephone lines, passive switch contacts for said lines at the exchange, an interconnecting link-circuit, a plurality of switch contacts associated with the ends of said link-circuit, one of said movable contacts cooperating with said passive contacts, other passive contacts associated with said other movable contacts, conductors leading from said other passive contacts, means for causing the substantially simultaneous operation of said movable contacts to select and connect a calling line to one end of said link-circuit and an idle conductor to the other end of said link-circuit, and manually controlled connecting means associated with the distant ends of said conductors.

15. A telephone exchange system comprising a plurality of subscribers' lines, passive switch contacts for said lines at the exchange, an interconnecting link-circuit, movable switch contacts associated with the ends of said link-circuit, one of said movable contacts cooperating with said passive contacts, other passive contacts associated with said other movable contact, conductors leading from said other passive contacts, and means under the control of the calling party for causing the substantially simultaneous operation of the movable contacts to select and connect the calling line to one end of said link-circuit and an idle conductor to the other end of said link-circuit.

16. A telephone exchange system comprising a plurality of subscribers' lines, passive switch contacts for said lines at the exchange, an interconnecting link-circuit, movable switch contacts associated with the ends of said link-circuit, one of said movable contacts cooperating with said passive contacts, other passive contacts associated with said other movable contact, conductors leading from said other passive contacts, means under the control of the calling party for causing the substantially simultaneous operation of the movable contacts to select and connect the calling line to one end of said link-circuit, and manually controlled connecting means associated with the distant ends of said conductors,

17. A telephone exchange system including a plurality of interconnecting link-circuits each terminating at its opposite ends in movable switch contacts, a set of passive contacts accessible to each movable contact, conductors terminating in said passive contacts and control means common to a plurality of said link-circuits for causing the substantially simultaneous operation of the movable contacts of an idle one of said link-circuits to establish connection between definite conductors.

18. A telephone exchange system comprising a plurality of telephone lines, passive switch contacts for said lines at the exchange, a plurality of interconnecting link-circuits each terminating at its opposite ends in movable switch contacts, the movable contacts at one end of said link-circuits coöperating with said passive contacts, other passive contacts associated with said other movable contacts, conductors leading from said other passive contacts, and means common to a plurality of said link-circuits for causing the substantially simultaneous operation of the movable contacts of an idle one of said link-circuits to establish connection between a calling line and an idle conductor.

19. A telephone exchange system comprising a plurality of telephone lines, passive switch contacts for said lines at the exchange, a plurality of interconnecting link-circuits each terminating at its opposite ends in movable switch contacts, the movable contacts at one end of said link-circuits coöperating with said passive contacts, other passive contacts associated with said other movable contacts, conductors leading from said other passive contacts, means common to a plurality of said link-circuits for causing the substantially simultaneous operation of the movable contacts of an idle one of said link-circuits to establish connection between a calling line and an idle conductor, and manually controlled connecting means associated with the distant ends of said conductors.

20. A telephone exchange system comprising a plurality of subscribers' telephone lines, passive switch contacts for said lines at the exchange, a plurality of interconnecting link-circuits each terminating at its opposite ends in movable switch contacts, the movable contacts at one end of said link-circuits coöperating with said passive contacts, other passive contacts associated with said other movable contacts, conductors leading from said other passive contacts, and means under the control of calling subscribers for causing the substantially simultaneous operation of the movable contacts of an idle one of said link-circuits to establish connection between a calling line and an idle conductor.

21. A telephone exchange system comprising a plurality of subscribers' telephone lines, passive switch contacts for said line at the exchange, a plurality of interconnecting link-circuits each terminating at its opposite ends in movable switch contacts, the movable contacts at one end of said link-circuits coöperating with said passive contacts, other passive contacts associated with said other movable contacts, conductors leading from said other passive contacts, means under the control of calling subscribers for causing the substantially simultaneous operation of the movable contacts of an idle one of said link-circuits to establish connection between a calling line and an idle conductor, and manually controlled connecting means associated with the distant ends of said conductors.

22. A telephone exchange system including an interconnecting link-circuit terminating at its opposite ends in movable switch contacts, a plurality of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, electrically controlled means for causing the substantially simultaneous operation of said movable contacts to automatically select and connect with definite conductors, and control circuits for said electrically controlled means independent of said link-circuit.

23. A telephone exchange system including an interconnecting link-circuit terminating at its opposite ends in movable switch contacts, a set of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, means for changing the normal relative condition of the contacts of each set of said passive contacts, electrically controlled means dependent upon the changed condition of said passive contacts for causing the substantially simultaneous operation of said movable contacts to automatically select and connect with definite conductors, and control circuits for said electrically controlled means independent of said link-circuit.

24. A telephone exchange system including a plurality of interconnecting link-circuits each terminating at its opposite ends in movable switch contacts, a set of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, electrically controlled means common to a plurality of said link-circuits for causing the substantially simultaneous operation of the movable contacts of an idle one of said link-circuits to establish connection with definite conductors, and control circuits for said electrically controlled means independent of said connected link-circuit.

25. A telephone exchange system comprising a plurality of telephone lines, passive switch contacts for said lines at the exchange, a plurality of interconnecting link-

circuits each terminating at its opposite ends in movable switch contacts, the movable contacts at one end of said link-circuits cooperating with said passive contacts, other passive contacts associated with said other movable contacts, conductors leading from said other passive contacts, electrically controlled means common to a plurality of said link-circuits for causing the substantially simultaneous operation of the movable contacts of an idle one of said link-circuits to establish connection between a calling line and an idle conductor and control circuits for said electrically controlled means independent of said link-circuit.

26. A telephone exchange system comprising a plurality of telephone lines extending to an exchange and terminating in a set of passive switch contacts, another set of passive switch contacts, other lines extending therefrom, a movable switch contact cooperating with each set of passive contacts, circuit connections extending between said two movable switch contacts, and means for causing the substantially simultaneous operation of said movable contacts to establish connection with desired passive contacts and their connected lines.

27. A telephone exchange system comprising a plurality of telephone lines extending to an exchange and terminating in a set of passive switch contacts, another set of passive switch contacts, other lines extending therefrom, a movable switch contact cooperating with each set of passive contacts, means for causing the substantially simultaneous operation of said movable contacts to establish connection with desired passive contacts and their connected lines, and manually operated connecting means associated with the distant ends of said other lines.

28. A telephone exchange system comprising a plurality of telephone lines extending to an exchange and terminating in a set of passive switch contacts, means for changing the normal electrical condition of the passive contact of one of said telephone lines, another set of passive contacts, other lines extending therefrom, a movable switch contact cooperating with each set of passive contacts, and means for causing the substantially simultaneous operation of said movable contacts to automatically establish connection with the said changed passive contact of the incoming line and a passive contact connected to an idle outgoing line.

29. A telephone exchange system comprising a plurality of telephone lines extending to an exchange and terminating in a set of passive switch contacts, means under the control of a calling party for changing the normal electrical condition of the passive contact of one of said telephone lines, another set of passive contacts, other lines

extending therefrom, a movable switch contact cooperating with each set of passive contacts, and means for causing the substantially simultaneous operation of said movable contacts to automatically establish connection with the said changed passive contact of the incoming line and a passive contact connected to an idle outgoing line.

30. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switches for establishing connection between a calling line and an idle link-circuit, means for extending the circuit of a selected link-circuit to a called line, and means operative upon the extension of said circuit to a busy called line to place the starting of the release movement of the actuated switch under the control of the calling party.

31. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switches for establishing connection between a calling line and an idle link-circuit, means for extending the circuit of a selected link-circuit to a called line, and means operative upon the extension of said circuit to a busy called line to transmit a busy signal to the calling party and to place the starting of the release movement of the actuated switch under his control.

32. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switches for establishing connection between a calling line and an idle link-circuit, operator's means for extending the circuit of a selector link-circuit to a called line, and means operative upon the extension of said circuit to a busy called line to place the starting of the release movement of the actuated switch under the control of the calling party.

33. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switches for establishing connection between a calling line and an idle link-circuit, operator's means for extending the circuit of a selected link-circuit to a called line, and means operative upon the extension of said circuit to a busy called line to transmit a busy signal to the calling party and to place the starting of the release movement of the actuated switch under his control.

34. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switches for establishing connection between a calling line and an idle link-circuit, plug and jack connecting means for connecting said link-circuit to a called line, and means operative upon the establishment

of a plug and jack connection with a busy called line to place the starting of the release movement of the actuated switch under the control of the calling party.

35. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switches for establishing connection between a calling line and an idle link-circuit, plug and jack connecting means for connecting said link-circuit to a called line, and means operative upon the establishment of a plug and jack connection with a busy called line to transmit a busy signal to the calling party and to place the starting of the release movement of the actuated switch under his control.

36. A telephone exchange system comprising a plurality of subscribers' lines, a plurality of associated link-circuits, a plurality of switch mechanism individually operative to establish connection between a calling line and an idle link-circuit, operator's means for extending the circuit of a selected link-circuit to a called line, and means under the absolute control of the operator for rendering the selected link-circuit selectable by other switch mechanisms.

37. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated link-circuits, a plurality of switch mechanisms individually operative to establish connection between a calling telephone line and an idle link-circuit, and means for rendering the selected link-circuit selectable by other switch mechanisms independently of the return of the operated switch mechanism to normal.

38. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, a plurality of switch mechanisms individually operative to establish connection between a calling line and an idle link-circuit, operator's means for extending the circuit of a selected link-circuit to a called line, and means for rendering the selected link-circuit selectable by other switch mechanisms independently of the return of the operated switch mechanism to normal.

39. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated link-circuits, a plurality of automatic switches individually operative to establish connection between a calling line and an idle link-circuit, and means independent of the position of the contacts of the operated switch for rendering the selected link-circuit selectable by other switch mechanisms.

40. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, a plurality of automatic switches individually operative to establish connection be-

tween a calling line and an idle link-circuit, operator's means for extending the circuit of a selected link-circuit to a called line, and means independent of the position of the contacts of the operated switch for rendering the selected link-circuit selectable by other switch mechanisms.

41. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switch mechanisms for establishing connection between a calling line and an idle link-circuit, master switch mechanism for rendering said first mechanisms available for establishing such connections, a signal displayed upon the establishment of such connection, operator's means for extending the circuit of a selected link-circuit to a called line, and means under the control of the operator for causing said signal to serve in a supervisory capacity.

42. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switch mechanisms for establishing connection between a calling line and an idle link-circuit, master switch mechanism for rendering said first mechanisms available for establishing such connections, a signal displayed upon the establishment of such connection, operator's means for extending the circuit of a selected link-circuit to a called line, and means operative upon the extension of said circuit to a called line to cause said signal to serve in a supervisory capacity.

43. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switch mechanisms for establishing connection between a calling line and an idle link-circuit, master switch mechanism for rendering said first mechanisms available for establishing such connections, operator's means for extending the circuit of a selected link-circuit to a called line, a signal and means for causing said signal to serve in a calling capacity upon the establishment of the automatic switch connection and in a supervisory capacity upon the extension of the circuit of the link-circuit to a called line.

44. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, means for extending the circuit of a selected link-circuit to a called line, means operative upon the extension of said circuit to a busy called line to place the release of said switch mechanism under the control of the calling party, and means for indicating the failure of the calling party to release said switch mechanism.

45. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, means for extending the circuit of a selected link-circuit to a called line, means operative upon the extension of said circuit to a busy called line to transmit a busy signal to the calling party and to place the release of said switch mechanism under his control, and means for indicating the failure of the calling party to release said switch mechanism.

46. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, operator's means for extending the circuit of a selected link-circuit to a called line, means operative upon the extension of said circuit to a busy called line to place the release of said switch mechanism under the control of the calling party, and means for indicating the failure of the calling party to release said switch mechanism.

47. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, operator's means for extending the circuit of a selected link-circuit to a called line, means operative upon the extension of said circuit to a busy called line to transmit a busy signal to the calling party and to place the release of said switch mechanism under his control, and means for indicating the failure of the calling party to release said switch mechanism.

48. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, plug and jack connecting means for connecting said link-circuit to a called line, means operative upon the establishment of a plug and jack connection with a busy called line to place the release of said switch mechanism under the control of the calling party, and means for indicating the failure of the calling party to release said switch mechanism.

49. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, plug and jack connecting means for connecting said link-circuit to a called line, means operative upon the establishment of a plug and jack connection

with a busy called line to transmit a busy signal to the calling party and to place the release of said switch mechanism under the control of the calling party, and means for indicating the failure of the calling party to release said switch mechanism.

50. A telephone exchange system comprising a plurality of subscribers' telephone lines, substation telephone equipment including a control switch, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, means for extending the circuit of a selected link-circuit to a called line, means operative upon the extension of said circuit to a busy called line to place the release of said switch mechanism under the control of the control switch at the calling substation, and signaling means for indicating the operation of said switch by the calling party.

51. A telephone exchange system comprising a plurality of subscribers' telephone lines, substation telephone equipment including a control switch, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, means for extending the circuit of a selected link-circuit to a called line, means operative upon the extension of said circuit to a busy called line to transmit a busy signal to the calling party and to place the release of said switch mechanism under the control of the control switch at the calling substation, and signaling means for indicating the operation of said switch by the calling party.

52. A telephone exchange system comprising a plurality of subscribers' telephone lines, substation telephone equipment including a control switch, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, means controlled by an operator for extending the circuit of a selected link-circuit to a called line, means operative upon the extension of said circuit to a busy called line to place the release of said switch mechanism under the control of the control switch at the calling substation, signaling means for indicating the operation of said switch by the calling party, and means whereby the operator may cause the display of said signaling means without extending the circuit of the selected link-circuit to a called line.

53. A telephone exchange system comprising a plurality of subscribers' telephone lines, substation telephone equipment including a control switch, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, means controlled by an operator for extending the circuit of a selected link-circuit to a

called line, means operative upon the extension of said circuit to a busy called line to transmit a busy signal to the calling party and to place the release of said switch mechanism under the control of the control switch at the calling substation, signaling means for indicating the operation of said switch by the calling party, and means whereby the operator may cause the display of said signal without extending the circuit of the selected link-circuit to a called line.

54. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, operator controlled means for extending the circuit of a selected link-circuit to a called line, means operative upon the extension of said circuit to a busy called line to transmit a busy signal to the calling party, means under the subsequent control of the calling party to discontinue said busy signal, and means for displaying a signal at the exchange during the continuance of the busy signal.

55. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, operator's means for extending the circuit of a selected link-circuit to a called line, means operative upon the extension of said circuit to a busy called line to transmit a busy signal to the calling party, means under the subsequent control of the calling party to discontinue said busy signal, and means for displaying a signal at the exchange during the continuance of the busy signal.

56. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of associated link-circuits, automatic switch mechanism for establishing connection between a calling line and an idle link-circuit, plug and jack connecting means for connecting said link-circuit to a called line, means operative upon the establishment of a plug and jack connection to a busy called line to transmit a busy signal to the calling party, means under the subsequent control of the calling party to discontinue said busy signal, and means for displaying a signal at the exchange during the continuance of the busy signal.

57. A telephone exchange system comprising a plurality of telephone lines, a plurality of interconnecting link-circuits, a pair of automatic switches each having passive and movable contacts, connections normally extending between the movable contacts of said pair of switches, the passive contacts of one switch being assigned to said telephone lines, and the passive contacts of said other

switch to said link circuits, means for causing a movable contact of one switch to engage a passive contact of a calling line, means for causing a movable contact of the other switch to engage a passive contact of an idle link-circuit, and means for interrupting the connection by causing the movable contact of one of said switches to move to an idle position.

58. A telephone exchange system comprising a plurality of telephone lines, a plurality of interconnecting link-circuits, a pair of automatic switches each having passive and movable contacts, connections normally extending between the movable contacts of said pair of switches, the passive contacts of one switch being assigned to said telephone lines, and the passive contacts of said other switch to said link circuits, means for causing a movable contact of one switch to engage a passive contact of a calling line, means for causing a movable contact of the other switch to engage a passive contact of an idle link-circuit, and means for interrupting the connection by causing the movable contact of one of said switches to move from its connecting position.

59. A telephone exchange system comprising a plurality of telephone lines, a plurality of interconnecting link-circuits, a pair of automatic switches each having passive and movable contacts, connections normally extending between the movable contacts of other switch to engage a passive contact of one switch being assigned to said telephone lines, and the passive contacts of said other switch to said link circuits, means for causing a movable contact of one switch to engage a passive contact of a calling line, means for causing a movable contact of the other switch to engage a passive contact of an idle link-circuit, means for interrupting the connection by causing the movable contact of one of said switches to advance from its connecting position, and means for discontinuing said advance movement at a definite non-connecting position.

60. A telephone exchange system comprising a plurality of telephone lines, a plurality of interconnecting link-circuits, a pair of automatic switches each comprising passive and movable contacts, the passive contacts of one switch being assigned to said telephone lines, and the passive contacts of said other switch to said link circuits, a motor magnet for driving the movable contact of each switch, means for maintaining a circuit for one of said magnets until its movable contact engages a passive contact of a calling line, means for maintaining a circuit for the other of said magnets until its movable contact engages a passive contact of an idle link-circuit, means for interrupting the connection thus established by again closing and maintaining the circuit of

one of said magnets until its movable contact reaches a definite non-connecting position.

61. A telephone exchange system comprising a plurality of subscribers' telephone lines extending to an exchange, two sets of manual connection terminals for said lines at the exchange, a plurality of associated automatic switch mechanisms for extending the circuits of said lines, and means for interchanging the connections between telephone lines and said switches and between telephone lines and one set of said manual connection terminals without altering the existing connections between said lines and the other set of said manual connection terminals.

62. A telephone exchange system comprising a plurality of subscribers' telephone lines extending to an exchange, two sets of manual connection terminals for said lines at the exchange, a plurality of automatic switch mechanisms for extending the circuits of said lines, and a distributing board located between the connections of said lines to one set of said manual connection terminals and the connections of said lines to the other set of manual connection terminals and to said switch mechanisms.

63. A telephone exchange system comprising a plurality of subscribers' lines extending to an exchange, manual connection terminals for said lines at the exchange, a plurality of automatic switch mechanisms for extending the circuits of said lines, a distributing board located between the external portion of said lines and the manual connection terminals and a second distributing board located between the connections of said manual connection terminals to said lines and the connections of said switch mechanisms to said lines.

64. A telephone exchange system comprising a plurality of subscribers' telephone lines extending to an exchange, link-circuits at the exchange extending to operators' positions, automatic switch mechanisms for extending the circuits of said lines to include said link-circuits, a distributing board located between the external portions of said lines and the connections of the switch mechanisms to said lines and a second distributing board located between said link-circuits and the connections of the switch mechanisms to said link-circuits.

65. A telephone exchange system comprising a telephone line extending to an exchange, manual connection terminals and signal circuits for said line at the exchange, a distributing board having jumper wires for operatively connecting said line, terminals and circuits, and automatic switch mechanism connected to said board in contacts equal in number to said jumper wires, whereby the jumper wires may be used to

connect said line operatively to said automatic switch mechanism and to said manual terminals.

66. A telephone exchange system comprising a plurality of telephone lines, a plurality of link-circuits, automatic switch mechanism associated with each link-circuit for connecting its link-circuit with a desired line, a master switch having a fixed contact corresponding to each link-circuit, a cooperating movable contact, and means for causing said movable contact to move out of engagement with the fixed contact of any link-circuit upon its selection and connection to a telephone line and to move into engagement with the fixed contact of an idle link-circuit.

67. A telephone exchange system including telephone lines, link circuits, a line selector and a link selector, normal circuit connections extending between said selectors, and means effective upon initiation of a call over one of said lines to cause substantially simultaneous operation of said selectors to connect the calling line and an idle link circuit by said circuit connections.

68. A telephone exchange system including telephone lines, link circuits, a line selector and a link selector, normal circuit connections extending between said selectors, terminals of said telephone lines included in said line selectors, terminals of said link circuits included in said link selectors, and means effective upon initiation of a call over one of said lines to cause substantially simultaneous operation of said selectors to connect the terminals of the calling line with the terminals of an idle link circuit.

69. A telephone system comprising telephone lines, link circuits, line selectors having wipers connected to the links and adapted for selecting calling lines, a master switch normally maintaining an idle selector switch available for selection of a calling line, and means whereby the wipers of a switch which has selected a calling line are maintained in an antecedent progressive position when disconnection of the link from the calling line is effected.

70. A telephone system comprising telephone lines, link circuits, means for extending calling lines to said link circuits including line selectors having wipers adapted for selecting calling lines, a master switch normally maintaining an idle selector switch available for selection of a calling line, and means whereby a switch which has selected a calling line is rendered available for establishing other connections to calling lines without moving its wipers from their antecedent progressive position when disconnection of the link from the calling line is effected.

71. A telephone system comprising telephone lines, link circuits for extending the

circuit of said lines, cut-off relays for the lines, supervisory and sleeve relays for the links, selector switches for interconnecting calling lines and links, release relays for the selector switches, the cut-off and sleeve relays of a connected line and link being energized responsive to such a connection followed by the energization of the supervisory relay, a circuit for the release relay controlled by normally open contacts of the sleeve relay and normally closed contacts of the supervisory relay whereby said circuit is closed during the said period between successive energizations of the sleeve and supervisory relays, and means for rendering said circuit ineffective upon the release relay during said period but subsequently effective.

72. A telephone system comprising telephone lines, operator's link circuits for extending the circuits of said lines, automatic switches less in number than the number of

lines but greater in number than the link circuits for connecting calling lines to idle link circuits, supervisory relays for the link circuits, a line signal operated through contacts of said relays to indicate a call, and means controlled by an operator for rendering said line signals available as disconnect signals by a control exercised by said relays.

73. A telephone system comprising telephone lines, operators' circuits, line and operator's circuit selective mechanisms for interconnecting calling lines and idle operators' circuits, line signals for said circuits for indicating calls, and means whereby the operators efface said signals and render them controllable as supervisory signals.

In witness whereof, I hereunto subscribe my name this ninth day of October 1906.

FRANCIS W. DUNBAR.

Witnesses:

L. D. KELLOGG,
CAROLYN WEBER.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

DISCLAIMER.

1,133,113.—*Francis W. Dunbar*, Chicago, Ill. TELEPHONE SYSTEM. Patent dated March 23, 1915. Disclaimer filed November 16, 1916, by the assignee, *Kellogg Switchboard & Supply Company*.

Enters its disclaimer—

"To the claims of the patent which read as follows, to wit:

"36. A telephone exchange system comprising a plurality of 'subscribers' lines, a plurality of associated link-circuits, a plurality of switch mechanism individually operative to establish connection between a calling line and an idle link-circuit, operator's means for extending the circuit of a selected link-circuit to a called line, and means under the absolute control of the operator for rendering the selected link-circuit selectable by other switch mechanisms.

"37. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated link-circuits, a plurality of switch mechanisms individually operative to establish connection between a calling telephone line and an idle link-circuit, and means for rendering the selected link-circuit selectable by other switch mechanisms independently of the return of the operated switch mechanism to normal.

"39. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated link-circuits, a plurality of automatic switches individually operative to establish connection between a calling line and an idle link-circuit, and means independent of the position of the contacts of the operated switch for rendering the selected link-circuit selectable by other switch mechanisms."

[*Official Gazette*, November 28, 1916.]