A. H. DYSON.

TELEPHONE SYSTEM.

APPLICATION FILED APR. 6, 1906.

1,214,492.

Patented Jan. 30, 1917.

3 SHEETS—SHEET 1.

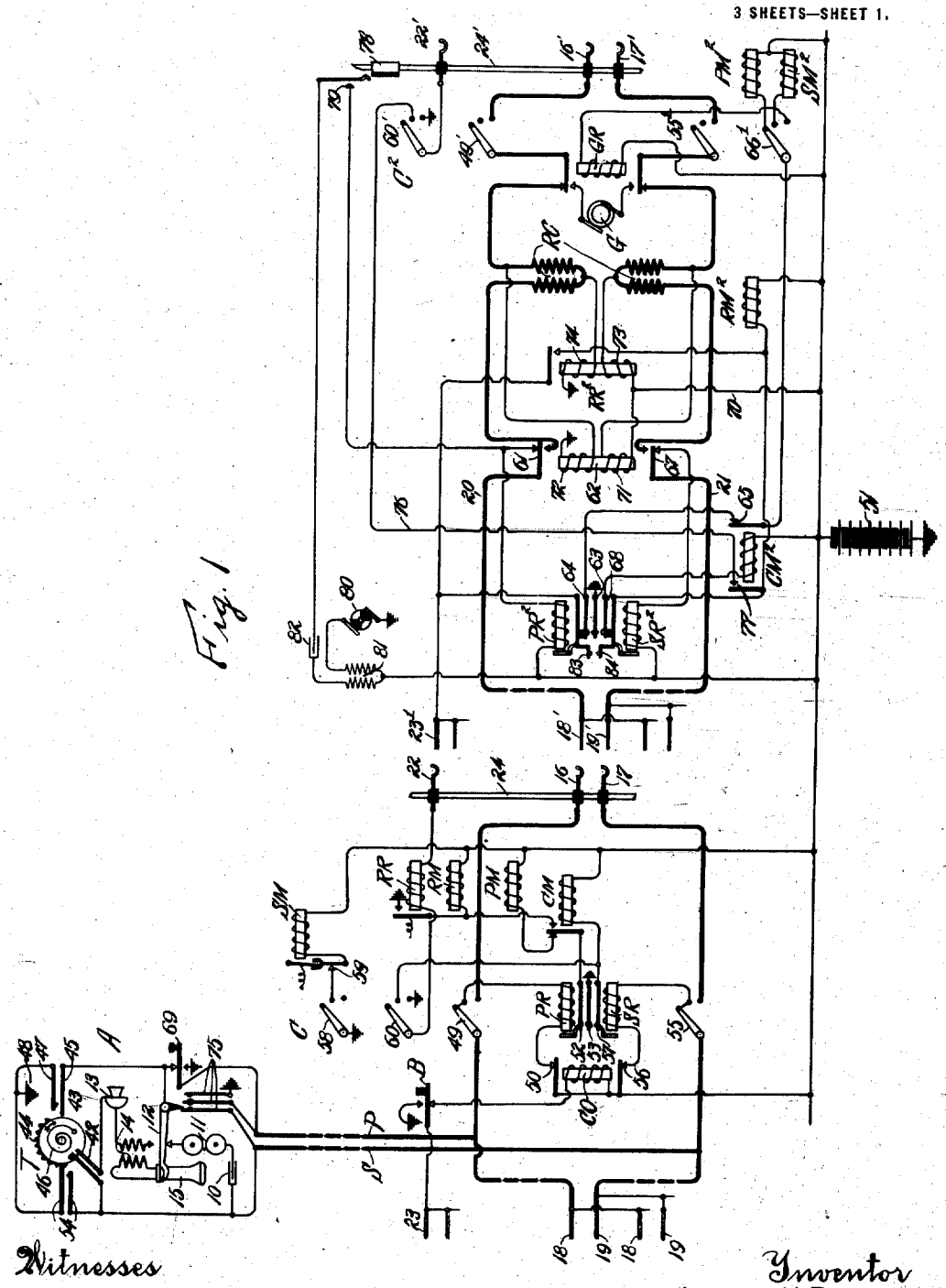

Fig. 1

Witnesses

Geo. E. Mueller.

H. C. Olmstead.

Inventor

ALFRED H. DYSON

by Thomas H. Ferguson

Attorney

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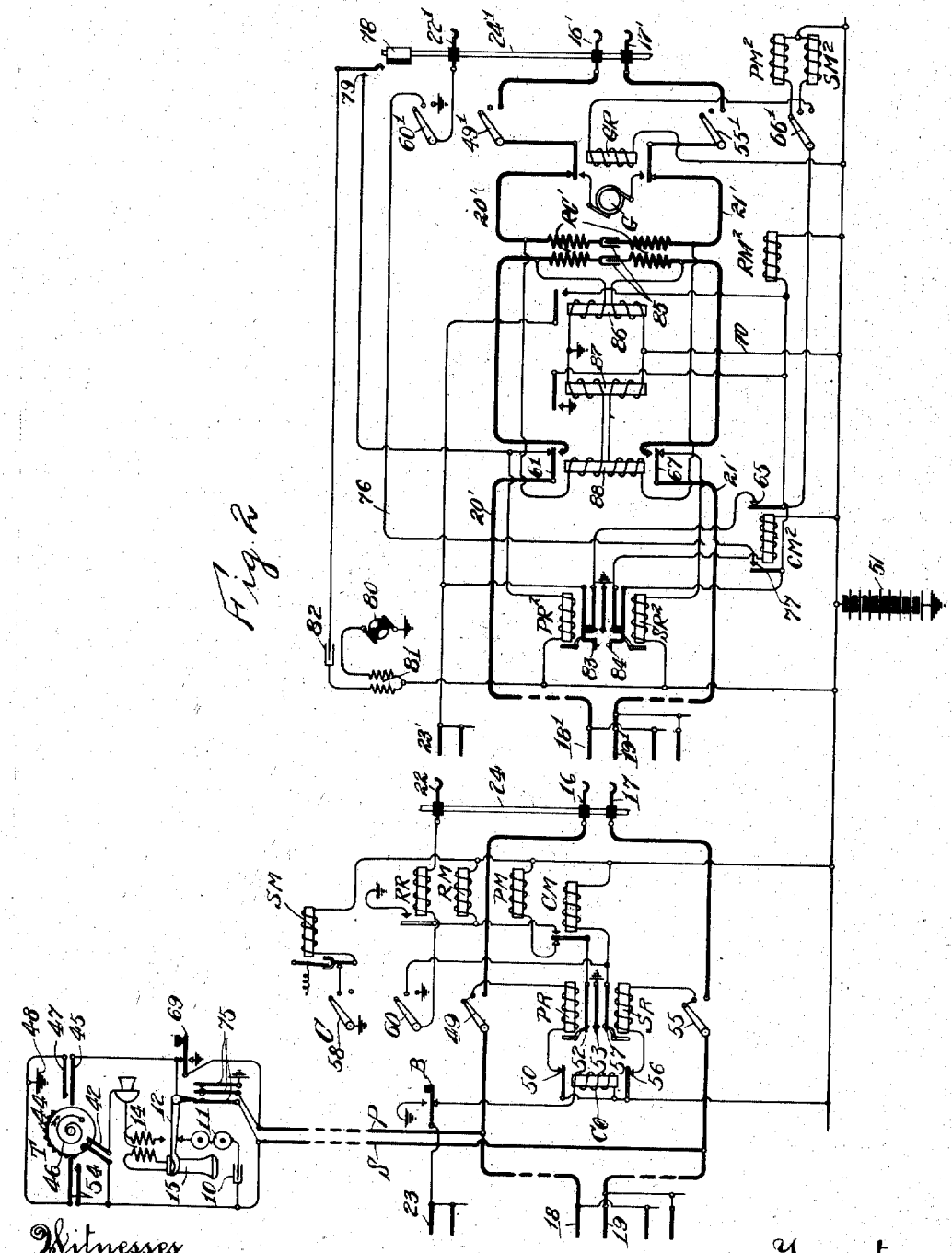

Fig. 2

Witnesses

Geo. E. Muller.

H. C. Olmstead

Inventor

ALFRED H. DYSON

by Thomas H. Ferguson

Attorney

A. H. DYSON.

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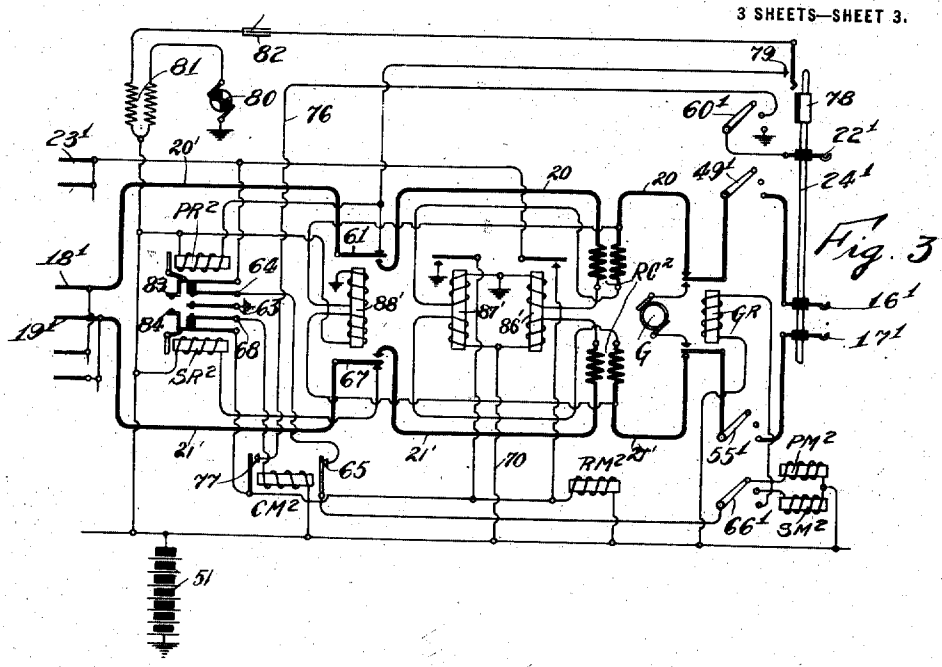

Fig. 3

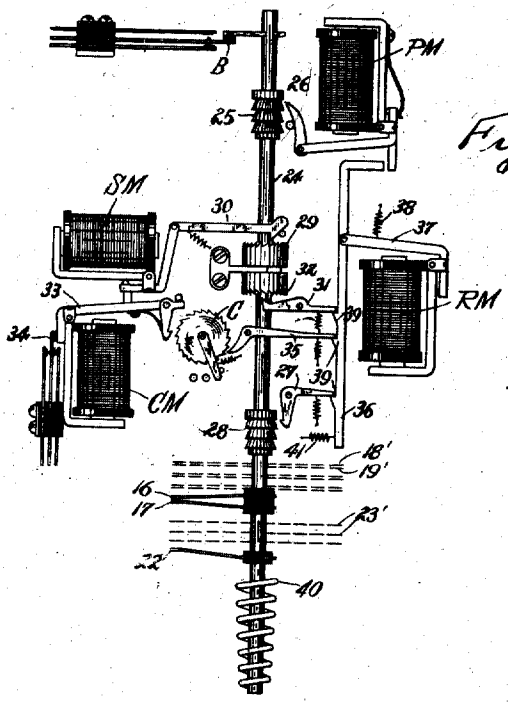

Fig. 4

Witnesses

Geo. E. Mueller

H. C. Olmstead

Inventor

ALFRED H. DYSON

by Thomas H. Ferguson

Attorney

UNITED STATES PATENT OFFICE.

ALFRED H. DYSON, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO KELLOGG SWITCHBOARD & SUPPLY COMPANY, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

1,214,492. Specification of Letters Patent. Patented Jan. 30, 1917.

Application filed April 6, 1906. Serial No. 310,307.

To all whom it may concern:

Be it known that I, ALFRED H. DYSON, a citizen of the United States, and resident of Chicago, county of Cook, and State of Illinois, have invented a new and useful Improvement in Telephone Systems, of which the following is a specification.

The present invention relates to automatic telephone exchange systems in which suitable step-by-step switching mechanism is operated in response to impulses sent over a calling line to automatically select and establish connection with a desired called line and is automatically restored to normal position at the end of conversation.

The invention has to do with a system in which the talking circuit is completed through the agency of repeating coils and it includes a novel circuit arrangement in such a system for disconnecting connected parties and restoring the parts to normal position and also novel means for completing the talking circuit between two stations only after a called party responds to the call.

The nature of the invention will be more fully understood upon reference to the following detailed description and the accompanying drawing which illustrates three forms of the invention, and the scope of the invention will be particularly pointed out in the appended claims.

Referring to the drawing, Figure 1 is a diagram of a portion of an automatic telephone exchange system constructed in accordance with my invention; Fig. 2 is a similar diagram of a modified form thereof; Fig. 3 is a diagrammatic illustration of a further modification; and Fig. 4 is a diagrammatic illustration of the type of switch employed in the systems illustrated.

Throughout these several views, like characters refer to like parts.

Referring to the drawing in detail and for the present to Figs. 1 and 4, each substation, of which the substation A only is illustrated, is provided with the usual condenser 10 and call-bell 11 included in a normally closed bridge between the line limbs S—P, and controlled by the switch-hook 12, and the usual transmitter 13 included in a normally open bridge also controlled by the switch-hook 12. In this instance, one winding of an induction coil 14 is included in this normally open bridge and the receiver 15 is included in a local circuit with its other winding. The substation is further provided with means for sending current impulses over either line limb separately, for establishing metallic connection between the line limbs and for grounding both line limbs simultaneously, as will more fully appear hereinafter. At the exchange, the line limbs terminate in the multiply connected fixed contacts of a plurality of electromagnetically actuated switches commonly called "connectors" and in the movable contacts of a single electromagnetically actuated switch commonly called a "selector." The fixed contacts of the selectors are connected to movable contacts of the connectors through the agency of link-circuits provided with repeating coils for inductively uniting their parts for conversation. In operation, the selector of a calling line is actuated to select one of a number of link-circuits extending to a group of connectors to which the called line is connected. In the present case, the line limbs S and P terminate in the multiply connected fixed or bank contacts 18—19 of a plurality of connectors and in the movable contacts or wipers 16—17 of a selector which has access to a plurality of fixed contacts 18′—19′ by which connection may be made through a suitable link-circuit comprising the strands 20 and 21 and the repeating coil RC to the movable contacts or wipers 16′—17′ of a connector having access to the desired line. Any desired type of electro-magnetically actuated switch may be employed to perform these selecting and connecting functions. For the purpose of making the operation of the system intelligible, I have illustrated conventionally in Fig. 4 a type of switch which may be employed to perform these functions. This switch, which may be assumed to be a selector, comprises three movable contacts or wipers 16, 17 and 22, which have access to a plurality of fixed contacts 18′, 19′ and 23′ respectively, which are arranged in banks of preferably one hundred contacts per wiper. For the purpose of moving the wipers into engagement with the desired bank contacts, they are mounted upon a shaft 24 which is given a primary or longitudinal step-by-step movement through the agency of a coöperating rack 25 and an actuating pawl 26 operated by the armature of the primary actuating magnet PM. The retaining pawl 27 coöperates with a rack 28 on the shaft to hold it against return. From

this it will be seen, that the wipers may be stepped to any desired level or row of bank contacts. The shaft is given a secondary or rotary movement through the coöperation of a rack 29 and pawl 30 actuated by the armature of the secondary actuating magnet SM, and the shaft is retained in its different operative positions by a retaining pawl 31 engaging a coöperating rack 32, the racks 29 and 32 being mounted so as to partake of the rotary movement of the shaft while permitting its free longitudinal movement with reference thereto. From this it will be seen that after having moved the wipers to the desired level, they may be moved to the desired bank contacts by the repeated energization and deënergization of the secondary magnet SM.

Associated with the switch mechanism is a control switch C, which is adapted to be moved into three different operative positions in response to the return movements of an armature 33 acted upon by the control magnet CM, the armature of the secondary magnet SM and the retractile spring 34. A retaining pawl 35 holds the switch C in its various operative positions. For the purpose of returning the parts to normal position, a release bar 36, carried by the armature 37 of the release magnet RM, is provided. Upon the energization of this magnet, the armature 37 is drawn against the tension of its retractile spring 38 so as to bring the teeth 39 on the bar into engagement with the ends of the retaining pawls 27, 31 and 35. With the parts in this position, as soon as the release magnet RM is deënergized, the retaining pawls are all thrown out of engaging position and both the switch C and the shaft 24 are returned to their normal positions, the latter through the agency of gravity and the spring 40. The retaining pawls 27, 31 and 35 remain in their non-engaging positions until the armature of the primary magnet PM is again energized. At this time, a portion of the armature engages the free end of lever 36 and rocks the latter out of engagement with the pawls, thus allowing them to return to their engaging positions. A spring 41 acts upon the lever 36 in opposition to the armature of the magnet PM. The shaft 24 also controls an auxiliary switch B.

With the above brief outline of the system and the electromagnetically operated connecting switch mechanism as introductory, the operation of the system in detail will now be considered.

Assuming that a party at substation A desires to converse with a party at some other station connected with the exchange, and assuming that the number of the latter's telephone is 234, he will first remove the receiver 15 from the hook 12, thereby completing a connection between the line limbs S—P, through the transmitter 13 and the normally closed contacts 42 of the calling device T. He will then move the disk 43 of the calling device in the direction of the arrow until two of the teeth 44 have passed below the contact spring 45 and then free said disk to allow its return to normal under the tension of the spring 46. The engagement of the teeth with the spring 45 will cause it to make and break contact with the coöperating spring 47 twice, thereby completing a circuit from ground at 48, over the line limb P, through the movable contact 49 of the control switch C, the winding of the primary relay PR, normal contact 50 of the cut-off relay CO to the live pole of the battery 51 at the exchange, thus energizing and deënergizing the primary relay PR twice. This relay, by its contacts 52—53, controls a circuit from ground, through the back contact of the control switch actuating magnet CM, through the winding of the primary magnet PM to the live pole of the battery, thus energizing the magnet PM twice and causing it to step the shaft of the first selector up so as to bring its wipers to the second level of the bank contacts. The two impulses sent over the line P are followed by a single impulse sent over the line S. This is brought about by one of the teeth on the disk 43 of the calling device T at the substation bringing contact springs 54 into engagement. This circuit extends from the ground at the substation, over the line S, through the movable contact 55 of the control switch C, winding of the secondary relay SR and the normal contact 56 of the cut-off relay CO to the live pole of the battery 51. The single impulse transmitted over this circuit causes the secondary relay SR, through the agency of its contacts 53 and 57, to close a circuit from ground, through the winding of the control switch magnet CM to the live pole of the battery. This causes the attraction and retraction of the magnet's armature, which steps all the movable contacts of the control switch C to their second position. The movement of the contact 58 of this switch to its second position completes a circuit from ground at said arm, through the winding of the secondary magnet SM to the live pole of the battery 51. This circuit also includes the normally closed contacts 59 which are broken in response to the energization of said magnet SM, thus producing a repetition of makes and breaks with resultant attractions and retractions of the armature of the magnet by which the shaft 24 of the selector is given its secondary movement. Thus, the wipers will be stepped around over the contacts in the selected level and this movement will continue until an idle contact is encountered.

As will more fully appear hereinafter, all

busy contacts encountered by the wiper 22 are connected to ground, and consequently, as long as the wiper 22 is in engagement with such a grounded contact, there will be a closed circuit from the live pole of the battery 51, through the winding of the control switch magnet CM, the contact 60 of the control switch C, the winding of the release relay RR, the wiper 22, the encountered contact 23′ to ground. This circuit will energize the magnet CM sufficiently to attract its armature and hold it in its attracted position. At this point, it may be noted that the magnets CM and RR, are so constructed that when thus included in circuit the former will attract its armature and the latter will not. As long as the armature 33 of the magnet CM remains attracted, the movable contacts of the switch C will remain in their second position and the secondary magnet SM will continue to rotate the shaft 24. However, as soon as an idle bank contact 23′ is encountered by the wiper 22, the circuit just traced will be broken and the armature of the magnet CM will be returned to its retracted position and, in so doing, will move the movable contacts of the switch C to their third and final positions, thus breaking the circuit of the secondary magnet SM and thereby discontinuing further movement of the wipers, connecting the wiper 22 to ground at the contact 60 and completing the connection of the line limbs S—P with the wipers 16 and 17 and simultaneously breaking their connection with the windings of the primary and secondary relays PR and SR. It may be noted at this point that the first upward movement of the selector switch grounds the contact arm B which is connected to the bank contacts 23 of the connectors to which the line limbs S—P are connected, thus establishing a condition to indicate that the line S—P is busy.

Having thus selected an idle link-circuit of the desired group corresponding to the "digit 2" of the number 234, the remaining impulses transmitted from the substation will operate the connector to whose wipers the selected link-circuit is connected. Thus, upon the calling party moving the disk 43 until three teeth pass the contact spring 45 and allowing the disk to return, three impulses will be sent over the line P from ground at the substation, through wiper 16, connected contact 18′, a portion of the link-circuit strand 20, the normal contact 61 of the relay 62, the winding of the primary relay PR^2 to the live pole of the battery. The three impulses transmitted over this circuit will energize and deënergize the primary relay three times, each time making and breaking a local circuit from ground, through relay contacts 63—64, normal contact 65 of the control switch magnet CM^2, the contact arm 66′ of the control switch C^2, through the winding of the primary magnet PM^2 to the live pole of the battery 51. This will cause primary magnet PM^2 to move the shaft 24′ so as to bring the wipers to the third level or row of stationary contacts. The single impulse over the line limb S, following the three impulses over the line P will complete a circuit over the line S, through the wiper 17, connected contact 19′, a portion of the strand 21, the normal contact 67 of the relay 62, the winding of the secondary relay SR^2 to the live pole of the battery 51, and the resulting engagement of the contacts 63 and 68 of this relay will close a momentary circuit through the control switch magnet CM^2 and thus cause its armature to be attracted and retracted once, the retraction moving the arms 49′, 55′, 60′ and 66′ of the control switch C^2 to their second position. The final four impulses transmitted over the line limb P from the substation, will momentarily energize the primary relay PR^2 four times in the manner previously described and cause four impulses of current to be transmitted through the secondary magnet SM^2, thereby stepping the wipers of the connector around four steps, and establishing connection with the contacts of the called line. The single impulse over the line limb S, following the four impulses over the line limb P, closes a circuit through the control switch magnet CM^2 in the manner heretofore described and causes said magnet to attract its armature which, upon release, moves the contacts of the control switch C^2 to their third and final position. By the movement of the contact 60′ of the control switch C^2 to its third position, the wiper 22′ of the connector is grounded and a circuit is completed thereby from the live pole of the battery 51, through the winding of the cut-off relay CO and switch B of the called line, and the connector contacts 23 and 22′ to ground. The closing of this circuit actuates the cut-off relay to disconnect the windings of the primary and secondary relays of the called line from battery, thereby preventing subsequent operation of the selector associated with the called line.

Having thus established connection between the calling and called lines, the party at substation A depresses the key 69 to ring the bell of the called party. By this act, he closes a circuit from ground at the substation, over line limb P, through the winding of the primary relay PR^2; and the latter, in response thereto, completes a circuit from ground through the contacts 63—64, normal contact 65 of the control switch magnet CM^2, contact 66′ of the control switch C^2 and winding of the generator relay GR to the live pole of the battery 51. The closing of this circuit sufficiently energizes the latter relay to connect the terminals of the generator G in circuit with the

called line, thereby sending current through the call-bell of the called subscriber. As soon as the called party removes his receiver from its hook in response to the call, he metallically connects the line limbs running to his station and thereby completes a circuit for battery current through the windings of the relay 62 which controls the continuity of the link-circuit strands 20 and 21 by means of its contacts 61 and 67. This circuit may be traced from the live pole of the battery 51, through conductor 70, winding 71 of the relay 62, to its connection with the strand 21 at the called station side of the repeating coil RC, thence over said strand, wiper 17′, line limbs of the called line, wiper 16′, a portion of the strand 20 to a point at the called station side of the repeating coil RC and thence through the winding 72 of the relay 62, to ground. These windings are arranged cumulatively and, upon the completion of this circuit, energize the relay 62 sufficiently to move its contacts to their alternate position to complete the talking circuit over the link-circuit strands 20 and 21. From this it will be seen, that the talking circuit between the substations is normally discontinuous at the contacts of the relay 62 and remains in this condition until the called partly answers the call. Such a system is particularly well adapted for use with pay substation devices.

In the form of the invention illustrated in Fig. 1, the release relay RR^2, which controls the supply of current to the release magnet RM^2 of the connector, has two differentially arranged windings 73—74 connected respectively between the live and grounded poles of the battery 51 and the link-circuit strands 20 and 21 at points between the repeating coil windings connected therewith. This relay is preferably made non-inductive so as to present no interference to speech transmission. During connection, the windings 73 and 74 of the relay RR^2 neutralizes each other, and the relay contacts remain separated. Now, if the calling party first hangs up his receiver at the end of conversation, the contact springs 75 associated with his switch hook will be moved into engagement, thereby grounding both line limbs S and P and thus destroying the balance between the windings 73 and 74 sufficiently to cause the relay RR^2 to close its contacts to complete a circuit from the live pole of the battery 51, through the release magnet RM^2, contacts of the relay RR^2, selector bank contact 23′, wiper 22, the winding of the release relay RR of the selector, to ground through the contact 60 of the control switch C. The completion of this circuit will momentarily energize the release magnet RM^2 to cause it to attract and retract its armature, thereby releasing the retaining pawls of the connector and allowing it to return to its normal position. The closing of this circuit will also momentarily energize the release relay RR of the selector and thereby momentarily close a circuit from ground at said relay, through the winding of the release magnet RM of the selector to the live pole of the battery 51, thus momentarily energizing the release magnet of the selector and removing its retaining pawls to allow it to return to its normal position. In case the called subscriber first hangs up his receiver, the circuit, by which the release relay RR^2 will have the balance of its windings 73 and 74 destroyed, will extend over the line limbs of the called subscriber, rather than the link-circuit strands 20 and 21 and the line limbs S and P of the calling subscriber.

Returning to that point in the operation at which the wipers of the selector are about to engage the bank contacts of the called line, if said line be in use then, upon the engagement of the wiper 22′ of the connector with the bank contact 23 associated with said station, a connection to ground will be established, either by way of the control switch contact 60′ of the connector previously connected to said line or by way of the grounding switch B of the selector of said line. Since at this time the movable contacts of the control switch C^2 will occupy their intermediate position, a path for current will be completed from the wiper 22′, through the contact 60′ of the control switch C^2 and the conductor 76 to the normally open contacts 77 of the control switch magnet CM^2. With the parts in this position, the final current impulse from the calling station over the line limb S, by which the control switch magnet CM^2 is energized, will cause the contacts 77 to be momentarily closed, thereby completing a circuit from the live pole of the battery 51, through the release magnet RM^2, contacts 77 of magnet CM^2, conductor 76, switch arm 60′ of the control switch C^2 and wiper 22′ over the connected bank contact to ground, thus energizing the release magnet RM^2 to cause the restoration of the connector switch to its normal position in the manner heretofore described. The selector, however, will remain connected with the link-circuit strands 20—21, and as soon as the calling party depresses the key 69 to apply ringing current to the called line, he will instead complete a circuit over the line limb P, through the primary relay PR^2 and thereby momentarily energize the said relay to complete a momentary circuit through the primary magnet PM^2, thus stepping up the shaft 24′ of the connector one or more steps, according to the number of times the substation switch 69 is closed. As soon as the first step is reached, a projection 78 on the shaft 24′ closes switch contact 79, which

completes a circuit from the interrupter 80, which is instrumental in producing a busy signal in the receiver 15 of the calling party. The interrupter is included in a local circuit including one winding of an induction coil 81 and the battery 51. The other winding of the induction coil 81 is included in a secondary circuit including the condenser 82, switch contacts 79, normal contact 61 of relay 62, link-circuit strand 20, selector switch contacts 18′—16, line limb P, switch-hook 12, one winding of the induction coil 14, transmitter 13, normally closed contacts 42, line limb S, selector switch contacts 17—19′, link-circuit strand 21, normal contact 67 of relay 62, winding of the secondary relay SR^2, back to the induction coil 81. A shunt path is also provided from the normal contact 61, through the winding of the primary relay PR^2. Upon observing the busy signal, the calling party will restore his receiver to its switch-hook and thus ground both line limbs S—P, thereby momentarily completing a circuit through the windings of both the primary and secondary relays PR^2 and SR^2 of the connector, thus bringing together the contacts 83 and 84 and thereby completing a circuit from the live pole of the battery 51, through the release magnet RM^2, contacts 84—83, selector contacts 23′—22, release relay RR of the selector and through the contact 60 of the control switch C to ground, thus energizing the release magnets of both the connector and selector and causing them to return to normal position.

From the above it will be seen, that I have devised an automatic telephone system in which repeating coils are used in the link-circuits for transmitting speech between connected stations. Transmission current is supplied from the central battery 51, through the windings 73 and 74 of the release relay RR^2 to points intermediate of the sections of the repeating coil windings associated with the link-circuit strands 20 and 21, respectively. From these points, the circuit of the calling party is completed through sections of the repeating coil windings, strands 20—21, selector contacts 16—18′ and 17—19′ and over the line limbs S—P. From the same points, the circuit of the called party is completed through the other sections of the repeating coil windings strands 20—21, wipers 16′—17′ of the connector and the connected bank contacts over the called line. Thus, two independent circuits are established, each including the co-acting windings of the repeating coil RC. As previously indicated, the relay RR^2 is made non-inductive, since it is included in the talking circuits of the two stations.

Obviously, in carrying out my invention, other circuit arrangements may be employed without departing from the spirit and scope of the invention. In Figs. 2 and 3 of the accompanying drawing, I have shown modified arrangements.

Fig. 2 is, in general, the same as Fig. 1, and therefore need be described only sufficiently to bring out the differences in arrangement and operation. In this instance, the link-circuit strands 20′ and 21′ are made up of two sections which are conductively independent of each other, and one section of these strands is normally discontinuous as heretofore described. Each section of the strands 20′ and 21′ includes windings of the repeating coil RC′ and condensers 85, as clearly illustrated. Since these sections are conductively independent, current is supplied to them from the battery 51 through independent connections, connected between the opposite poles of the battery and points in the strands on the substation sides of the repeating coil windings. Release relays 86 and 87 are also associated with the calling and called sections of the link-circuit, respectively. Each of these is provided with two differentially arranged windings which are included in the connection between the opposite poles of the battery 51 and the link-circuit strands; and relay 88, having cumulatively arranged windings, is also associated with the called section of the link-circuit and has its windings included between the opposite poles of the battery 51 and the strands 20′ and 21′ of said section of the link-circuit. Preferably, the windings of the relays 87 and 88 are included in series, as illustrated. The relay 88 controls the continuity of the strands 20′ and 21′ in the same manner as the relay 62 of Fig. 1. The release relay 86 likewise controls a circuit through the release magnet RM^2 in the same manner as the release relay RR^2 of Fig. 1, but in this instance, it is under the sole control of the calling party, while the relay 87 under the sole control of the called party controls a grounded branch leading from the release magnet RM^2. In the operation, connection with the desired line is obtained in the manner heretofore described in connection with Fig. 1, and the party is rung up in the same manner. Upon responding to the call, the removal of his receiver from its hook will complete a circuit from the live pole of the battery 51, through conductor 70, the lower windings of the relays 87—88, the right hand section of the strand 21′, the wiper 17′ of the connector, thence out over the line, through the substation and back through the wiper 16′, the right hand section of the strand 20′, the upper windings of the relays 88—87, to ground. By reason of the differential arrangement of the windings of the relay 87, its contacts will remain in normal open position; and by reason of the cumulative arrangement of the windings of the relay 88, said relay will attract its armatures and

thus render the left hand sections of the link-circuit strands 20′ and 21′ continuous. Conversation may then be held over the conductively independent circuits, inductively united by the repeating coil RC′, as shown in heavy black lines. At the conclusion of the conversation, if the party at the calling station hangs up his receiver, he will momentarily ground both limbs of the line and thereby destroy the normal balance between the windings of the relay 86 and cause the latter to attract its armature to complete a circuit from the live pole of the battery 51, through the release magnet RM^2 of the connector, the selector contacts 23′—22 and the release relay RR of the selector to ground at the contact arm 60 of the control switch C, which will cause both the selector and connector to return to normal position in the manner previously described. If the called party hangs up his receiver first, by momentarily grounding both limbs of his line he will destroy the normal balance between the windings of the relay 87 and thereby cause it to attract its armature and complete a circuit from the live pole of the battery 51, through the release magnet RM^2 of the connector, to ground. This will release the connector and cause it to return to its normal position. The subsequent restoration of the receiver of the calling party to its hook will simultaneously ground both limbs of the lines S—P and thereby energize both primary and secondary relays PR^2—SR^2 and cause an engagement of the contacts 83—84 to complete a circuit through the magnets RM^2 and RR to cause the restoration of the selector to its normal position. In other respects, the operation of this form of the invention is substantially the same as that heretofore described.

In Fig. 3, the link-circuit strands 20′ and 21′ are divided into sections which are inductively united by means of repeating coil RC^2, but the condensers 85 of Fig. 2 are omitted and the windings of the relays 86′ and 87′ are connected in series with the sections of the windings of the repeating coil, as clearly illustrated. Thus, between the sections of the repeating coil winding associated with the calling end of the link-circuit, are included the windings of the release relay 86′ and the battery 51, while between the sections of the winding of the repeating coil associated with the called end of the link-circuit, the windings of the relay 87′ and the battery 51 are included in circuit. In this instance too, the windings of the relay 88′ are connected on the one hand, to the right hand section of the link-circuit, and on the other hand to the opposite poles of the battery 51 directly, instead of in series with the windings of the relay 87′, as the windings of the relays 87 and 88 are connected in Fig. 2. In operation, the connection of the calling and called lines is accomplished as heretofore described, and the removal of the receiver of the called party from its hook energizes the relay 88′, as before, to complete the continuity of the link-circuit strands 20′ and 21′; and at the same time supplies current to the windings of the relay 87′. The windings of the relay 86′ are also supplied with current as soon as the relay 88′ is actuated to complete the strands 20′ and 21′, but the relays 86′—87′ are not actuated by the current thus supplied, since their windings are balanced, as before described. The balance between these relay windings is destroyed to complete a circuit through the release magnets of the connector and selector in the manner previously described in connection with Fig. 2, and in all other respects the operation of this form of the invention is the same.

It is apparent that still other alterations and modifications may be made in addition to those herein disclosed, without departing from the spirit and scope of my invention. I, therefore, do not wish to be limited to the specific matter presented, but aim to cover by the terms of the appended claims all such alterations and modifications.

I claim—

1. A telephone exchange system comprising telephone lines extending from substations to a central station, link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuits for inductively uniting parts thereof, switching mechanism controlled from a calling station for connecting calling and called lines to opposite ends respectively of one of said link-circuits for conversational purposes, disconnecting means independent of said repeating coil under the subsequent control of each of the connected parties for destroying the established connection and restoring all parts to normal, a central source of current and means controlled by the response of the called subscriber for bridging said source across the calling line and placing said disconnecting means in operative relation with said calling line.

2. A telephone exchange system comprising telephone lines extending from substations to a central station, link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuits for inductively uniting parts thereof, switching mechanism controlled from a calling station for connecting calling and called lines to opposite ends respectively of one of said link-circuits for conversational purposes, means for destroying the established connection and restoring all parts to normal comprising a differential electromagnet having its windings normally balanced, and means at each connected substation for destroying

said balance to cause the restoration of the parts to normal.

3. A telephone exchange system comprising telephone lines extending from substations to a central station, link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuits for inductively uniting parts thereof, switching mechanism controlled from a calling station for connecting calling and called lines to opposite ends respectively of one of said link-circuits for conversational purposes, a central source of current, means for destroying the established connection and restoring all parts to normal, comprising a differential electromagnet having its windings included between the opposite poles of said source of current and the included link-circuit strands respectively, and means at each substation for varying the normal current flow in one of said windings to cause the restoration of the parts to normal.

4. A telephone exchange system comprising telephone lines extending from substations to a central station, normally electrically-discontinuous link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuits for inductively uniting parts thereof, switching mechanism controlled from a calling station for connecting calling and called lines to opposite ends respectively of one of said link-circuits, a central source of current and means independent of said repeating coil under the control of the called party for bridging said source across the calling line and rendering the included link-circuit continuous thus completing the talking circuit between the two substations.

5. A telephone exchange system comprising telephone lines extending from substations to a central station, normally electrically-discontinuous link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuits for inductively uniting parts thereof, switching mechanism controlled from a calling station for connecting calling and called lines to opposite ends respectively of one of said link-circuits, and means independent of said repeating coil, comprising an electro-magnet included in circuit with the called station, for supplying talking current to the calling line and rendering the included link-circuit continuous so as to complete a talking circuit between the two substations.

6. A telephone exchange system comprising telephone lines extending from substations to a central station, normally electrically discontinuous link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuit for inductively uniting parts thereof, switching mechanism controlled from a calling station for connecting calling and called lines to opposite ends respectively of one of said link-circuits, and means independent of said repeating coil, including an electro-magnet connected in bridge of the talking circuit at the called station side of the link-circuit repeating coil, for rendering the included link-circuit continuous so as to complete the talking circuit between the two substations.

7. A telephone exchange system comprising telephone lines extending from substations to a central station, normally electrically-discontinuous link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuits for inductively uniting parts thereof, switching mechanism controlled from the calling station for connecting calling and called lines to opposite ends respectively of one of said link-circuits, means under the subsequent control of the called party for changing the connections of said link-circuit to render the same continuous and supply talking current to the calling line, and disconnecting means independent of said repeating coil under the subsequent control of the connected parties for destroying the established connection and restoring all parts to normal.

8. A telephone exchange system comprising telephone lines extending from substations to a central station, normally electrically-discontinuous link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuits for inductively uniting parts thereof, switching mechanism controlled from the calling station for connecting calling and called lines to opposite ends respectively of one of said link-circuits, means under the subsequent control of the called party for rendering the included link-circuit continuous and thus completing the talking circuit between the two substations, and disconnecting means for destroying the established connection and restoring all parts to normal comprising a differential electromagnet connected in bridge of the talking circuit and under the subsequent control of the connected parties.

9. A telephone exchange system comprising telephone lines extending from substations to a central station, normally electrically-discontinuous link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuits for inductively uniting parts thereof, switching mechanism controlled from the calling station for connecting calling and called lines to opposite ends respectively of one of said link-circuits, a source of current, a relay for controlling the continuity of the included link-circuit having two energizing windings connected respectively between the opposite poles of said source of current and said link-circuit strands at the called station side of the link-circuit repeating coil, and disconnecting means for destroying the established

connection and restoring all parts to normal comprising a differential relay having its windings connected respectively between the opposite poles of said source of current and the link-circuit strands.

10. A telephone exchange system comprising telephone lines extending from substations to a central station, normally electrically-discontinuous link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuits for inductively uniting parts thereof, switching mechanism controlled from a calling station for connecting calling and called lines to opposite ends respectively of one of said link-circuits, a source of ringing current associated with the included link-circuit, means under the control of the calling party to connect said source in circuit with the called substation, means dependent upon the response of the called party for supplying talking current to the calling line and rendering the included link-circuit continuous and thus completing a talking circuit between the two substations, and means independent of said repeating coil for destroying the established connection between said calling and called lines.

11. A telephone exchange system comprising telephone lines extending from substations to a central station, normally electrically-discontinuous link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuits for inductively uniting parts thereof, switching mechanism controlled from a calling station for connecting calling and called lines to opposite ends respectively of one of said link-circuits, sources of battery and ringing current associated with the included link-circuit, means under the control of the calling party to connect said source of ringing current in circuit with the called substation, a relay for controlling the continuity of the included link-circuit having two energizing windings connected respectively between the opposite poles of said source of battery current and said link-circuit strands at the called station side of the link-circuit repeating coil, whereby the completion of the talking circuit between the two stations is dependent upon the response of the called party, and means independent of said repeating coil for restoring said switching mechanism.

12. A telephone exchange system comprising telephone lines extending from substations to a central station, normally discontinuous link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuits for inductively uniting parts thereof, switching mechanism controlled from a calling station for connecting calling and called lines to opposite ends respectively of one of said link-circuits for conversational purposes, a ringing key at the calling substation, a busy signaling device, means for indicating to the calling party a busy condition of the called line in response to the actuation of said ringing key by the transmission of a signal from said device, means controlled by the called party for rendering said link circuit continuous, and means independent of said repeating coil for restoring said switching mechanism.

13. A telephone exchange system comprising telephone lines extending from substations to a central station, normally electrically discontinuous link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuits for inductively uniting parts thereof, switching mechanism controlled from a calling station for connecting calling and called lines to opposite ends respectively of one of said link-circuits, means rendered operable upon completion of the connection to the called party for rendering the included link-circuit continuous for conversational purposes, a ringing key at the calling substation, means for indicating to the calling party a busy condition of the called line controlled by said ringing key, and means independent of said repeating coil for restoring the said switching mechanism.

14. A telephone exchange system comprising telephone lines extending from substations to a central station, normally electrically discontinuous link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuits for inductively uniting parts thereof, switching mechanism controlled from a calling station for connecting calling and called lines to opposite ends respectively of one of said link circuits, a circuit interrupter, means for rendering the included link-circuit continuous for conversational purposes after connection made to a called line, means for connecting said interrupter to the calling end of said link-circuit to supply current impulses to the calling station as an indication that the desired line is busy, responsive to a manually actuated switch at the calling telephone, and a relay connected in circuit with the winding of said repeating coil and adapted upon response of the called subscriber to control the release of said switching mechanism.

15. A telephone exchange system comprising telephone lines extending from substations to a central station, normally electrically discontinuous link-circuits at the latter station for uniting said lines, repeating coils included in said link-circuit for inductively uniting parts thereof, switching mechanism controlled from a calling station for connecting calling and called lines to opposite ends respectively of one of said link-circuits, a circuit interrupter, a re-

lay for controlling the continuity of the included link-circuit, means controlled by the associated switching mechanism and said relay to supply current from said interrupter to the calling station when the desired line is busy, responsive to a manually actuated switch at the calling substation, and a second relay connected in circuit with the winding of said repeating coil and adapted upon response from the called substation to control the release of said switching mechanism.

16. An automatic telephone system including subscribers' lines, and a connector for connecting directly with called lines comprising a repeating coil for transmitting voice currents between connected telephones, and a differential relay operable from connected telephones for restoring said connector.

17. A telephone system comprising telephone lines, a connector for connecting directly with called lines, including a repeating coil for transmitting voice currents between connected telephones, a differential relay for restoring purposes connected with said repeating coil, said relay being operable from connected stations to restore said connector to normal, and a second relay actuated by current over a called line to connect said differential relay with the calling telephone.

18. A telephone system including telephone lines, a connector for connecting directly with called lines, a pair of bridged relay coils for said connector, operable responsive to current over the calling line to adjust said connector to connection with the called line, an inductive device having four windings arranged in pairs for transmitting voice currents between connected telephones, a differential relay having a pair of windings connected respectively to intermediate points of said pairs of windings, a relay adapted to be operated when the called subscriber answers, and switching mechanism controlled by said relay for disconnecting said bridged relay coils from the calling line and operatively connecting said differential relay therewith.

19. A telephone system including telephone lines, a connector for connecting directly with called lines, having a repeating coil for transmitting voice currents between connected telephones, a differential relay for said connector for release purposes, means for interchangeably connecting the answering end of said connector with different calling lines, and a second relay for said connector for operation when the called subscriber answers the call, adapted to connect said repeating coil and said differential relay with a calling line in connection with said connector.

20. A telephone system including telephone lines, a connector for connecting directly with called lines, selectors adapted to be operated from calling telephone lines to interchangeably connect said calling lines with said connector, a repeating coil for said connector for transmitting voice currents between connected telephones, a differential release relay for said connector, a trunk release circuit controlled by said relay and a second relay for said connector for operation to connect said release relay with the calling telephone line.

21. A telephone system including telephone lines, a connector for connecting directly with called lines, selectors for operation responsive to current transmitted from calling substations to interchangeably connect calling lines with said connector, a pair of bridged relays for operation responsive to currents transmitted over calling lines to adjust said connector to connection with called lines, a repeating coil for said connector for transmitting voice currents between connected telephones, a differential release relay for said connector, and an auxiliary relay for said connector for operation to disconnect said bridged relays from the calling line and operatively connect said release relay therewith.

22. A telephone system including a calling subscriber's line and a called subscriber's line, a connector switch for directly connecting with said called line provided with a repeating coil for transmitting voice currents between said lines, a selector switch for connecting said calling line to said connector switch, means controlled by the called subscriber for connecting the said repeating coil to the calling subscriber's line, a double wound battery supply relay connected to said repeating coil, a trunk release circuit extending between said selector and connector switches, and means under control of said calling subscriber for operating said relay whereby said trunk release circuit is rendered effective.

23. A telephone system including a calling subscriber's line and a called subscriber's line, a connector switch for directly connecting with said called line, a repeating coil individual to said connector switch for transmitting voice currents between connected lines, a selector switch for connecting the said calling line to the said connector switch, means under the control of the called subscriber for connecting said repeating coil to said calling line, a relay for supplying talking current to one of said telephone lines, a trunk release circuit extending between said selector and connector switches, and means controlled at the said substation receiving talking current for operating said relay whereby said trunk release circuit is closed to bring about a restoration of said switches.

24. A telephone system including a calling subscriber's line and a called subscriber's line, a connector switch for directly connecting with said called line provided with a repeating coil for transmitting voice currents between said lines, a selector switch for connecting said calling line to said connector switch, means controlled by the called subscriber for connecting the said repeating coil to the calling subscriber's line, a double wound battery supply relay connected to said repeating coil, electromagnetic release mechanism for each of said switches, and means controlled by one of said subscribers for operating said relay whereby said electromagnetic release mechanism is operated to cause a restoration of said switches.

25. A telephone system including a calling subscriber's line and a called subscriber's line, a connector switch for directly connecting with said called line, a normally inoperative repeating coil individual to said connector switch for transmitting voice currents between connected lines, a selector switch for connecting the said calling line to the said connector switch, a release circuit extending between said switches, substation controlled means for rendering said repeating coil operative, a battery supply relay for supplying talking current to the line of the calling subscriber, and means controlled by said calling subscriber for operating said relay to effect said circuit thereby causing the restoration of said selector switch to normal.

26. A telephone system comprising calling and called subscriber's lines divided into groups, a selector switch for extending calls from said calling lines in the direction of said called lines, a connector switch for connecting directly to said called lines including a repeating coil for transmitting voice currents between connected lines, a release relay for restoring purposes connected to said repeating coil, and means controlled over each of the connected lines for operating said release relay to restore said connector.

27. A telephone system including a calling subscriber's line and a called subscriber's line, a connector switch for directly connecting with said called line, a repeating coil individual to said connector switch for transmitting voice currents between connected lines, a selector switch for connecting the said calling line to the said connector switch, a battery feed relay for supplying talking current to the said called line, and means controlled by the called subscriber for operating said relay to bring about a release of said connector switch.

28. A telephone system including a calling subscriber's line and a called subscriber's line, a connector switch for directly connecting with said called line provided with a repeating coil for transmitting voice currents between the said subscribers' lines, a selector switch controllable from said calling line for connecting with said connector switch, an operating bridge for said connector switch for controlling a selecting operation thereof, means controlled by the called subscriber for disconnecting said operating bridge and for connecting said repeating coil to the calling subscriber's line, a double wound relay connected to the said called line, and means controlled by the called subscriber for operating said relay to cause a release operation of said connector switch.

29. A telephone system including a calling subscriber's line and a called subscriber's line, a connector switch for directly connecting with said called line, an operating bridge for said connector switch for controlling an operation of said connector, a repeating coil for said connector switch for transmitting voice currents between connected lines, a selector switch for connecting the said calling line to the said connector switch, means for disconnecting said operating bridge and for connecting said repeating coil to the calling subscriber's line, a battery feed relay for supplying talking current to the said calling subscriber's line, and means controlled by said calling subscriber to operate said relay to bring about a release of said selector switch.

30. A telephone system including a calling subscriber's line and a called subscriber's line, a connector switch for directly connecting with said called line provided with a repeating coil for transmitting voice currents between the said subscribers' lines, a selector switch controllable from said calling line for connecting with said connector switch, an operating bridge for said connector switch for controlling a selecting operation thereof, means controlled by the called subscriber for disconnecting said operating bridge and for connecting said repeating coil to the calling subscriber's line, a double wound current supply relay for supplying one of said lines with talking current, and means controlled at the substation of said last line for operating said relay to disconnect said subscribers' lines.

31. A telephone system including a calling subscriber's line and a called subscriber's line, a connector switch having selecting motion in two intersecting planes for directly connecting with said called line and provided with a repeating coil for transmitting voice currents between the said subscribers' lines, a selector switch having motions in two intersecting planes controllable from said calling line for connecting with said connector switch, an operating bridge for said connector switch for controlling a selecting operation thereof, means controlled

by the called subscriber for disconnecting said operating bridge and for connecting said repeating coil to the calling subscriber's line, a double wound current supply relay for supplying one of said lines with talking current, and means controlled at the substation of said last line for operating said relay to disconnect said subscribers' lines.

32. A telephone system including a calling subscriber's line and a called subscriber's line, a connector switch for directly connecting with said called line provided with a repeating coil for transmitting voice currents between the said subscriber's lines, a selector switch controllable from said calling line for connecting with said connector switch, an operating bridge for said connector switch for controlling a selecting operation thereof, means controlled by the called subscriber for disconnecting said operating bridge and for connecting said repeating coil to the calling subscriber's line, a battery feed relay for supplying talking current to the said calling line, release mechanism for each of said switches, a release circuit for said release mechanism, and means controlled by the calling subscriber for operating said relay whereby the said circuit is closed to cause a release operation of both of said switches.

33. A telephone system comprising subscribers' telephone lines divided into groups, a selector switch for extending calls from calling lines in the direction of called lines, a connector switch for connecting directly with called lines including a repeating coil for transmitting voice currents between connected telephones, a release relay directly controlled from each of the connected lines for restoring said connector.

34. A telephone system including subscribers' telephone lines, a connector switch for directly connecting with one of said lines, a repeating coil individual to said connector for transmitting voice currents between a pair of connected subscribers' lines, a selector switch adapted to be operated to connect with said connector switch, an operating bridge for said connector switch for controlling an operation thereof after said selector has connected to said connector, means controlled over said subscriber's line for disconnecting said operating bridge and for substituting said repeating coil to render the same effective to transmit the voice currents, a battery supply relay for supplying talking current, and means controlled by said relay for releasing said selector.

In witness whereof, I hereunto subscribe my name this 31st day of March, 1906.

ALFRED H. DYSON.

Witnesses:
CAROLYN WEBER,
T. H. FERGUSON.

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