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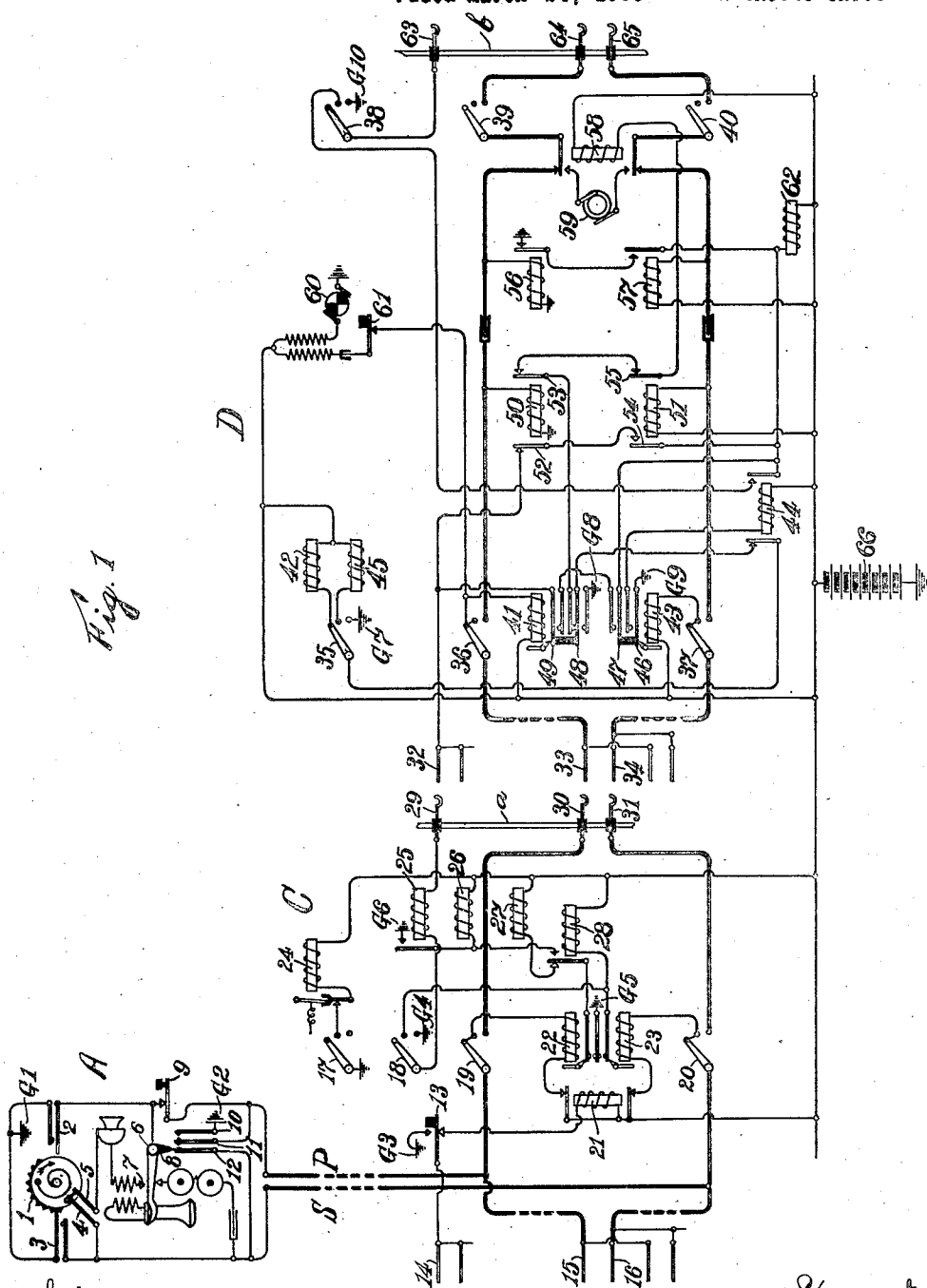
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A. H. DYSON

AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Filed March 24, 1906

2 Sheets--Sheet 1



Witnesses

Geo. E. Mueller.
H. C. Overstead

Inventor

Alfred H. Bacon

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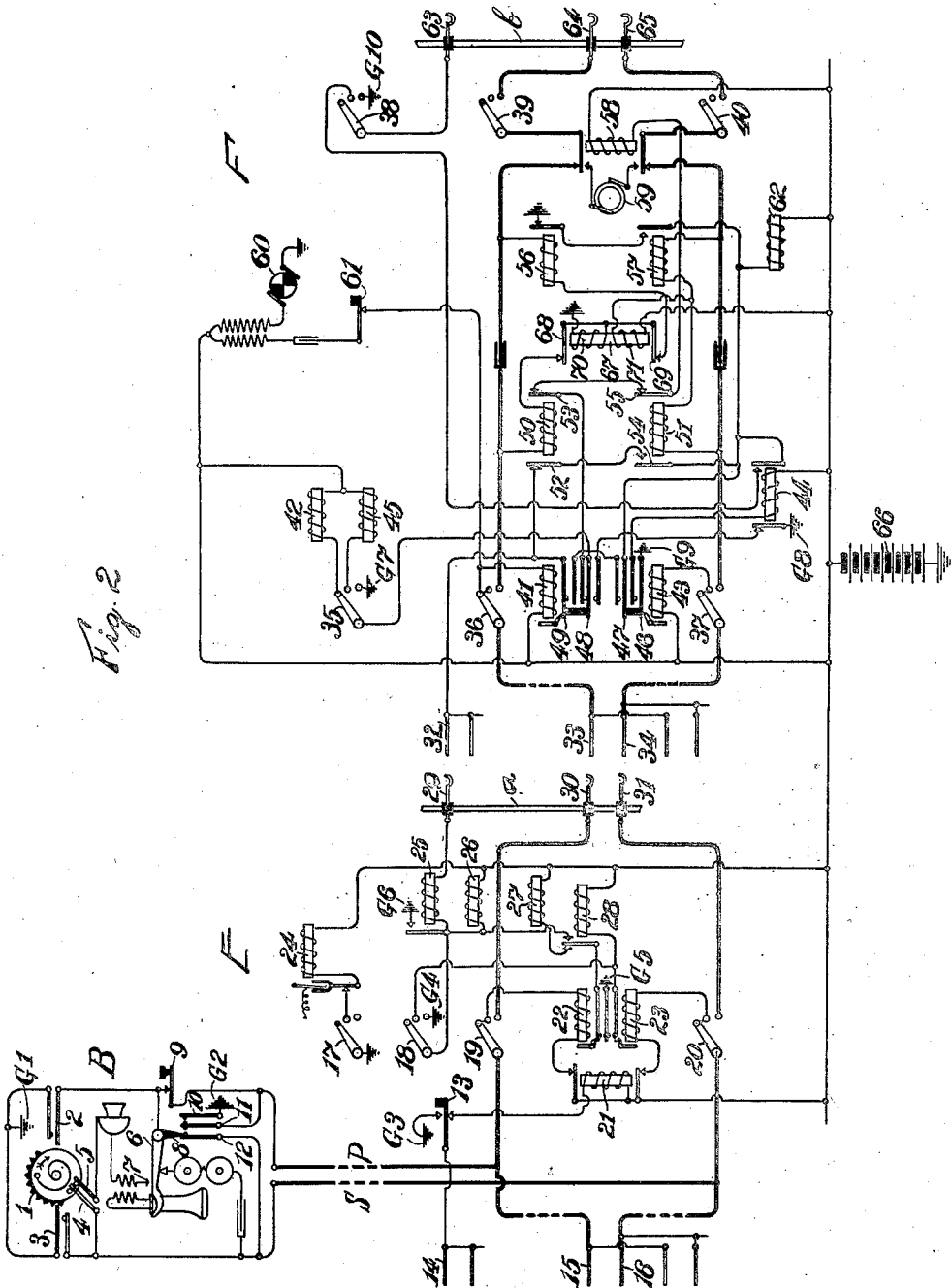
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2 Sheets-Sheet 2



Witnesses

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UNITED STATES PATENT OFFICE.

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

AUTOMATIC TELEPHONE-EXCHANGE SYSTEM.

Application filed March 24, 1906. Serial No. 307,845.

To all whom it may concern:

Be it known that I, ALFRED H. DYSON, a resident of Chicago, county of Cook, and State of Illinois, have invented new and useful Improvements in Automatic Telephone-Exchange Systems, of which the following is a specification.

My invention relates to automatic telephone exchange systems in which selector switches are employed to select the groups of lines in which the lines of the wanted subscribers are included, and in which connector switches are employed, which connect directly with the wanted lines.

My invention is especially directed to the improvement of the circuits employed for operating the connectors and of the means employed in connection with them for including ringing current in circuit with the called subscriber's line to signal the substation, and for releasing the switches employed in a connection at the conclusion of the conversation.

Referring to the drawings, in Fig. 1 I show a subscriber's station connected by a line with a selector circuit at the exchange and a connector circuit arranged in accordance with my invention. In Fig. 2 I show a second substation connected by its line with a selector, and the circuit of a connector embodying my invention in a form varying from that shown in Fig. 1.

My invention is directed to circuit arrangements only, and I have therefore not shown any particular switch mechanism to be operated by the circuits as any desired or known mechanical arrangement may be employed, for instance such a switch mechanism as that shown in United States Letters Patent to A. H. Dyson, No. 830,981 dated September 11, 1906.

The substation at A includes the usual condenser and call bell normally held in bridge of the line limbs P and S by the hook-lever 6, while the transmitter is adapted, upon the removal of the receiver from the hook lever, to be connected across the two line limbs by the closure of contact 6—7, the receiver being in local circuit with the secondary winding of the induction coil. The arrangement at the substation A also includes the dial 1, which is provided with

ratchet teeth of insulating material and which is adapted for rotation by hand in the direction indicated by the arrow, the said dial being returned in the opposite direction when rotated and released by the spring fastened to it. When so operated, its teeth cause the spring 2 to engage its associated contact spring and to connect ground G' with limb P of the line as many times as teeth are passed below the spring. After the last movement of spring 2, the dial in its return causes spring 3 to engage its associated spring a single time and then disengage it, whereby ground G' is momentarily connected to limb S of the line. Springs 4 and 5 are provided in the transmitter circuit and are normally held in contact by a stop upon the dial 1. When the dial is in other than normal position, however, the movement of the stop removes the tension from spring 4 which disengages 5 and thereby maintains open the circuit through the transmitter while the dial is being operated and the switching impulses transmitted.

A key 9 is provided for opening the metallic circuit of the line extending through the transmitter for ringing purposes.

The hook-lever 6 with arm 8, is so arranged that when the receiver is removed arm 8 passes to the left over the extremity of spring 12 to a position such that when the receiver is replaced, its movement to the right will cause the springs 12, 11 and 10 to be for a moment simultaneously connected, whereby the two line limbs are at the same time grounded.

The selector shown in Fig. 1 includes the terminal contacts 14, 15 and 16, multiplied to a plurality of connector switches in the usual manner and employed when another subscriber is seeking connection with the line of subscriber A. Contacts 15 and 16 are connected to limbs P and S respectively, while contact 14 is connected through off-normal switch spring 13 and its normal contact and the winding of cut-off relay 21 to battery 66.

Connected to limb P through side switch arm 19 and its normal contact is primary relay 22 whose circuit extends through an armature of relay 21 to battery, the said relay 22 closing when actuated, the circuit

of primary magnet 27 employed to move wipers 29, 30 and 31 to select the group of connector switches common for connection to the 100 line group of subscribers, among
 5 which the line of the wanted subscriber will be included.

The secondary relay 23 is connected to limb S of the line through side switch arm 20 and to battery 66, and by its armature
 10 controls the circuit of private magnet 28, which has the function when energized and de-energized of moving side switch arms 17, 18, 19 and 20 one step in a downward direction from their positions as shown to
 15 engage respectively their second contact points. Side switch arm 17 when brought to engage its second contact, closes circuit through secondary magnet 24, which vibrates its armature to move the switch
 20 wipers 29, 30 and 31 in search of idle connector switch terminals of the selected group, and the engagement of 17 with its third contact opens the circuit of 24 which brings the wipers to rest. Side switch arm 18
 25 when brought to engage its second contact, connects the private wiper 29 through the winding of release relay 25 with the winding of private magnet 28 to render the said private magnet sensitive to the grounded or un-
 30 grounded condition of contacts 32 of the connector switches of the group, so that the said magnet 28 will release its armature as soon as 29 reaches an idle or ungrounded contact, which causes the side switch arms
 35 to move to their third positions. The windings of relay 25 and magnet 28 are so proportioned that a flow of current through 25 in series with 28 is not sufficient to cause the attraction of its armature, although the
 40 armature at 28 will be attracted. Side switch arm 18 when in its third position, connects ground G⁴ to wiper 29 and the contact 32 of a selected idle connector to render the said connector busy, and also
 45 places release relay 25 in operative relation with contact 32 of the connector in order that at the proper time it may be energized by a flow of current initiated at the connector to cause the operation of the release
 50 magnet 26 whereby the selector is caused to return to normal.

Wipers 29, 30 and 31 are fastened to shaft
 α, which shaft, with the form of switch before referred to, is given a series of upward
 55 steps to select the group of switches wanted, under the influence of primary magnet 27, while under the influence of secondary magnet 24 the shaft receives a rotary step or steps, carrying with it the switch wipers
 60 and moving them over successive terminal contacts 32, 33, 34 of connectors, which contact, as indicated, are multiplied to other first selectors.

The connector shown at D includes the
 65 primary relay 41, connected to contact 33

through arm 36 and the battery 66, controlling by the spring 48 and its alternate contact the operation of primary magnet 42 when arm 35 is in its normal position, and the operation of secondary magnet 45
 70 when arm 35 is in engagement with its second contact.

The secondary relay 43, connected to contact 34 through side switch arm 37 and to battery 66, controls by its armature spring
 75 46 the private magnet 44, the latter being arranged when energized and de-energized to move side switch arms 35, 36, 37, 38, 39 and 40 downwardly to engage the contacts of their respective sets adjacent to those
 80 engaged by them prior to its energization and de-energization. Side switch arm 35 in its normal position connects magnet 42 with spring 48, in its second position connects magnet 45 with said spring, and in its
 85 third position connects ground G⁷ through the armatures of relays 41, 50 and 51 with ringing relay 58 and battery so that when all of the said relays are de-energized, 58
 90 will be energized and will include the ringing generator 59 in circuit with wipers 64 and 65 to cause the bell of the called subscriber to ring. Arms 36 and 37 in their normal and second positions connect the windings
 95 of 41 and 43 with contacts 33 and 34 and in their third positions complete the talking circuit of the connector, (and leave open the circuits of relays 41 and 43) the talking circuit being indicated by the heavily
 100 marked lines. Arm 38 in its second position connects wiper 63 with a switch contact of private magnet 44, which contact is closed when the magnet is operated so that should wiper 63 be brought to rest in contact with
 105 the terminal of a busy line, release magnet 62 may thereupon be operated by current flowing from the grounded terminal of the busy line through the closed switch contact of magnet 44 to battery 66. When in its
 110 third position side switch arm 38 connects ground G¹⁰ to wiper 63 and the terminal of the called line engaged by it and to the multiples of the said terminal rendering the called line busy with respect
 115 to other connectors having access to it. Arms 39 and 40 when engaging their first and second contacts are in open circuit, and when engaging their third contacts complete the talking circuit to wipers 64 and
 120 65 respectively. Relays 50 and 51 permanently connected from the opposite sides of battery 66 to the two talking conductors of the connector, are by the operation of switch arms 36 and 37 brought under the control
 125 of the calling subscriber A in such manner that by the operation of key 9 the subscriber is able to interrupt the flow of current through both of them and cause retraction of their armatures 53 and 55 to complete
 130 a circuit from ground G⁷ through arm 35,

spring 48, armatures 53 and 55 and the winding of ringing relay 58 to battery to cause the energization of relay 58; and by the operation of the hook lever the subscriber at A can cause the de-energization of relay 50 by shunting current out of its winding by the grounding of limb P of the line, while current continues through relay 51 to ground at the substation over limb S, this being the condition wherein the armature 52 is retracted and armature 54 is attracted to complete circuit through the devices for releasing the switches.

Relays 56 and 57 are connected from the opposite sides of battery 66 by means of side switch arms 39 and 40, when in their third positions, to wipers 64 and 65 and the limbs of the called line and through their windings is passed the current for energizing the called subscriber's transmitter.

At the conclusion of the conversation and the replacing of the receivers upon the hook levers, current is shunted from relay 56, while current continuing through relay 57, its armature is attracted to close circuit through release magnet 62 and subsequently open circuit therethrough to release the connector. Assuming an exchange of 1000 subscribers, the usual and preferred arrangement of apparatus will be as follows. Each subscriber's line will be provided with a selector, whose wipers will be capable of being caused to reach terminals of 100 connectors. For an exchange of this size, 100 connectors would be required and each connector would be arranged so that its wipers could select multiple terminals of 100 subscribers' lines of the 1000. The 100 connectors would therefore be divided into groups of ten, one such group being assigned for connection to each 100 lines. The terminals of each group of connectors would be grouped before the wipers of each selector in separate levels (when switches of the character before mentioned are employed), upward steps of the wipers selecting the several groups, and rotary steps selecting an idle switch of the proper group.

Each group of 100 subscribers' lines have their terminals multiplied to 10 connectors, the terminals being divided into groups according to the tens of the 100, each group being placed on a different level of a connector, upward step-by-step movements of the connector wipers being caused to select the tens group of the 100, and rotary movements of the wipers being caused to select the particular line wanted of the tens group.

The calling subscriber first operates his selector to pick the group of connectors of the hundred lines including the line wanted. The selector then automatically picks out an indifferent idle connector and places it under control of the subscriber, who then transmits impulses to the connector to se-

lect the tens group including the line wanted, and thereafter another set of impulses to select the particular line wanted out of the tens group.

Assuming that subscriber A desires to have conversation with subscriber No. 345, subscriber A first removes his receiver and turns to the proper extent the dial 1 and releases it, whose teeth operate upon springs 2 and 3, sending three impulses of current over limb P of the line, and thereafter a single impulse over limb S of the line. The three impulses flowing from ground G' through spring 2, key 9, limb P, arm 19, relay 22 to battery, energize and de-energize the said relay three times, a corresponding number of impulses flowing from ground G⁵, armature spring of relay 22, armature of magnet 28 through primary magnet 27, the resulting energizations and de-energizations of 27 causing wipers 29, 30 and 31 to select a group of connector terminals belonging to connectors each of which is common for connection to the third 100 line group of subscribers including Nos. 300 to 399. With the first movement of the selector off-normal switch spring 13 engages its alternate contact to connect ground G⁸ with connector contact 14, to render the line of A busy to incoming calls via the connectors.

The single impulse of current before referred to flows from ground G', through spring 3, over limb S, through side switch arm 20, relay 23 to battery, the resulting energization of relay 23 causing a single impulse to flow from ground G⁵ through the armature springs of said relay and private magnet 28 to battery, causing the energization and de-energization of said magnet, whose armature upon its retraction moves the side switch arms 17, 18, 19 and 20 to engage their respective second contacts. Arms 19 and 20 when so moved leave unaltered the connections of relays 22 and 23 to limbs S and P respectively. Arm 17 in its new position closes circuit from ground through secondary magnet 24 to battery, causing the magnet to attract and release its armature, its circuit being of vibratory character. This energization and de-energization of 24 moves wipers 29, 30 and 31 to engage terminals of the first connector of the selected group. In accordance with the well known practice, a mechanical connection exists between the armature of magnet 24 and the side switch arms, of such character that (unless private magnet 28 is energized) upon the attraction and release of the armature of 24, the side switch arms will be moved to their third position. Assuming first that contacts 32, 33 and 34 belong to a connector which is in its normal or idle condition, upon the engagement of wiper 29 with contact 32 no flow of current results through private magnet 28 which is now

connected with contact 32 by arm 18 and wiper 29, because as shown, the said contact 32 is on open circuit. Side switch arms 17, 18, 19 and 20 therefore move to their third positions, the movements of arms 19 and 20 cutting off relays 22 and 23 and completing the talking circuit of the selector (indicated by heavy conductors) while arm 17 opens the circuit of secondary magnet 24 to prevent further operation thereof. The arm 18 connects ground G^4 through the winding of release relay 25 and wiper 29 to contact 32 and its multiples, rendering the connector busy to the other selectors having access to the multiple terminals of it.

Assuming now that at the time when wiper 29 engaged contact 32, as before described, another selector was connected to a multiple of 32; upon the closure of contact 29—32 a flow of current would result from ground G^4 at the other selector through its arm 18, its relay 25, its wiper 29, to multiple of 32, thence through contact 32, 29 of Fig. 1, relay 25, arm 18 its second contact, private magnet 28 and to battery, which flow would energize magnet 28, whose attracted armature as before mentioned would prevent movement of the side switch arms of the selector, so that a second energization of secondary magnet 24 would result, bringing wipers 29, 30 and 31 to engage contacts, terminals of the second connector of the selected group. The windings of relays 25 and of magnet 28 are so proportioned that when current passes in series through the said windings to cause 28 to attract its armature, relays 25 do not receive sufficient current to cause their armatures to be attracted.

Should the second connector be in use, a path for current similar to that above described, will exist as soon as wiper 29 engages the contact of the second connector, and the side switch arms will hence remain immovable. Secondary magnet 24 will therefore continue its energizations and de-energizations seeking terminals of an idle connector until such terminals are found, when the ensuing de-energization of private magnet 28 will allow the side switch arms to pass to their third positions, with results as before described.

An idle connector having been selected, subscriber A by dial 1 now sends four impulses of current over limb P of the line from ground G^1 , the current passing through side switch arm 19, contact 30—33, arm 36, relay 41, to battery, causing four energizations and de-energizations of said relay, whose attracted and released armature causes four impulses to flow from ground G^8 through spring 48, armature of magnet 44, arm 35, primary magnet 42 to battery. Wipers 63, 64 and 65 have before them multiple terminals of the lines of subscribers 300 to 399 arranged in groups of 10 and,

the four energizations of primary magnet 42, now occurring, cause wipers 63, 64 and 65 to select a tens group of terminals of subscribers' lines so disposed that the fifth terminals of the group are those of the line 345.

A single impulse of current flowing from ground G^1 over limb S, succeeding the said four impulses over limb P, passes through side switch arm 20, contact 31—34, arm 37, relay 43 to battery, causing 43 to attract and release its armature and an impulse to flow from ground G^9 through spring 46, its associated contact spring, private magnet 44 to battery. The said magnet 44 attracts and releases its armature, and upon the release thereof side switch arms 35, 36, 37, 38, 39 and 40 move to engage their respective second contacts.

Subscriber A by dial 1 now sends five impulses from ground G^1 through spring 2 over limb P and over the before traced path through relay 41, whose five times attracted and released armature causes five impulses to flow from ground G^8 through spring 48, armature of magnet 44, arm 35, its second contact and secondary magnet 45 to battery, which magnet 45 affects five secondary or rotary switching movements of wipers 63, 64 and 65, bringing them to engage the fifth contacts of the selected tens group, which as before stated, are multiple terminals of the subscriber's line No. 345.

The circuit of such a line is shown at E in Fig. 2 (which circuit is identical with the circuit C of Fig. 1) and for the better understanding of the operation of the connector of Fig. 1 with respect to the called line, the said Fig. 2 may be placed so that wipers 63, 64 and 65 of Fig. 1 are approached to terminals 14, 15 and 16 of the line of subscriber B which may be considered as that of the called subscriber No. 345.

A single impulse flowing from ground G^1 , succeeding the last of the five impulses over limb P, flows through spring 3, over limb S, contact 31—34, arm 37, relay 43 to battery, which relay, attracting and releasing its armature causes a second energization and de-energization of private magnet 44. As soon as the said magnet attracts its right hand armature, a connection is completed from the active side of battery 66, through winding of release magnet 62, armature of relay 44, its second contact and arm 38, to wiper 63 and terminal 14 of the called line. As will be observed this terminal is normally connected to the active side of battery and in this condition no energization of release magnet 62 is possible, and upon the de-energization of private magnet 44, side switch arms 35, 36, 37, 38, 39 and 40 leave their second contacts and engage their third contacts. In so doing, arms 36, 37, 39 and

40 complete the talking circuit of the connector, arms 36 and 37 in addition cutting off the winding of relays 41 and 43 from contacts 33 and 34. Arm 38 connects
 5 ground G^{10} through contact 63—14 and cut-off relay 21 of Fig. 2, of the called line with the active side of battery 66 and the cut-off relay is operated to open the normal battery connections to limbs P and S of the called
 10 line. The connecting of ground G^{10} to contact 14 and its multiples also renders the called line busy to other connectors, as will be hereafter explained. The movement of arm 35, Fig. 1, connects ground G^7 through
 15 armature of relay 44, spring 48 and its normal contact to armature 53 and would complete circuit through armature 55 and ringing relay 58 were it not for the fact that at this time relays 50 and 51 are both energized
 20 by current flowing from ground through relay 50, through its third contact and arm 36, contact 33—30, arm 19, limb P, key 9, contact 6—7, (the receiver being removed) through the transmitter supplying current
 25 to energize it, through contact 5—4, returning over limb S, through arm 20, contact 31—34, arm 37 and its third contact, relay 51 to battery 66.

30 Subscriber A now depresses key 9 to open circuit through the substation causing relays 50 and 51 to be simultaneously de-energized, and their retracted armatures 53 and 55 complete the before mentioned circuit through ringing relay 58, whose attracted armatures include generator 59 in
 35 circuit with the called line to ring the substation bell. When subscriber A releases key 9, again closing circuit through the substation, relays 50 and 51 attract armatures 53 and 55 to open circuit through relay 58, whose thereupon retracted armatures disconnect the generator from the
 40 called line.

45 When subscriber B removes his receiver, contact 6—7 (Fig. 2) is closed and circuit is completed from ground through relay 56, arm 39, its third contact, contact 64—15, over limb P, through the transmitter of the substation, energizing it for talking,
 50 returning over limb S, contact 16—65, arm 40 and relay 57 to battery, said relays 56 and 57 attracting their armatures. The two subscribers are now in conversation through the two condensers placed in opposite sides of the talking circuit at the
 55 connector.

Assuming that at the end of conversation, subscriber B replaces his receiver before
 60 subscriber A, the resulting momentary and simultaneous grounding of limbs P and S of his line by springs 10, 11 and 12, shunts current from the winding of relay 56, whose armature is retracted, while current continues through relay 57. Circuit is thereby
 65 momentarily closed from ground, through

the back contact of relay 56 and armature of relay 57, and through release magnet 62 to battery, the resulting energization and de-energization of release magnet 62 causing the return of the connector to normal.

The release of the selector remains to be accomplished from substation A and occurs in the following manner. The side switch arms of the connector having returned to
 75 normal, the simultaneous grounding of limbs P and S of the line of subscriber A, when he replaces his receiver, causes simultaneous impulses of current to flow through relays 41 and 43 and their simultaneously attracted armatures complete circuit from ground G^4 at the selector, through
 80 its third contact and arm 18, release relay 25, contact 29, 32, through spring 49 and its associated contact, its associated contact and spring 47, release magnet 62 to battery 66. Relay 25 is thereby energized and effects the energization of release magnet 26 by a
 85 flow of current passing from ground G^4 through said magnet and the attracted armature of 25. As soon as arm 8 of hook lever 6 at substation A passes over the end of spring 12, ground is removed from the line limbs, relays 43 and 41 are de-energized, and circuit opened through relay 25 whose retracted armature opens the circuit of
 90 release magnet 26 and upon the de-energization of 26 the selector is restored.

Assuming that subscriber A replaces his receiver in advance of B, the resulting
 100 grounding of the two line limbs takes current from relay 50, whose armature 52 is retracted, while current continues through relay 51, whose armature 54, continuing in its attracted position, allows current to flow
 105 from ground G^4 at the selector, through side switch arm 18, release relay 25, contact 29—32, through armature 52, its back contact and armature 54, release magnet 62 to battery 66. The resulting attraction of the armature of relay 25 causes the energization of release magnet 26 of the selector. As soon as, with the return of the hook lever, ground is removed from the line limbs as substation A, circuit is broken
 110 through both relays 50 and 51, release magnet 62 is de-energized, restoring the connector and release relay 25 effects the de-energization of release magnet 26 restoring the first selector.

Returning now to the point at which wipers 63, 64 and 65 were first brought to engage contacts 14, 15 and 16 of the called line, if the said line were already in use its
 125 terminal 14 would be connected to ground G^3 , at its own selector, or to ground G^{10} , at a connector, depending upon whether the line of B was a calling or a called line. In such case the impulse of current energizing relay 44, occurring immediately after
 130

the establishment of contact 63—14, would, by the attraction of the right hand armature of relay 44, complete a circuit from ground at contact 14 through wiper 63, arm 38, and its second contact, armature of relay 44, release magnet 62 to battery 66. Release magnet 62 would be energized until the impulse through 44 ceased, when the retracted armature of 44 would effect the de-energization of release magnet 62 and the return of the connector to normal. As soon as the connector is restored, off normal switch 61 engages its associated contact and busy machine 60 is thereby brought into circuit with the line of subscriber A through arm 36 and its normal contact, and the subscriber A receives in his telephone the busy signal. He thereupon replaces his receiver, and the return to normal of the selector follows the momentary simultaneous energization of relays 41 and 43 in the manner before described.

The circuit shown in Fig. 2 includes the substation B and the first selector F (similar respectively to the substation A and selector C of Fig. 1) and the connector F differing from that shown at D in Fig. 1 in this respect: that a differential relay 67 is provided through whose winding 71 is supplied the current for relays 51 and 57, while through its winding 70 is supplied current for energizing relays 50 and 56. Its armatures 68 and 69 are arranged when the core of the relay 67 is magnetized to open the circuits of relays 50 and 56 respectively; in order to insure the de-energization of these relays when the subscribers at the respective substations replace their receivers. The structure employing the relay 67 would be desirable in exchanges where a material difference of ground potential existed between the exchange and the outlying substations. Should there be such a difference of potential and the circuit of Fig. 1 be employed, the grounding of the two limbs of the lines at the substations might sometimes be unavailing to take sufficient current from relays 50 and 56 to secure the retraction of their armatures, and the release of the switches could, therefore, not be accomplished. In the employment of the structure of Fig. 2 the simultaneous grounding of the two limbs of their line at the substations will without fail, unbalance the magnetic effect of windings 70 and 71 upon the core of relay 67 so that armatures 60 and 69 of said relay will be attracted and the circuit through relays 50 and 56 entirely opened.

The employment of more than one class of selector switches, of the character herein described, is well known, and it is not my intention to limit myself to the employment of a single selector employed for each completed connection, or to the precise struc-

ture herein shown and described, but what I claim and desire to secure by Letters Patent is:

1. An automatic telephone exchange system including a calling subscriber's line and a called subscriber's line, a connector adapted to be operated responsive to currents controlled at the calling substation to connect directly with the called line, talking conductors for said connector having normally open switching contacts, a central source of current, a pair of relays, an electro-magnet associated with said connector effective when connection is made with the called line to close said switching contacts whereby a circuit of said source is closed through said relays to energize them, mechanism at the exchange adapted to be operated responsive to the simultaneous de-energization of said relays to cause the bell of the called subscriber's line to ring, mechanism responsive to the de-energization of one only of said relays, the second remaining energized, for disconnecting said lines, and switching means at the calling substation adapted to effect the de-energization of both said relays or the de-energization of the one only according to the election of the subscriber.

2. An automatic telephone exchange system including a calling subscriber's line and a called subscriber's line, a connector adapted to be operated responsive to currents controlled at the calling substation to connect directly with the called line, talking conductors for said connector having normally open switching contacts, a central source of current, a pair of relays, back contacts for said relays closed when said relays are de-energized, a front contact for one of said relays adapted to be closed when said relay is energized, an electro-magnet adapted to be energized responsive to the closing of the back contacts of both said relays to include ringing current in circuit with the called line, a second electro-magnet adapted to be controlled responsive to the closing of the back contact of one relay and the front contact of the other, for disconnecting said lines, and switching means at the calling substation controlled by the subscriber for energizing and de-energizing said relays according to the election of the subscriber.

3. A connector for automatic exchanges including a pair of talking conductors, a condenser connected in each said conductor, a central source of current connected to one of said conductors on opposite sides of its condenser, a pair of relay magnets, one connected in each such connection, connections from the opposite pole of said source to the other conductor, one on each side of its condenser, a relay magnet connected in each said connection, a control circuit jointly controlled by the two magnets connected to the opposite conductors at one side of their

condensers, a second control circuit jointly controlled by the two magnets connected to the opposite conductors at the other sides of their condensers, and means for controlling the operation of said magnets.

4. A telephone system comprising a calling line and a called line, means, including an automatic switch and a two-strand link-circuit, for uniting said lines into a conversational circuit, condensers in said strands, a source of current, a pair of relays connected in bridge of said strands on each side of said condensers with said source interposed in series between them, a source of ringing current, a ringing relay for controlling the application of said ringing source to the called line, a control circuit for said ringing relay including contacts of one of said pairs of relays, a release magnet for said switch, and a control circuit for said magnet including contacts of the other pair of relays.

5. A telephone system comprising a calling line and a called line, means, including an automatic switch and a two-strand link-circuit, for uniting said lines into a conversational circuit, condensers in said strands, a source of current, a pair of relays connected in bridge of said strands on each side of said condensers with said source interposed in series between them, a source of ringing current, a ringing relay for controlling the application of said ringing source to the called line, a control circuit for said ringing relay including contacts of one of said pairs of relays, a release magnet for said switch, and control circuits for said magnet including contacts of both said pairs of relays.

6. A telephone system comprising a calling line and a called line, means, including an automatic switch and a two-strand link-circuit, for uniting said lines into a conversational circuit, condensers in said strands, a source of current, a pair of relays connected in bridge of said strands on each side of said condensers with said source interposed in series between them, means for applying ringing current to the called line including a circuit extending through contacts of one of said pairs of relays, and a release circuit for the switch including contacts of the other pair of relays.

7. A telephone system comprising a calling line and a called line, means, including an automatic switch and a two-strand link-circuit, for uniting said lines into a conversational circuit, condensers in said strands, a source of current, a pair of relays connected in bridge of said strands on each side of said condensers with said source interposed in series between them, means for applying ringing current to the called line including a circuit extending

through contacts of one of said pairs of relays, and alternative release circuits for the switch including contacts of both pairs of relays.

8. A telephone system comprising a calling line and a called line, means, including an automatic switch and a two-strand link-circuit, for uniting said lines into a conversational circuit, condensers in said strands, a source of current, a pair of relays connected in bridge of said strands on each side of said condensers and in circuit with said source, a source of ringing current, a ringing relay for controlling the application of said ringing source to the called line, a control circuit for said ringing relay including contacts of one of said pairs of relays, a release magnet for said switch, and a control circuit for said magnet including contacts of the other pair of relays.

9. A telephone system comprising a calling line and a called line, means, including an automatic switch and a two-strand link-circuit, for uniting said lines into a conversational circuit, condensers in said strands, a source of current, a pair of relays connected in bridge of said strands on each side of said condensers and in circuit with said source, a source of ringing current, a ringing relay for controlling the application of said ringing source to the called line, a control circuit for said ringing relay including contacts of one of said pairs of relays, a release magnet for said switch, and control circuits for said magnet including contacts of both said pairs of relays.

10. A telephone system comprising a calling line and a called line, means, including an automatic switch and a two-strand link-circuit, for uniting said lines into a conversational circuit, condensers in said strands, a source of current, a pair of relays connected in bridge of said strands on each side of said condensers and in circuit with said source, means for applying ringing current to the called line including a circuit extending through contacts of one of said pairs of relays, and a release circuit for the switch including contacts of the other pair of relays.

11. A telephone system comprising a calling line and a called line, means, including an automatic switch and a two-strand link-circuit, for uniting said lines into a conversational circuit, condensers in said strands, a source of current, a pair of relays connected in bridge of said strands on each side of said condensers and in circuit with said source, means for applying ringing current to the called line including a circuit extending through contacts of one of said pairs of relays, and alternative release circuits for the switch including contacts of both pairs of relays.

12. A telephone system comprising call-

ing and called lines, a two-strand link-circuit for use in connecting said lines into a conversational circuit, condensers in said strands, a pair of relays connected in bridge of said strands on each side of said condensers, a source of ringing current, control circuits including contacts of each pair of relays, and a differential relay controlled over one of said lines and operative to disconnect certain of said relays.

13. A telephone system comprising calling and called lines, a two-strand link-circuit and automatic switch mechanism for use in connecting said lines into a conversational circuit, condensers in said strands, a pair of relays connected in bridge of said strands on each side of said condensers, a source of ringing current, a circuit for controlling the application of said source to the called line including contacts of one pair of said relays, a release circuit for controlling the release of said switch mechanism, including contacts of a pair of said relays, and a differential relay controlled over one of said lines and operative to disconnect certain of said relays.

14. A telephone system comprising calling and called lines, a two-strand link-circuit and automatic switches for connecting the ends of said circuit with said lines to complete a conversational circuit between them, condensers in the strands of said link-circuit, a pair of relays connected in bridge of said strands on each side of said condensers, release magnets for said switches, a release circuit including said release magnets and contacts of a pair of said relays, and a switch control circuit including contacts of the other pair of said relays.

15. A telephone system comprising calling and called lines, a two-strand link-circuit and automatic switches for connecting the ends of said circuit with said lines to complete a conversational circuit between them, condensers in the strands of said link-circuit, a pair of relays connected in bridge of said strands on each side of said condensers, release magnets for said switches, a release circuit including said release magnets and contacts of a pair of said relays, and a release circuit for the release magnet of one of said switches including contacts of the other pair of said relays.

16. A telephone system including subscribers' telephone lines divided into groups, automatic connector switches divided into corresponding groups and provided with release magnets, trunking means for extending concurrent connections from calling lines of one of said groups to a group of said connector switches, a plurality of relays for each of said connector switches through which current is supplied to the substations for talking purposes, a number of said relays for each connector switch be-

ing adapted to remain energized while the connectors are in use to prevent the energizing of said magnets and the release of the connectors.

17. A telephone connector comprising a pair of voice-current conductors, an inductive connection in each conductor, a bridge in front of said inductive connections, a bridge back of said inductive connections, electrically-propelled and step-by-step-actuated connecting mechanism, electrically operated release mechanism, a battery included in both bridges, and four electromagnets included in said bridges, the windings of said electro-magnets constituting the sole or only artificial resistance between the battery and the voice-current conductors.

18. In a telephone exchange system the combination of a talking circuit, inductive connections in said circuit, a bridge in front of said inductive connections, a bridge back of said inductive connections, two relays in each bridge, a battery included in both bridges, switching mechanism controlled by at least one of said relays, release mechanism controlled by at least one of said relays, subscribers' telephones receiving talking current from said battery, and subscriber-operated means for controlling the energizing of at least one of said relays, the windings of said relays constituting the sole or only artificial resistance between the battery and the said talking circuit.

19. In a telephone exchange system, the combination of a talking circuit, an inductive connection in each side of the talking circuit, a bridge in front of said inductive connections, a bridge back of said inductive connections, a pair of relays in each bridge, suitable means for supplying talking current through the windings of said relays to the talking circuit, subscribers' telephones receiving the talking current supplied through the said relay windings, switching mechanism controlled by at least one of said relays, release mechanism controlled by at least one of said relays, and subscriber-operated means for controlling the energizing of at least one of said relays, the said relay windings constituting the sole or only artificial resistance through which talking current is supplied to the talking circuit.

20. A telephone connector provided with a pair of voice-current conductors, an inductive connection in each conductor, a bridge in front of said inductive connections, a bridge back of said inductive connections, a pair of relays in each bridge, suitable means for supplying current through the windings of said relays to the said voice-current conductors, switching mechanism controlled by at least one of said relays, and release mechanism controlled by at least one of said relays, the windings of said relays constituting the sole or only artificial resistance

through which current is supplied to the said voice-current conductors.

21. In a telephone exchange system, the combination of a calling telephone line, a called telephone line, a selector intermediate the two lines, a connector intermediate the selector and the called line, subscribers' telephones, subscriber-operated means for controlling the selector and connector, and means for supplying talking current through the connector to the calling and called telephone lines, said connector provided with four relay coils constituting the sole or only artificial resistance through which talking current is supplied to the telephone lines.

22. A telephone connector comprising a pair of voice-current conductors, an inductive connection in each conductor, a bridge in front of said inductive connections, a bridge back of said inductive connections, electrically-propelled and step-by-step-actuated connecting mechanism, electrically operated release mechanism, a battery included in both bridges, four electro-magnets included in said bridges, the windings of said electro-magnets constituting the sole or only artificial resistance between the battery and the voice-current conductors, and a ringer relay controlled by at least one of said bridged relays.

23. In a telephone exchange system, the combination of a calling telephone line, a called telephone line, a selector intermediate the two lines, a connector intermediate the selector and the called line, subscribers' telephones, subscriber-operated means for controlling the selector and connector, means for supplying talking current through the connector to the calling and called telephone lines, said connector provided with four relay coils constituting the sole or only artificial resistance through which talking current is supplied to the telephone lines, and a ringer relay controlled by at least one of said bridged relays.

24. An automatic telephone connector provided with a release circuit having two parallel and normally open branches, parallel voice-current conductors, inductive connections in said voice-current conductors, a

relay bridge in front of said inductive connections, a relay bridge back of said inductive connections, a set of switch springs for each relay bridge, the continuity of each said parallel branch being controlled by relay springs of both bridges.

25. A telephone connector provided with a release circuit having normally open parallel branches, a pair of relays, another pair of relays, a set of switch springs for each pair of relays, the continuity of each said parallel branch being controlled by springs of both pairs of relays.

26. An automatic telephone connector provided with a release circuit having two parallel and normally open branches, parallel voice-current conductors, inductive connections in said voice-current conductors, a relay bridge in front of said inductive connections, a relay bridge back of said inductive connections, a set of switch springs for each relay bridge, the continuity of each said parallel branch being controlled by relay springs of both bridges, and means for furnishing talking current through the relay windings.

27. A telephone connector provided with a release circuit having normally open parallel branches, a pair of relays, another pair of relays, a set of switch springs for each pair of relays, the continuity of each said parallel branch being controlled by springs of both pairs of relays, and means for furnishing talking current through the relay windings.

28. In a telephone exchange system, the combination of a talking circuit, an automatic switch having two pairs of relays bridged across said circuit, means for supplying talking current through the relay windings to the talking circuit, subscribers' telephones receiving talking current from the said means of supply, each relay-coil of each bridge being non-inductively related to the other coils.

In witness whereof, I hereunto subscribe my name this 22nd day of March A. D. 1906.

ALFRED H. DYSON.