

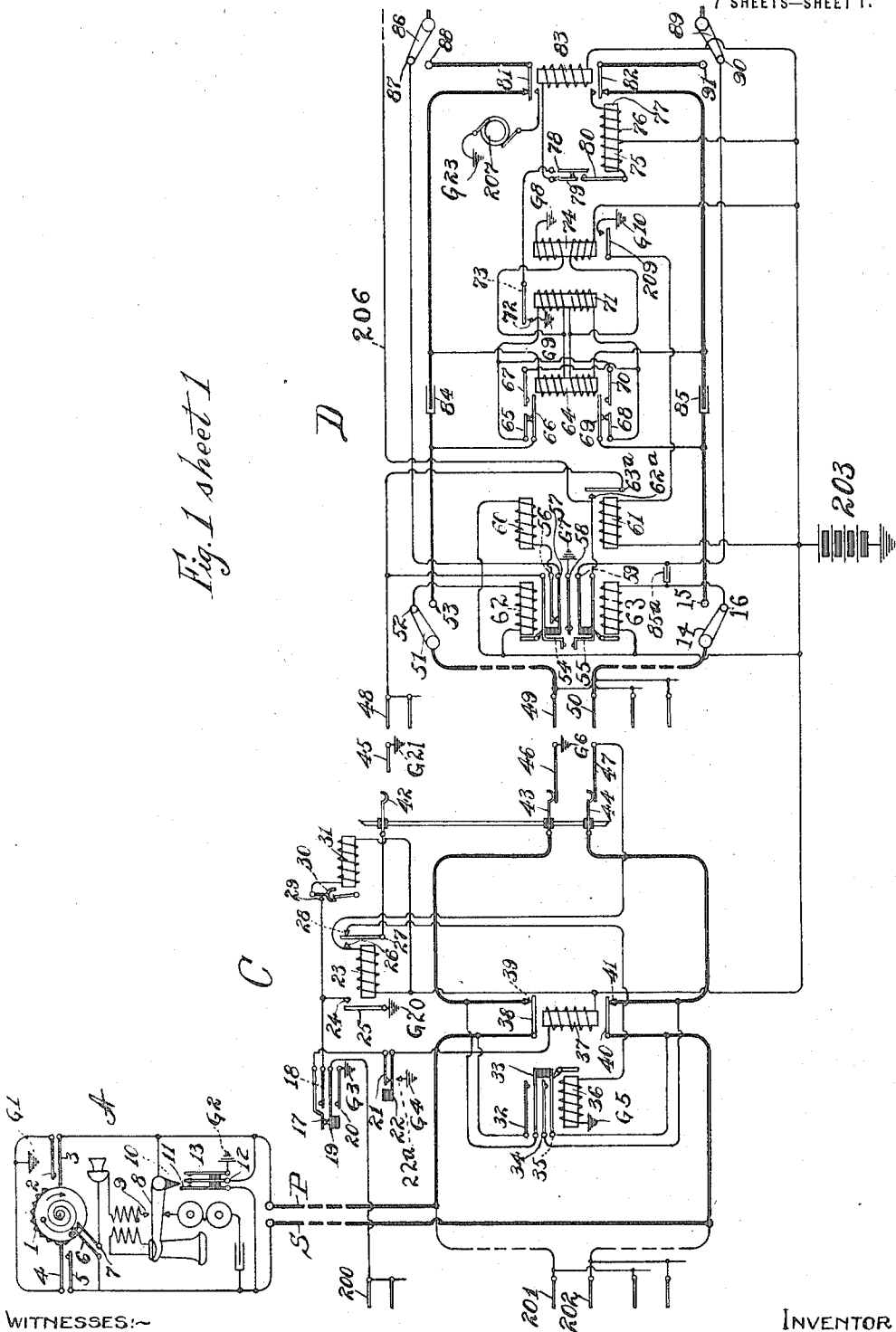
A. H. DYSON.
AUTOMATIC TELEPHONE SYSTEM.
APPLICATION FILED OCT. 31, 1905.

1,184,932.

Patented May 30, 1916.

7 SHEETS—SHEET 1.

Fig. 1 sheet 1



WITNESSES:~

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G. E. Mueller

INVENTOR

Alfred H. Dyson

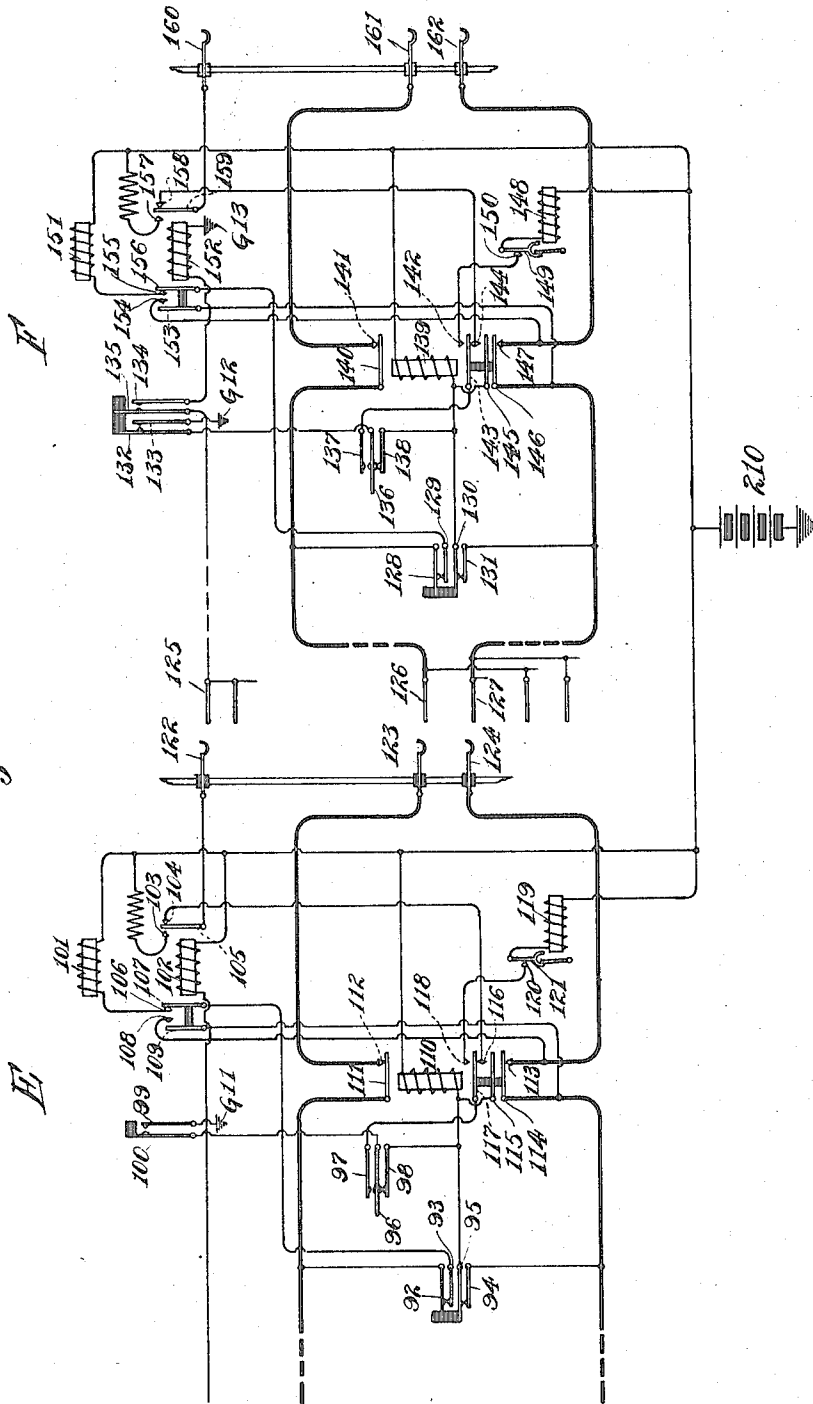
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7 SHEETS—SHEET 2.

Fig. 1 sheet 2



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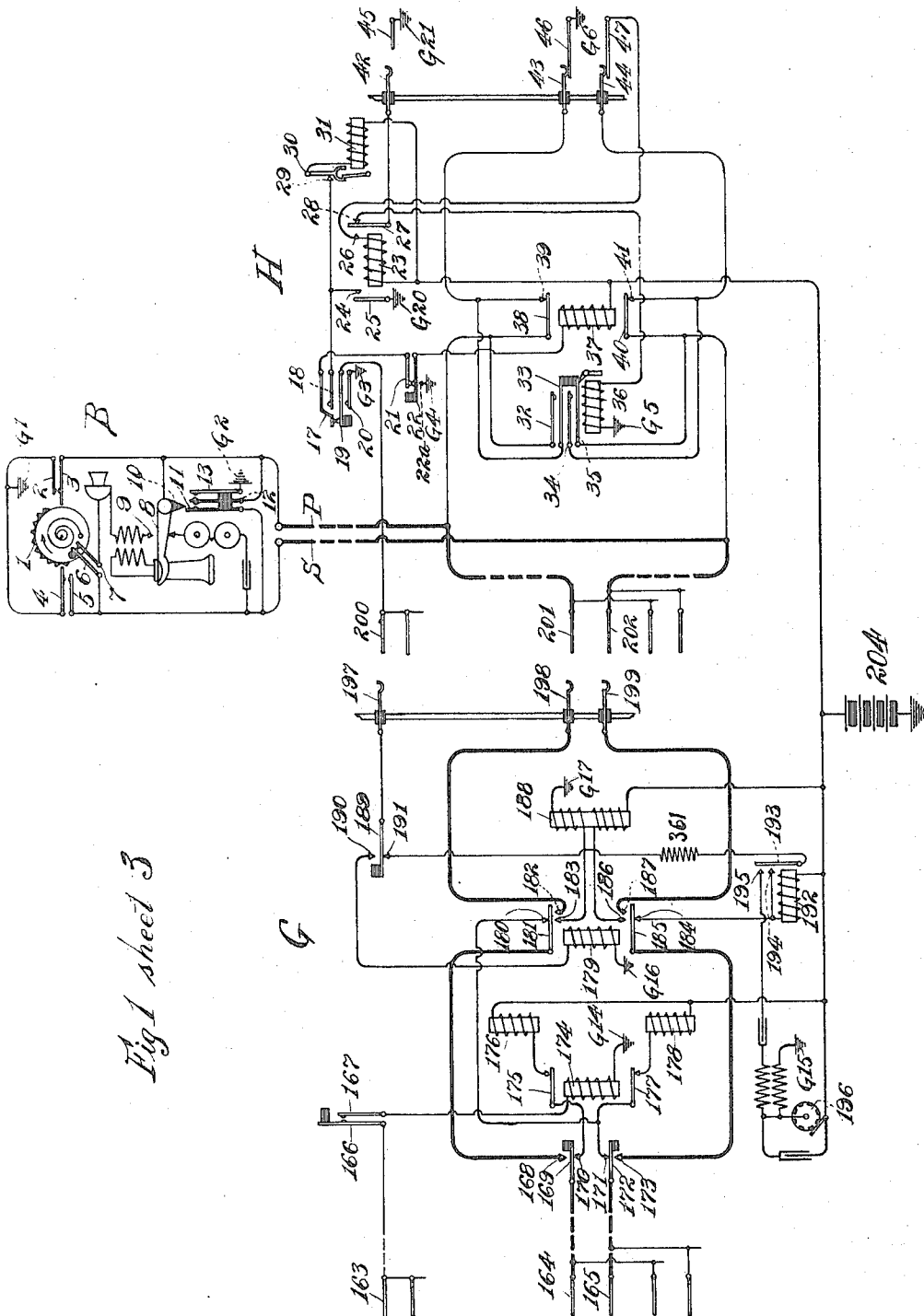


Fig 1 sheet 3

WITNESSES:~

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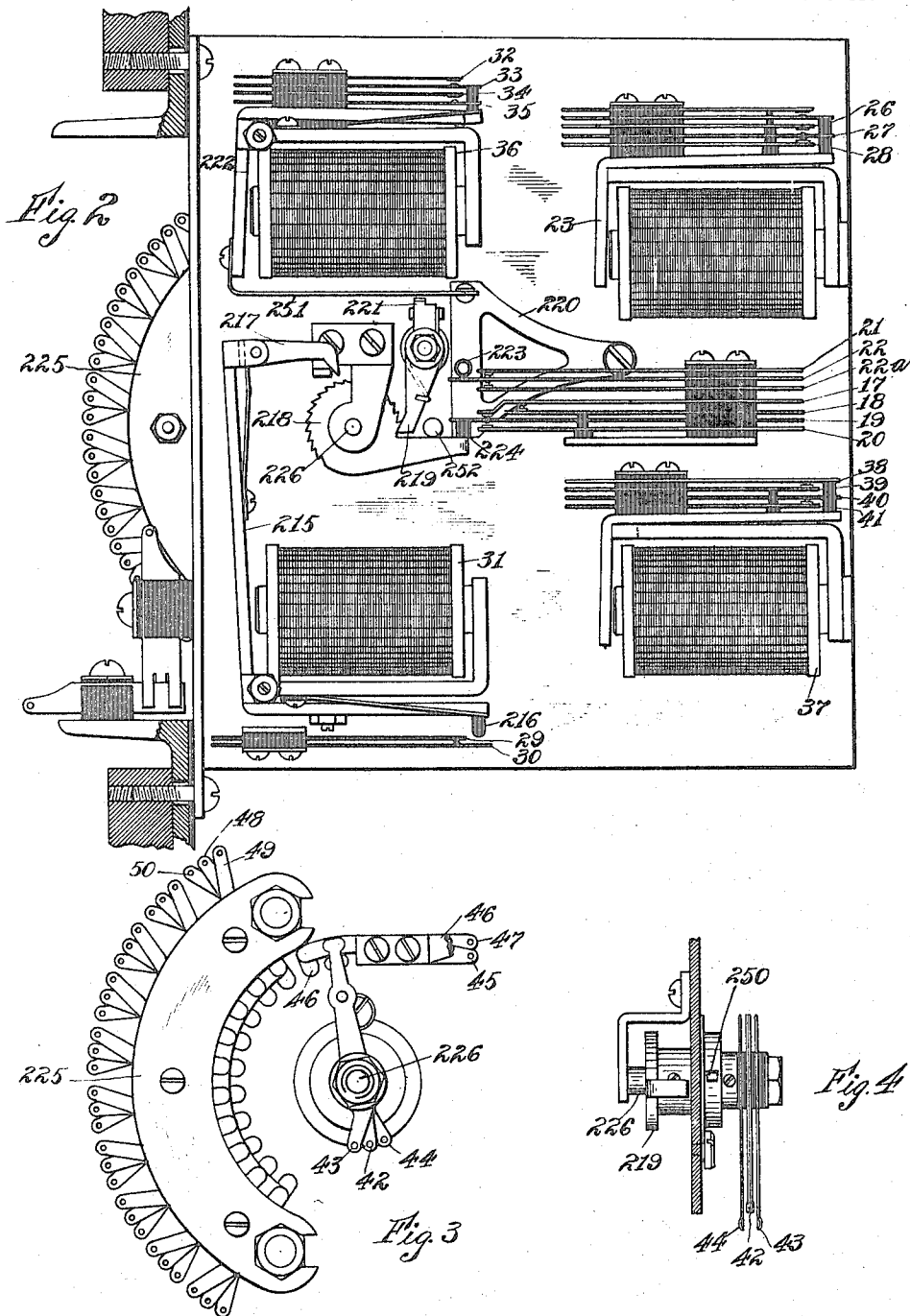
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7 SHEETS—SHEET 5.



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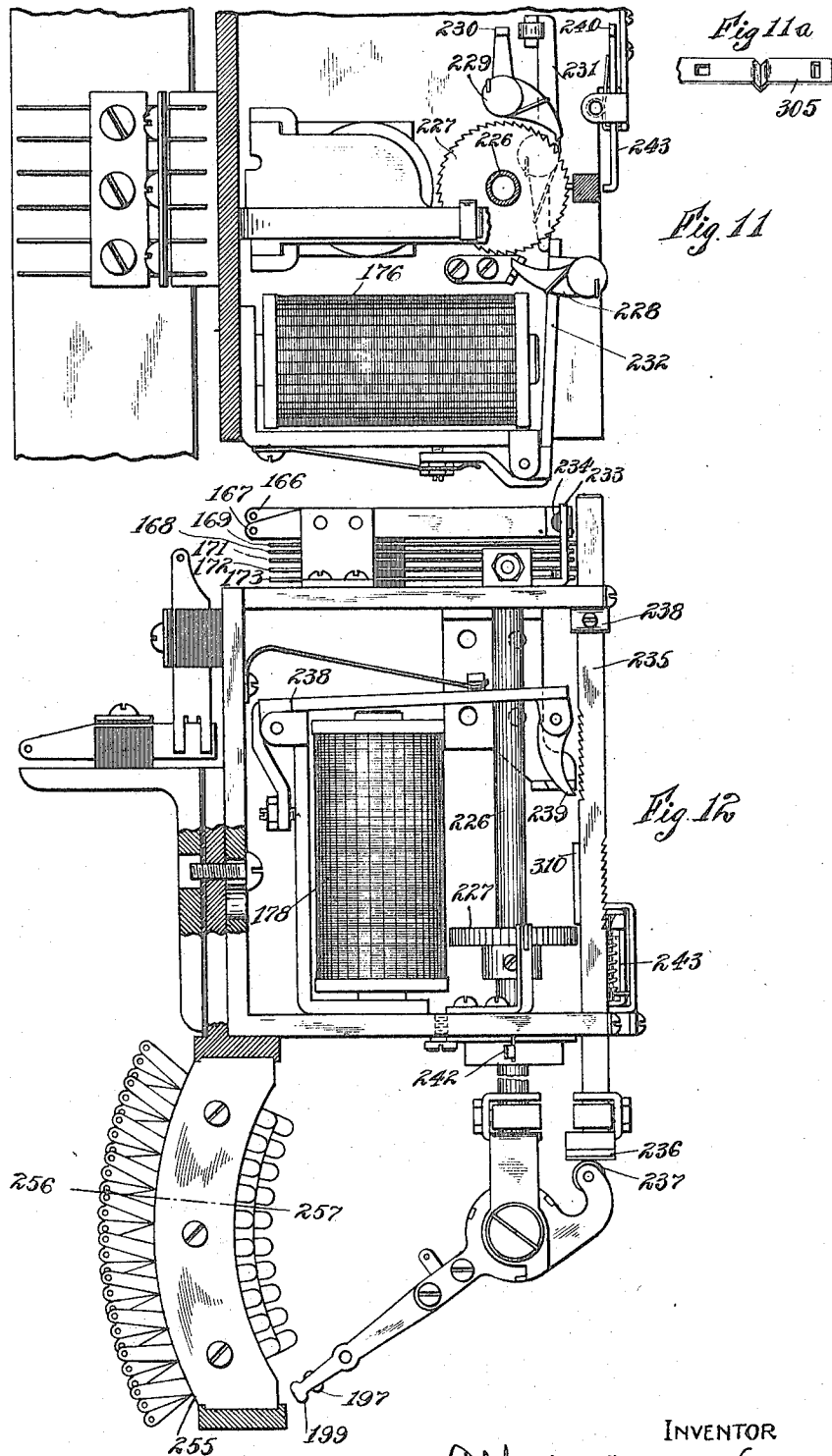
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7 SHEETS—SHEET 6.



WITNESSES:
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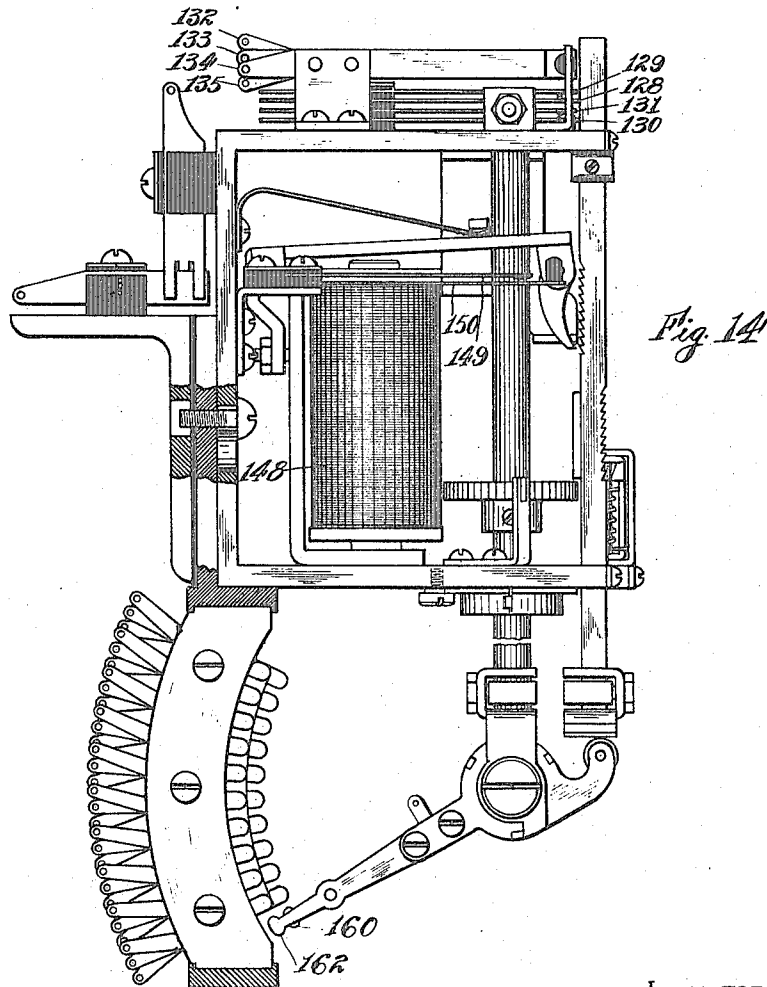
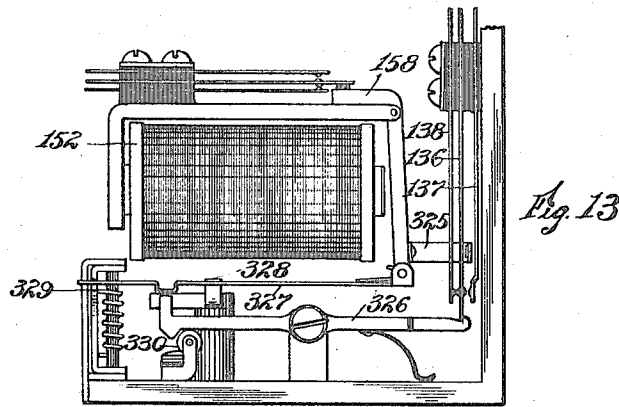
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7 SHEETS—SHEET 7.



WITNESSES:~

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

1,184,932.

Specification of Letters Patent.

Patented May 30, 1916.

Application filed October 31, 1905. Serial No. 285,321.

To all whom it may concern:

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

My invention relates to telephone systems in which the interconnecting of subscribers' lines is secured by means of electrically controlled switching mechanisms at the exchange, operating responsive to substation switching mechanisms controlled by the subscribers.

15 An object of my invention is to provide an organization of electrical circuits at the central exchange, using as few electromagnets as possible, thus securing a system of low initial cost and one that may be maintained at a comparatively low expenditure.

20 A further object is to provide an improved form of mechanical switch adapted for use in connection with the circuits of my invention.

25 As is well known, it has heretofore been the practice to employ in connection with the switching devices of automatic telephone exchanges, magnets in local circuits controlled by relays operated over the telephone
30 lines, the relays serving merely to repeat the impulses sent over the lines to the magnets of the switches. This arrangement is employed because the magnets have relatively heavy work to do in adjusting the mechanical parts of the switch, and it would not be
35 feasible to place their windings directly in circuit with the lines on account of the varying resistances of such lines. Were they so placed, it would be found that on long lines, conditions under which the magnets would
40 operate would not permit them to properly perform their work.

The work required to be done by the relays operating over the line circuits is of an
45 extremely exacting nature even when it is considered that their only work is to attract and release their armatures to close and break circuits through the magnets. This is because the impulses transmitted over the
50 line come in quick succession, and unless a relay is very sensitive and rapid in its operation, it may happen that its armature will fail to be retracted at the conclusion of each and every impulse, the relay sometimes holding its armature up while two im-
55

pulses are passing through it, which of course, results in transmission of too small a number of impulses to the magnet it is operating. It is thus seen that relays operated by the line impulses must be very
60 carefully constructed, and after placed in operation must be kept very carefully tuned up and maintained in the highest possible state of efficiency and sensitiveness.

In the systems of automatic telephony
65 hitherto known, it has been customary to provide one such relay for each selective switch in the exchange. In such systems where several switches are successfully employed in completing one connection, one to
70 select the thousands, another to select the hundreds and a third to select the units, for instance, three such relays will be brought into operation in completing each connection. In practising my invention however,
75 in connection with such systems as that before indicated, but one such relay would be used which would receive all the sets of current impulses transmitted from the substation and distribute them directly to the
80 magnets of the various switches.

It has heretofore been the practice in the systems in general commercial use, to provide a first selector for each telephone line in the exchange, and a number of second
85 selectors and connectors proportionate to the number of co-existing calls expected to occur at the busiest hour of the day. Assume a 10,000 line system of this character provided with facilities for 10 per cent. trunking, there would be 10,000 such relays operated by the line impulses described, one for each first selector; there would also be 1,000 such relays, one for each of the second selectors employed, and another 1,000 relays,
90 one for each of the connectors, making a total of 12,000 relays each of which should be ready at all times to respond with absolute accuracy to the line impulses. In accordance with my present invention, I do
100 away with first selectors individual to the subscribers' lines, and provide means for interchangeably temporarily associating a limited number of such selectors with the different telephone lines upon the initiation
105 of calls at the substations. In a 10,000 line system with 10 per cent. trunking, I would therefore employ 1,000 first selectors, 1,000 second selectors and 1,000 connectors, and in addition, automatically controlled means
110

whereby on the removal of a receiver at a substation, one of the first selectors will be brought into operative association with the calling line. This may be accomplished in any desired manner, and I do not wish to be limited to the particular means herein disclosed, consisting of a simple switch, one for each telephone line.

Associated with each first selector, I provide a relay adapted, when the first selector has been automatically associated with the calling line, to receive the directive impulses transmitted from the substation, said relay serving to re-transmit the impulses, first to the magnet of a first selector; after the adjustment of the latter, to the magnet of a second selector, and after the adjustment of the latter, to the magnets of a connector, and thus in a 10,000 line exchange, but 1,000 relays of which is required the exacting service heretofore referred to are needed.

It will be noted that I not only do away with a large number of relays heretofore used of which this particular service was required, but that in carrying out my invention, I also do away with a large number of relays heretofore used, one for each switch, for receiving impulses transmitted over the opposite side of the telephone line from that over which the directive impulses are transmitted. This I do by providing one such relay associated with the first selector, and employing it to receive all currents transmitted over the other line limb, above referred to.

I thus do away with a large amount of apparatus and moreover, with the apparatus of a character particularly likely to give trouble in automatic telephone exchange systems and to cause a very heavy operating and maintenance expense.

These and other features of my invention will be more particularly described and pointed out in the general description and claims.

Referring to the drawings, Figure 1, consisting of Sheets 1, 2 and 3, illustrates, in diagrammatic form, two substations connected by their respective telephone lines with the exchange, and circuits at the exchange for interconnecting them. Fig. 2 is a side view of a private switch. Fig. 3 is a view of the wipers and contact bank of the said switch. Fig. 4 is a sectional view, showing the arrangement of wipers and shaft. Fig. 5 illustrates a connector switch. Fig. 6 illustrates detail of the off normal switching mechanism of the said connector switch. Fig. 7 is a sectional view of a contact bank of said switch. Fig. 8 shows the mechanism of a private magnet and a release magnet for said switch. Fig. 9 shows mechanism employed in the control circuit shown in Fig. 1. Fig. 10 is a top view of the

circuit-changing springs shown in Fig. 9. Fig. 11 is a sectional view of a connector switch, showing details of the primary magnet and its associated mechanism. Fig. 11^a is a top view of a portion of the releasing lever for said switch. Fig. 12 is a side view of a connector switch, showing details of the secondary magnet and its associated mechanism. Fig. 13 illustrates a release magnet for a selector switch and its associated mechanism. Fig. 14 is a side view of a selector switch. Fig. 15 illustrates a detail of Fig. 8.

Referring first to Fig. 1, I show at A a substation circuit connected by limbs P and S of the telephone line with the private switch C at the exchange, which latter is individual to the telephone line and is operated by a preliminary switching movement at the substation. After being initially operated, its movement is independent of the substation. Associated with its wipers 42, 43 and 44, are a plurality of contacts similar to 48, 49 and 50, terminals of control circuits similar to D, each control circuit being connected with the circuit of a first selector switch common for connection to all subscribers.

One hundred private switches may be conveniently grouped together and ten control circuits assigned to them, multiplied terminals of said circuits appearing before the wipers of each private switch. Thus, assuming a ten thousand line exchange, there would be one hundred groups of one hundred private switches each, and one hundred groups of control circuits of ten each.

The control circuit D is provided with relays 62 and 63, adapted to be operated by current impulses transmitted over the two limbs of the line and act as relays to transmit corresponding currents to the operating magnets of the first selector, second selector and connector switches. These relays are common for operating all three switches, and I am thus enabled to avoid the use of separate primary and secondary relays for each switch such as have hitherto been employed in systems of this character. A material saving in apparatus is thus secured, and the size of mechanical switches may be reduced. The control circuit shown at D also comprises means for controlling the supply of talking battery which is supplied from a central source, apparatus for automatically ringing an idle called subscriber's line and apparatus for controlling the release of the various switches used in the connection.

A first selector switch, the circuit of which is shown at E, may comprise wipers 122, 123 and 124 and multiplied terminals of one hundred second selector switches which may be divided into ten groups of ten switches each, the different groups being common

for connection to, or representative of, the different thousands of the exchange, assuming a ten thousand line exchange. The terminals of each group may be disposed in a section of contacts by itself. The circuits, shown at E, comprise means for causing wipers 122, 123 and 124 to execute primary movements, each movement bringing the wipers adjacent to a different section or group of second selector switch terminals. Said circuits also provide means for starting the wipers moving over the terminals of a selected group, such movement being automatically controlled and arrested when terminals of an idle second selector switch are reached. Thus, a first selector switch may pick out a limited group of one thousand subscribers' lines by selecting an idle second selector switch representing such a group.

A second selector switch, circuits of which are shown at F, may comprise wipers 160, 161 and 162 and terminals such as 163, 164 and 165 of one hundred connector switches, divided into groups of ten, each group being common for connection to a different one hundred lines of the thousand of which the second selector switch is representative. The terminals of each group of connector switches may be disposed in a separate section. The circuit, shown at F, includes means for causing wipers 160, 161 and 162 to select any one of these sections or groups of terminals of connector switches, and further means for causing the wipers to move over the terminals of a selected group, their motion being automatically controlled and arrested when they engage terminals of an idle switch. Thus, by means of the circuit shown at F, a second selector switch may be caused to pick out a limited group of one hundred subscribers represented by an idle connector switch, of the thousand.

A connector switch, the circuits of which are shown at G, may comprise wipers 197, 198 and 199 and contacts, multiplied terminals of one hundred subscribers' lines adapted to be engaged by said contacts. The said contacts may conveniently be divided into groups of ten, according to their values in the hundred, the terminals of each group being placed in a separate section. The circuit, shown at G, includes means for causing wipers 197, 198 and 199 to select a desired one of these groups of ten, and further means for causing them to select any desired terminals out of such a group.

If wipers 197, 198 and 199 are brought to rest in engagement with contacts, terminals of a busy subscriber's line, the calling subscriber receives the busy signal and, by replacing his receiver, disconnects the various switches. If the line of the called subscriber is idle, the bell of the called subscriber is automatically rung and his response operates to cut the ringing generator out of cir-

cuit. At the end of the conversation, the replacing, by either subscriber, of his receiver upon the hook operates upon control circuit D to effect the disconnection of all the switches used in establishing the connection. This provision of means, by which all switches may be released from either substation, is believed to be new in a system of this character, employing a trunk release system.

The system, as a whole, operates, as will be understood from the foregoing, upon the multiple trunk system, the principles of which are well known, and it will be understood that the numerical ratios suggested above may be varied to suit particular conditions.

The detail of the circuit arrangement of my invention will be best understood from the following narrative of operation, reference being had to Fig. 1, the three sheets being placed in their numerical order, Sheet 1 being at the left.

Assuming that subscriber A desires to connect his line with the line of subscriber B, to whom is assigned number 3456, subscriber A first removes his receiver from the hook lever, whereupon contact 8-9 is closed. Current thereupon flows from ground G⁵ at the exchange, over the heavy conductor to limb P, through the substation, through contact 8-9 and the transmitter, returning over limb S, over the other heavy conductor, through contact 44-47, through electromagnet 23 to battery 203. Electromagnet 23 is energized and attracts armatures 25 and 27. Current flows from ground G²⁰, through contact 24-25, through contact 29-30, through operating magnet 31 and to battery, the magnet attracting its armature to open contact 29-30, thus effecting its deenergization. Magnet 31 vibrates its armature as long as contact 24-25 is closed, each vibration effecting a step-by-step movement of wipers 42, 43 and 44. The first vibration of armature of magnet 31 effects the closure of contacts 20-19 and 18-17. The closure of the first contact connects ground G³ to contact 200 and renders the line of subscriber A busy to incoming calls. The closing of contact 17-18 establishes a path for the flow of current from ground G²⁰, through the said contact, through cut-off relay 37 to battery 203, the cut-off relay attracting its armatures to disengage anvils 39 and 41, thus opening circuit through wipers 43 and 44 and preventing interference with existing conversations while they are wiping over terminals of busy control circuits.

The first energization of magnet 31 causes wiper 42 to engage contact 45, thus closing circuit from ground G²¹, through the said contact, through contact 27-26 to battery, locking electromagnet 23. This first move-

ment of the wipers does not open contacts 43—46 and 44—47, a second movement of the wipers being required to bring them to engage contacts, terminals of the first control circuit. This feature insures the operation of cut-off relay 37 before the first control circuit is reached. The second movement of the wipers causes them to engage contacts, terminals of the first control circuit. Should this be already in use, its contact, corresponding to contact 48, will be grounded from ground G^5 of some other private switch by way of contact 27—28 of said switch; and electromagnet 23 of the private switch of subscriber A will continue energized, circuit being traced from the ground G^5 of the other private switch referred to, through the winding of its electromagnet 36 to wiper 42 of the private switch of the subscriber A and through the winding of electromagnet 23 to battery. The resistance of electromagnet 36 to that of electromagnet 23 is so proportioned that the former does not attract its armature. Similar circuits will be successively established through electromagnet 23 until wiper 42 engages a contact, terminal of an idle control circuit. Such terminal will be ungrounded, electromagnet 23 will be deenergized, its armatures resume their normal positions shown in Fig. 1 and operating magnet 31 will cease to vibrate its armature, owing to the opening of contact 24—25 which opening also opens circuit through cut-off relay 37. The armatures of the latter again engage anvils 39 and 41 and circuit is closed from the limbs of the line of subscriber A to wipers 43 and 44.

Assuming the idle control circuit selected to be that shown at D, wipers 42, 43 and 44 are now resting in engagement with contacts 48, 49 and 50 of the said circuit. The closing of contact 28—27, upon the deenergization of electromagnet 23, connects ground G^5 , through the winding of magnet 36 and the said contact and wiper 42, to terminal 48 of the control circuit and its multiples, so that the circuit is rendered busy with respect to other private switches. Subscriber A now rotates dial 1 to the right until three teeth have passed below spring 3. When the dial is in other than normal position, the stop shown thereon allows contact 6—7 to open, separating the two limbs of the line, the return of the dial to normal operating to again close them. Subscriber A now releases the dial and it rotates from right to left, the three teeth referred to closing contact 2—3 three times and causing three impulses of current to flow from ground G^1 at the substation, through the said contact, over limb P of the line, over the heavy conductor, through contacts 43—49 and 51—52, through the winding of primary relay 62 to the live side of battery 203.

Primary relay 62 is energized three times and three attractions and releases of its armature cause three impulses of current to flow from ground G^7 , through contacts 58—57, 87—86, 92—93 (first selector switch E), contact 107—106, through the winding of primary magnet 101. The three resulting energizations of the said magnet bring wipers 122, 123 and 124 adjacent to a section of contacts, terminals of second selector switches, assigned for connection to the third thousand group of subscribers' lines. With the first primary movement of the wipers, contact 99—100 is closed, to remain so until the switch is released; also, contact 96—98 is broken and contact 97—96 is closed.

Referring now to the substation A, with the return of dial 1 to normal, a tooth thereon engages spring 4, momentarily closing contact 4—5, causing the flow of current from ground G^1 , through the said contact, over limb S of the line, through contacts 40—41, 44—50, 14—16, through the winding of secondary relay 63 to battery 203. The attraction and release of the relay's armature effects a flow of current from ground G^7 , through contacts 58—59, 90—89, 94—95 at the first selector switch, through the winding of private magnet 110 to battery 210. Said magnet attracts its armatures, opening contacts 111—112 and 113—114 which remain open, due to the continued energization of the said magnet, as long as wipers 123 and 124 are wiping contacts, terminals of busy second selector switches. The closing of contact 117—118, upon the energization of magnet 110, establishes a path for the flow of current from ground G^{11} , through contacts 99—100, 96—97, 117—118, 120—121, through the winding of secondary magnet 119 to battery 210. The said magnet is energized and deenergized, owing to its vibratory circuit, and moves wipers 122, 123 and 124 to engage contacts, terminals of the first second selector switch of the group. With the first secondary movement of the wipers, contacts 92—93 and 94—95 are opened. If the first second selector switch is busy, its contact, engaged by wiper 122, will be grounded from ground G^{11} of another first selector switch, through its contacts 99—100, 96—97, 117—116, 104—105, through its wiper 122, to a multiple of the contact engaged. Current will therefore flow from the grounded contact, through wiper 122 of switch E, through its contacts 105—104 and 116—115, through the winding of private magnet 110 to battery 210, thus locking the said magnet. Secondary magnet 119 will vibrate its armature, causing wipers 122, 123 and 124 to engage contacts, terminals of successive second selector switches, until an idle switch is reached, successive locking paths for magnet

110 being established until an idle switch is reached. When this occurs, its contact, engaged by wiper 122, will be ungrounded, circuit through private magnet 110 will be opened, and its armatures will return to the positions shown in Fig. 1, the opening of contact 118—117 preventing further vibration by magnet 119 of its armature. Wipers 122, 123 and 124 therefore rest in engagement with contacts, terminals of the idle second selector switch assumed to be switch F.

Subscriber A now transmits four impulses of current by means of dial 1, over limb P of the line, through primary relay 62 of control circuit D, and a similar number of impulses are transmitted by the said relay from ground G^7 , through contacts 58—57, 87—86, 111—112, 123—126, 128—129 (switch F), through contact 156—155, the winding of the primary magnet 151, to battery 210. Four primary movements of wipers 160, 161 and 162 are effected by the four resulting energizations of magnet 151 to bring the wipers adjacent to a section of contacts, terminals of connector switches assigned to the fourth hundred of the third thousand group of lines. With the first primary movement of the wipers, contacts 132—133 and 135—134 are closed; also, contact 136—138 is opened and contact 137—136 closed.

A single impulse transmitted from ground G^1 , with the return of the dial to normal, causes a single energization of secondary relay 63, which transmits a single impulse of current from ground G^7 , through contacts 58—59, 90—89, 114—113, 124—127, 131—130, through the private magnet 139 of switch F, and to battery 210. The said magnet is energized and attracts its armatures, opening contacts 140—141 and 146—147, which remain open until an idle selector switch is reached. Magnet 139 also closes contacts 142—143 and 144—145. The closure of the first contact causes a flow of current from ground G^{12} , through contacts 133—132, 136—137, 143—142, 150—149, through secondary magnet 148 to battery 210, the magnet vibrating its armature and causing wipers 160, 161 and 162 to engage terminals of the first connector switch of the group. With the first secondary movement of wipers 160, 161 and 162, contacts 128—129 and 130—131 are opened and remain so until the switch is released. Should this switch be busy, a circuit will be established from ground G^{12} of another second selector switch rendering it busy, to a multiple of the contact engaged, through the contact and wiper 160 of switch F, through contacts 159—158 and 144—145 and the winding of the private magnet to battery 210. Secondary magnet 148 will continue to vibrate its armature, with each vibration

moving the wipers to engage terminals of successive switches, successive locking paths for magnet 139 being established until an idle connector switch is reached. When this occurs, assumed to be when wipers 160, 161 and 162 engage contacts 163, 164 and 165 of the connector switch G, the contact engaged by wiper 160 will be ungrounded, circuit will be broken through magnet 139, its armature will return to the position shown in the illustration and, owing to the resulting opening of contact 143—142, the further energization of electromagnet 148 is prevented and the wipers rest in engagement with the terminals of the idle switch. The closing of contact 143—144, with the de-energization of magnet 139, connects ground G^{12} , through contacts 133—132, 136—137, 143—144, 158—159, through wiper 160 to terminal 163 and its multiples, rendering the selected connector switch busy.

Subscriber A now transmits five impulses of current from ground G^1 , through primary relay 62, which in turn causes five impulses to flow from ground G^7 , through contacts 58—57, 87—86, 111—112, 123—126, 140—141, 161—164, 169—170 (connector switch G), through armature 175 and the winding of primary magnet 176 to battery 204. The five energizations of the primary magnet effect five primary switching movements of wipers 197, 198 and 199, bringing them adjacent to a section of multiplied line terminals, including those of subscribers to whom are assigned numbers running from 3451 to 3460. With the first primary movement of the wipers, contact 166—167 is closed, to remain closed until the release of the switch. The return of the dial to normal causes a single energization of secondary relay 63, which causes an impulse of current to flow from ground G^7 at circuit D, through contacts 58—59, 90—89, 114—113, 124—127, 146—147, 162—165, 172—171 at switch G, through armature 177, through the winding of secondary magnet 178 to battery 204. A secondary movement of the wipers is effected by the energization of the said magnet, but their normal positions are such, with respect to the contacts with which they are adapted to engage, that this first movement approaches them to the first contact of a selected row only. With the first movement of the wiper, contacts 170—169 and 171—172 are broken and contacts 169—168 and 172—173 are closed. Six impulses, now sent from substation A, cause six energizations of the primary relay 62 at circuit D, and a corresponding number of impulses are transmitted from ground G^7 at the said circuit, over the previously traced path, through contacts 161—164, contact 169—168 at switch G, contact 181—180, through armature 177, through secondary magnet 178 to battery 204. Six energizations of the sec-

ondary magnet are caused, and the first of these brings wipers 197, 198 and 199 into engagement with the first terminal contacts of the selected group of lines, and the sixth into engagement with the sixth contacts of the group, or contacts 200, 201 and 202, terminals of the line of subscriber 3456, or subscriber B. Should the line be busy at this time, wiper 200 will be connected to ground G^3 at switch H, should subscriber B be a calling subscriber, or to ground G^{16} at some other connector switch, should subscriber B be a called subscriber. A single impulse of current sent from ground G^7 at substation A, by the energization of relay 63, will cause a single impulse to flow from ground G^7 , over the previously traced path, through contacts 162—165, 172—173, 185—184, through the winding of electromagnet 192 to battery 204. Magnet 192 thereupon attracts its armature 193 to engage anvils 194 and 195.

On the closing of contact 193, 194 ground at G^7 will momentarily be connected, over a circuit practically without resistance, to armature 193. If another connector G has already connected with the called line its relay 179 will be energized by a circuit extending from ground G^{16} through said relay 179, contacts 190—189, 197—200, 19—17, to battery through relay 37 of the called line. Resistance 361 is provided in order that current may not be momentarily nearly all shunted from relay 179 of the other connector by a branch of the before traced circuit extending from multiple 200 engaged by wiper 197 of the connector whose relay 179 is energized and to the before mentioned ground G^7 . Said resistance serves merely to protect the relay 179 of such other connector.

Contact 200, engaged by wiper 197, being grounded, as before mentioned, current flows from ground, through contacts 200—197, 189—191, 193—194, through electromagnet 192 to battery 204, locking the said magnet. Subscriber A, having at this time his receiver to his ear, will receive the busy signal from interrupter 196 at switch G, circuit being traced through double contact 195—193—194, through contact 184—185, over the heavily marked conductor, through contact 89—90, condenser 85^a, contact 16—14, thence over the heavily marked conductor through the exchange, to limb S of the line, through contact 9—8 at the substation, returning over limb P of the line, over the heavily marked conductor contact 51, contact 52 and relay 62 to battery.

Being thus notified that the called line is busy, subscriber A replaces his receiver, arm 10, associated with hook lever 8, cooperating with springs 11, 12 and 13 to simultaneously ground the two sides of the line. Primary relay 62 and secondary relay 63 at switch D

are simultaneously energized and their armatures attracted to close contact 55—54. Current thereupon flows from ground G^5 at private switch C, through the winding of release magnet 36, through contacts 28—27, 42—48, 54—55, then over conductor 206, through the winding of release magnet 102 of the first selector switch, to battery 210. Release magnets 36 and 102 of switches C and E, respectively, are energized, preparatory to the return of the switches to normal. The energization of release magnet 102 attracts its armature 105 to establish a path for the flow of current from ground G^{13} at switch F, through release magnet 152, contacts 134—135, 125—122, 105—103 to battery 210. Release magnet 152 is therefore energized, preparatory to the return of switch F to normal. It attracts its armature 159 to establish a path for the flow of current from ground G^{14} at the connector switch, through the winding of release magnet 174, contacts 167—166, 163—160, 159—157, to battery 210. Release magnet 174 is energized, preparatory to the return of the connector switch to normal.

Referring to substation A, with the return of the hook lever to normal, arm 10 passes over the extremity of spring 11, springs 11, 12 and 13 disengage, thus removing ground from the limbs of the line and causing the deenergization of relays 62 and 63. The resulting opening of contacts 54 and 55 deenergizes release magnet 36 of switch C and 102 of switch E. The deenergization of the latter magnet effects the deenergization of release magnet 152 of switch F, which in turn effects the deenergization of release magnet 174 of switch G. The deenergizations of their respective release magnets cause the returns of the various switches to normal and their disconnection.

Returning now to the point at which wipers 197, 198 and 199 first engage contacts 200, 201 and 202, and assuming that the line of subscriber B is idle at this time, which is the condition shown in Fig. 1, it will be observed that contact 200 is connected, through contact 19—17 and the winding of cut-off relay 37, to the active side of battery 204. When electromagnet 192 is in this case energized, with the return of the substation dial to normal, the closing of contact 193—194, instead of causing the establishment of a locking circuit for electromagnet 192, connects wiper 197 to the active side of battery 204; and contact 200 being also connected to the same side of the battery, electromagnet 192 is deenergized upon the cessation of the impulse transmitted from the substation. The release of its armature 193 causes arm 189 to disengage anvil 191 and to engage anvil 190. A path for the flow of current is thereby

established from ground G^{16} , through relay 179, contacts 190—189, 197—200, 19—17, through the winding of cut-off relay 37 to battery 204, causing the energization of relay 37, which opens up the circuits of the line of subscriber B at his private switch. This flow also energizes electromagnet 179, which attracts its armatures 181 and 185, the former to engage anvils 182 and 183, the latter to engage anvils 186 and 187. Current thereupon flows as follows: from ground G^{17} at switch G, through the upper winding of impedance coil 188, through contacts 183—181, 168—169, to the left over the heavily marked conductors, through contact 86—87, contact between springs 57 and 56, through the winding of electromagnet 60, to the active side of battery 203. The resulting energization of magnet 60 moves arms 14, 51, 86 and 89 to engage contact points 15, 53, 88 and 91, respectively. Current thereupon flows as follows: from ground G^s at control circuit D, through the upper winding of differential relay 74, through the upper winding of relay 71 which is serially wound, then through contacts 65—66, 53—51, 49—43, 39—38, over limb P to substation A, through contact 8—9, through the substation transmitter, supplying current thereto energizing the same, through contact 7—6, returning over limb S, through contacts 40—41, 44—50, 14—15, 69—68, through the lower winding of relay 71, through the lower winding of differential relay 74 to battery 203. Relay 74 remains neutral. The relatively high resistance windings of relay 64 and of impedance 188 now in series are at this time shunted by the relatively low resistance windings of relay 74, and relay 64 does not attract its armatures. Relay 71 attracts its armature and current flows from ground G^s , through contacts 72—73, 78—79, through the winding of ringing relay 83 to battery 203. The relay attracts its armatures, armature 81 operating to cut ringing generator 207 into circuit with the line of subscriber B, the current flowing from the said generator, over the heavily marked conductor through the exchange to limb P, through the condenser and bell at the substation, returning over limb S and over the other heavily marked conductor, through armature 82 and, the said armature being attracted, through winding 76 of relay 77 to battery 203. This being alternating current, relay 77 does not attract its armature.

When, however, subscriber B removes his receiver, which operates to close contact 9—8 at his substation, current flows from ground G^{23} at the battery control circuit to limb P of the line, through contact 8—9 at the substation, returning over limb S, through armature 82, through winding 76 of relay 77, to battery 203. This flow of

direct current causes relay 77 to attract its armature 80 to engage spring 78, thereby establishing a locking circuit for itself from ground G^{19} , through contact 72—73. Subsequent to the closing of contact 80—78, the movement of armature 80 opens contact 79—78, thereby deenergizing ringing relay 83, whose armatures resume their positions shown, establishing the talking circuit. Current now flows from ground G^s , through the upper winding of relay 74, through the upper winding of relay 64, through armature 81, through contact 88—86, over the heavily marked conductor to the right, through the exchange to limb P of the line of subscriber B, over the limb, through contact 8—9, through the transmitter, supplying talking current thereto, through contact 7—6, returning over limb S, over the other heavily marked conductor through the exchange to the left, through contact 89—91, through armature 82, through the lower winding of relay 64, through the lower winding of relay 74 to battery 203. Relay 64 is serially wound and this flow of current is of sufficient volume to cause it to attract its armatures to close contacts 67—66 and 70—69, opening contacts 65—66 and 68—69 at a time subsequent to the closing of the first mentioned contacts. The switching operations described reverse the connection of ground G^s and the active side of battery 203 to the respective limbs of the line of subscriber A, ground G^s being now connected through the upper winding of relay 74, the upper winding of relay 71 and contact 70—69, and the heavy conductor, to limb S of the line of subscriber A, while the active side of battery 203 is connected to the lower winding of relay 74, the lower winding of relay 71, contact 67—66 and the other heavy conductor, to limb P. Thus, the direction of the flow of current in the line of subscriber A is, by the response of the called subscriber, reversed.

The two subscribers are now in conversation through condensers 84 and 85. It will be noted that the supply of current through both lines is through the windings of differential relay 74 a portion of the transmitter current supply for the called line being also fed through the windings of impedance coil 188. The flow through the two windings being of equal volume, the core is neutral. Either subscriber, however, may, by grounding the two limbs of his line, unbalance the neutralizing effect of the two windings and cause the magnetization of the core. Thus, when either or both subscribers, at the end of the conversation, replace their receivers, thus simultaneously grounding the two limbs of one or both lines at the substation, by the operation of arm or arms 11, the core of relay 74 is magnetized and armature 209 is attracted, whereupon current

flows from ground G^{10} , armature 209, through the winding of control circuit release relay 61, to battery 203. Relay 61 attracts its armature to close contact 62^a-63^a and current flows from ground G^5 at private switch C, through the winding of release magnet 36, through contacts 28—27, 42—48, 63^a-62^a , over conductor 206, through the winding of release magnet 102 of switch E, to battery 210. Release magnet 36 of the private switch is energized, closing contacts 35—34 and 33—32. It also opens contact 21—22 and connects ground G^4 to spring 22, whereupon current flows from ground G^4 , through the winding of cut-off relay 37 to battery 203. The cut-off relay attracts armatures 38 and 40, opening circuit from wipers 43 and 44 to the line limbs, in order that, upon the release of the switch, the wipers may be open while wiping over busy contacts in their return to normal. Contact 22—21 is again closed when the switch reaches normal. The closing of contacts 32—33 and 34—35 mentioned is for the purpose of providing means for continuing the unbalancing effect of the two grounded limbs of the line of subscriber A upon the winding of relay 74, until ground is removed at the substation. Otherwise the energization of cut-off relay 37 would prematurely disconnect the line of subscriber A from the windings of relay 74.

Referring to E, the flow of current through release magnet 102 energizes it, and contact 105—103 is closed, establishing a path for current from ground G^{13} , through release magnet 152, 134—135, 125—122, 105—103 to battery 210, energizing release magnet 152. The energization of release magnet 102 also effected the closure of contact 96—98 and the energization of magnet 110 by current flowing from ground G^{11} , contacts 99—100, 96—98, and through the said relay to battery 210. The magnet 110 attracts its armatures, opening the circuit of wipers 123 and 124, the relay remaining energized until switch E returns to normal.

The energization of magnet 152 established a path for the flow of current from ground G^{14} at switch G, through the winding of release magnet 174, contacts 167—166, 163—160, 159—157, to battery 210, causing the energization of release magnet 174. Magnet 152, when energized, also effects the closure of contact 136—138 and current flows from ground G^{12} , through contacts 133—132, 136—138, through magnet 139 to battery 210. The magnet is energized and attracts its armatures, opening circuit through wipers 161 and 162, and remains energized till the return of the switch to normal. Release magnet 174 is energized, the energization causing contact 189—190 to be opened, whereupon relay 179 is de-energized and its armatures are retracted to open the circuits of wipers 198 and 199. When, in the course of the release operations, ground is removed from the limbs of the subscriber's line, by which the unbalancing of the windings of relay 74 is being effected, or in case the subscribers are simultaneously replacing their receivers, ground is removed from the limbs of both lines, the core of relay 74 will be de-magnetized and armature 209 will be retracted. Its retraction opens circuit through release relay 61, and arms 14, 51, 86 and 89 return to the positions shown. Contact 62^a-63^a is now opened and the circuit is broken through release magnet 36 of the private switch C. Its armature is released and contacts 32—33 and 34—35 are broken. With the return of the switch's wipers to normal, contact 22—21 is again closed, and contacts 20—19 and 18—17 are opened, while contact 17—19 is again closed. Circuit is broken through cut-off relay 37, the retraction of whose armatures again connects wipers 43 and 44 with limbs P and S of the line. The opening of contact 62^a-63^a at circuit D also caused release magnet 102 at switch E to be deenergized and the wipers of the switch to return to normal. With their return, contacts 92—93 and 94—95 are again closed and contact 99—100 is opened. The opening of the latter de-energizes magnet 110, and the relay's armatures return to the positions shown. The deenergization of magnet 102 also opens contact 103—105, circuit being broken through release magnet 152 at switch F, and the magnet deenergized, whereupon the switch's wipers return to normal. With the return of the wipers to normal, contacts 128—129 and 130—131 are again closed. Also, contacts 135—134 and 132—133 are opened, the opening of the latter causing the deenergization of magnet 139, and the return of its armatures to the positions shown in the illustration. When magnet 152 is deenergized, its armatures return to the positions shown, contact 159—157 is opened and, as a result, release magnet 174 at the connector switch is deenergized. This causes the return of the switch's wipers to normal, and with their return, contacts 172—171 and 170—169 are again closed, while contact 166—167 is opened. All apparatus, used in the connection, has now been restored to normal. I also provide means for enabling the calling subscriber, should he so desire, to release and disconnect whatever switches he may have caused to be connected in the course of making the call. At any time after a control circuit has been selected by the private switch, by grounding the two limbs of the line, relays 62 and 63 will be simultaneously energized, closing contact 54—55. Current will then flow from ground G^5 at the private switch,

through contacts 28—27, 42—48, 54—55, and through release magnet 102 of first selector switch E, to battery. The energizations of release magnets of other switches proceed as before. When ground is removed from the two limbs at the substation, contact 54—55 is broken, the various release magnets are deenergized, and disconnection proceeds as before. While I have shown a plurality of batteries in Fig. 1, they may be one and the same battery.

Referring now to Fig. 2, the mechanism there shown is adapted to perform the work of circuits C and H. The circuit changing springs shown in the said Fig. 2, are supplied with reference characters corresponding to the circuit drawings and their operation where effected directly by the armature mechanism of the electromagnets, will be obvious. I show a shaft 226 to which is attached ratchet 218, adapted to be rotated with each attraction of armature 215 of magnet 31 by the engagement therewith of pawl 217. Associated with ratchet 218 is detent 219, which engages the teeth of the ratchet and holds it and the shaft in whatever rotated position they may be brought by the operations of pawl 217. Spring 19 has attached to it a lug 224. Lug 224 is normally engaged by the extension of ratchet 218, the spring being held in the raised position shown thereby. With its first movement, the ratchet disengages lug 224 and the spring moves downward, opening contact 19—17 and closing contact 19—20. The electromagnets and their associated parts, shown in Fig. 2, may conveniently be mounted upon one side of a metal plate, upon the opposite side of which may be mounted contact bank 225. Shaft 226 extends through the mounting plate and supports wipers 42, 43 and 44, the arrangement of these parts being shown in Fig. 3. A sectional view, showing mounting plate, wipers and shaft, is shown in Fig. 4, in which view is also shown spring 250, against the tension of which the shaft is rotated and which returns the shaft and wipers to normal when the switch is released.

Referring now to Fig. 2, when magnet 36 is energized, it attracts armature 222, which draws to the right spring lever 251. The latter, when drawn forward, engages lug 221, by means of an orifice such as shown in Fig. 11^a. When this occurs, carrier 220 is moved downward by tension of lever 251, and contact 21—22 is opened and contact 22—22^a is closed. When the magnet is deenergized, armature 222 is retracted and lever 251 draws detent 219 out of engagement with the tooth of ratchet 218, in engagement with which it may have been placed by the operation of the switch. This allows ratchet 218, carrying with it shaft 226, to rotate in the opposite direction. As

it returns to normal, the ratchet again engages lug 224 upon spring 19, raising the spring upward and returning it and springs 17, 18 and 20 to normal. Ratchet 218 also engages carrier 220 on its return to normal moving the carrier upward, which causes spring 22 to again engage spring 21. The upward movement described also causes lever 251 to disengage detent 221, which returns to normal, resuming its supporting relation with lever 251.

Referring now to Fig. 12, I there show a side elevation of a connector switch, including one section 255 of a contact bank. In Fig. 7, is shown a sectional view of a bank on line 256—257 of Fig. 12. The terminal contacts of the bank are disposed as if projecting through the inner surface of a hollow sphere, as will be apparent from an inspection of Fig. 7 and section 255, shown in Fig. 12. Referring to the said Fig. 12, the wipers or contact arms of the switch may be rotated from left to right by means of shaft 226 to which ratchet 227 is attached, the said ratchet being rotatable by primary magnet 176, the details of this being shown in Fig. 11. Thus, the wipers may be rotated to positions in front of, and into engagement with, different sections of contacts similar to that shown at 255. A second shaft 235 is provided, adapted to be moved downward by the operation of secondary magnet 178, as indicated in Fig. 12. Upon the extremity of this shaft is a lug 236 which, as the shaft moves downward, presses downward the extremity of the wipers engaged by it. The ends of the wipers are so spaced with respect to the bank, that the first movement toward the bank only approaches them to it, without causing their engagement with bank contacts. The wipers being pivotally associated with shaft 226, successive downward movements of shaft 235, after the first, bring the wipers into engagement with successive sets of contacts of a selected section. There being the proper number of teeth on ratchet 227 and the proper number of ratchet teeth in shaft 235, the contact end of the wipers may be brought to engage any of one hundred sets of contacts in a bank.

Referring to Fig. 5, it will be noted that lug 236, upon the end of shaft 235, is broad in order that primary movements may not bring end 237 of the wipers beyond the extremity of the lug.

Referring now to Fig. 11, the primary movements of the wipers are controlled as follows: Primary magnet 176 is provided with armature 232 to which is attached pawl 228. When the said magnet is energized, its armature draws the said pawl forward, the latter engaging a tooth of ratchet 227 and rotating the ratchet of the primary shaft one step from left to right. Detent 229 is provided, associated with ratchet 227, and holds

the ratchet in whatever position it may be rotated. Detent 229 is normally held out of engagement with the ratchet, the first movement of armature 232 cooperating with lever 231 to release the said detent, as will be hereinafter described. The ordinary circuit changes, directly effected by the armatures of connector switch electromagnets, will be obvious in the illustration and will not be described.

Referring now to Fig. 5, attached to the rotary shaft is an arm 233 which, when the shaft is in its normal position, presses against buffer 234 and holds spring 166 out of engagement with spring 167. A top view of these parts is shown in Fig. 6. The first rotary movement of shaft 226 is in a direction to move arm 233 away from buffer 234 so that spring 166 engages spring 167. When the primary shaft is released and returned to normal, the arm again engages the buffer and restores the springs to their normal positions. Assuming the rotary shaft has been stepped a sufficient number of times to bring the wipers of the switch opposite a desired section of contacts, their movement along the section to select desired contacts will be described, having reference to Fig. 12. Secondary magnet 178 is provided with armature 238, with which is associated pawl 239. With each movement of the armature, said pawl engages a tooth on vertical shaft 235 and moves the shaft downward a step. Below the ratchet engaged by pawl 239 is a second ratchet, whose teeth detent 243 is adapted to engage. Detent 243 is normally out of engagement with its ratchet. The first movement of armature 232, acting upon lever 231 (Fig. 11), operates to release the said detent and cause it to engage the ratchet. The said detent engages, with each thrust of pawl 239, successive teeth of its appropriate ratchet and holds shaft 235 in whatever downward position it may have been carried by a thrust of pawl 239. Attached to shaft 235 is arm 238, which, when the shaft is in its normal position, holds stud 265 in the position shown in Fig. 5, whereby contacts 169—170 and 171—172 are maintained closed and contacts 169—168 and 172—173 are maintained open. With the first downward movement of shaft 235, arm 238 is carried down so that stud 265, which extends through the frame of the switch, is carried downward by the tension of springs 169 and 172 and opens contacts 170—169 and 171—172, closing contacts 169—168 and 172—173. When shaft 235 is released after the switch has been operated and returns to normal, arm 238 again engages stud 265, and the springs associated with it are returned to normal. Electromagnet 192 (see Fig. 8) is provided with armature 301, with which is associated arm 302, provided with a lug

toward its extremity. When magnet 192 is energized, its armature draws arm 302 to the left so that the lug thereon engages a buffer of insulating material, shown associated with spring 189. When the magnet is de-energized, its armature retracts arm 302, which carries with it spring 189, opening contact 189—191 and closing again contact 189—190. Release magnet 174, shown in Fig. 8, is provided with armature 304, associated with which are arms 305 and 306. When the magnet is energized, the latter of these arms, which is interlocked with arm 302, retracts the latter out of engagement with spring 189, whose tension again closes contact 189—191. Detail of this is shown in Fig. 15. A dog 360 is provided, its normal relation to arm 302 being such that when the arm is attracted, its solid right extremity is brought over dog 360. If, under this condition, release magnet 174 is energized, arm 306, depressing arm 302, causes dog 360 to engage the extremity of said arm. When the switch is released under these circumstances, although magnet 192 has been energized and deenergized, circuit changing spring 189 remains in its normal position, dog 360 holding arm 302 depressed until its lug passes to the right of the buffer on spring 189. This combination prevents movement of spring 189 when a calling subscriber releases after connecting with a line already in use. When armature 304 is attracted, arm 305 moves to the left and engages lugs 230 and 240 on detents 229 and 243 by means of orifices provided in the arm. In Fig. 11^a is shown a top view of the operating end of arm 305. In the portion of Fig. 11 adjacent thereto is shown the operating relations of lugs 240 and 230 to detents 243 and 229. When the armature is retracted, it draws the said detents out of engagement with the primary and secondary shafts, respectively. Associated with arm 305 is lever 231, provided with a roller as shown in Fig. 11. This lever, it will be remembered, is actuated upon the first movement of armature 232 of the primary magnet. Detents 230 and 240 are held by arm 305 in their retracted positions after the connector switch is returned to normal. The actuation of lever 231 causes the roller, shown in Figs. 8 and 11, at its extremity, to engage the bent portion of arm 305 which is thus raised, the arm disengaging lugs 230 and 240. The springs, shown in association with detents 229 and 243, then move them to engage their respective ratchets.

Referring to Fig. 12, when the detents are simultaneously withdrawn from the ratchets of the two shafts as described, spring 241, against the tension of which shaft 235 is operated, raises the shaft upward until it resumes the position shown, in which the contact ends of the wipers are

free of the lower edge of the bank. Attached to shaft 235 is a projecting tooth 310 which, with the first downward movement of said shaft, engages a tooth of ratchet 227, the two shafts being thus interlocked. When shaft 235 reaches normal, tooth 310 disengages ratchet 227, and shaft 226 is free to be rotated, by the influence of spring 242, to its normal position. The mechanical elements of first and second selector switches are, for the most part, the same as those of the connector switch. To avoid encumbering the application with unnecessary duplication of drawings, cross references to Figs. 6-12 will be made in describing selector switch mechanisms which, in conjunction with Figs. 13 and 14 illustrative of such variations as exist, fully disclose the mechanisms required to perform the functions of the circuits shown at E and F in Fig. 1. Referring first to second selector switch circuit F, wipers 160, 161 and 162 are associated with a bank of contacts similar to that provided for the connector switch. Similar primary and secondary shafts are provided for operating the wipers. Primary magnet 151 has mechanical parts associated with it such as magnet 176 of the connector switch has, and its operation with respect to them is the same. Secondary magnet 148 as plainly shown in Fig. 14 has operating parts like those of magnet 178 of the connector switch. Magnet 139 takes the place of magnet 179 on the switch mechanism, being provided with the switch spring combination shown in Fig. 1. Primary magnet 101 of the first selector switch circuit E is like primary magnet 176 of the connector switch; secondary magnet 119 is like magnet 148 of the second selector; and magnet 110 takes the place of magnet 179, being provided with the switch spring combination shown at E. Magnets of function similar to that of magnet 192 of the connector switch are not required for the selector switches.

Referring to Fig. 14, a side view of a second selector switch, it will be noted, first, that the normal position of the wipers, with reference to the edge of the contact bank, is such that a first secondary step-by-step movement will cause it to engage the first set of contacts of a section. In the connector switch, two such movements were required. The first selector switch is similar to the second selector switch in this respect. Secondly, it will be noted that the spring combination of the second selector switch, operated on the first movement of the primary shaft, varies from the corresponding combination of the connector switch. In this case, springs 132 and 135 engage springs 133 and 134 upon the first movement of the said shaft. The first selector switch is similar to the connector switch with respect to

this combination. Thirdly, the spring combination of the second selector switch, actuated on the first movement of the secondary shaft, varies from that of the connector switch. In this case, contacts 129-128 and 130-131 are broken. The first selector switch has here a spring combination similar to that of the second selector switch, comprising springs 92, 93, 94 and 95, shown in Fig. 1. Fourth,—the secondary magnets of both selector switches are provided with vibratory circuits. Springs 149 and 150 in Fig. 14 are separated with each downward stroke of the armature of magnet 148, and again engage on the upward stroke. The same spring arrangement is provided for the first selector switch.

In Fig. 13 is shown the mechanism of a selector switch release magnet, the said magnet and its associated parts being for convenience provided with reference numbers corresponding to circuit F. The said mechanism is shown at normal. At 328 and 329 are shown the lugs of the detents of the primary and secondary shafts, respectively. As shown, the detents will be out of engagement with their respective ratchets. Lever 330 is actuated upon the first movement of the armature of the primary magnet (compare lever 231 of Fig. 11) and its roller engages the downwardly extending portion of rocker arm 326, the latter engaging release arm 327. The said arm is moved in an upward direction, so that lugs 328 and 329 are freed and the detents, of which they are part, move to engage the primary and secondary shafts, respectively. The right hand portion of rocker arm 326 moves downwardly, disengaging spring 136 whose tension causes the opening of contact 136-138 and the closing of contact 136-137. When release magnet 152 is energized, release arm 327 is drawn to the left and by two orifices, such as are shown in Fig. 11^a, engages lugs 328 and 329. With the attraction of armature 158, arm 325 is drawn to the left and, engaging spring 136, moves it to the left to again close contact 136-138. When this occurs, the lower end of the spring engages the tooth at the end of arm 326 and the spring is held in the position shown until the next initial operation of the switch. When release magnet 152 is de-energized, armature 158 draws arm 327 to the right and lugs 328 and 329 are drawn with it, moving their respective detents out of engagement with the ratchets of the primary and secondary shafts. The shafts and their associated parts then return to normal, as described in connection with the shafts of the connector switch. Release magnet 102 of the first selector switch has operating parts similar to those of magnet 152.

Referring now to Figs. 9 and 10, showing the mechanical combination of relays 60 and

61 of control circuit D in Fig. 1; associated with relay 61 is a lever 343, provided with two studs 344 and 345, as shown in Fig. 10. Hooked arm 340 normally engages lever 343, as shown, and the arm being normally held retracted, owing to its pivotal connection with the armature of relay 61, studs 344 and 345 maintain their respective spring combinations in the condition shown in Fig. 10. When relay 60 is energized, its armature 342, pivotally connected to arm 341, lifts the said arm upward. The latter engages loosely the pin shown on arm 340, and the hook of said arm is raised to disengage lever 343. The tensions of springs 14, 51, 86 and 89, acting upon studs 344 and 345, now push them and lever 343 to the right, and contacts 14-15, 51-53, 86-88 and 89-91 are closed. When, now, relay 61 is energized, its armature draws arm 340 to the right and its hook is brought to again engage lever 343. This movement of arm 340 also closes contact 63^a-62^a, holding it closed as long as relay 61 continues energized. When the relay is deenergized, arm 340 is retracted, the said contact is again opened, and lever 343 is brought to its normal position shown, studs 344 and 345 causing their spring combinations to assume the normal conditions shown.

My invention is not restricted to the application shown, comprising selector switches of two classes only, and in the claims I desire not to be limited in this respect.

An off-normal switch is a switch adapted to be actuated on the first movement of an operating part, additional movements in the same direction as the first causing no further operation of the switch.

I claim:

1. A telephone exchange system including manually operated impulse controlling mechanism, a relay at the exchange adapted to be controlled responsive to said mechanism, a step-by-step switch mechanism at the exchange including movable contact arms, an operating magnet for said arms, a second step-by-step switch mechanism at the exchange including movable contact arms, an operating magnet for said arms, multiplied terminals of trunking circuits arranged in groups, associated with each switch mechanism, adapted for use in establishing connections, a conductor adapted to transmit currents controlled by said relay, normally connected with the operating magnet of said first switch mechanism, and apparatus for disconnecting said conductor from said magnet and connecting it through to the operating magnet of said second switch mechanism.

2. A telephone exchange system including manually operated impulse controlling mechanism, a relay at the exchange adapted

to be controlled responsive to said mechanism, a step-by-step switch mechanism at the exchange including movable contact arms, an operating magnet for said arms, a second step-by-step switch mechanism at the exchange including movable contact arms, an operating magnet for said arms, multiplied terminals of trunking circuits arranged in groups, associated with each switch mechanism, adapted for use in establishing connections, a conductor adapted to transmit currents controlled by said relay, normally connected with the operating magnet of said first switch mechanism, apparatus for disconnecting said conductor from said magnet and connecting it through to the operating magnet of said second switch mechanism, a second relay at the exchange adapted to be controlled responsive to said calling mechanism, apparatus for causing said first switch mechanism to select terminals of an idle trunking circuit, an electromagnet for said switch, controlling such selection, apparatus for causing said second switch mechanism to select terminals of an idle trunking circuit, an electromagnet for said switch, controlling such selection, a conductor adapted to transmit currents controlled by said second relay, normally connected with said second electromagnet of said first switch mechanism, and apparatus for disconnecting said conductor from said magnet and connecting it through to said second magnet of said second switch mechanism.

3. A telephone exchange system including manually operated impulse controlling mechanism, a relay at the exchange adapted to be controlled responsive to said mechanism, a step-by-step switch mechanism at the exchange including movable contact arms, a second step-by-step switch mechanism at the exchange including movable contact arms, multiplied terminals of trunking circuits arranged in groups, associated with each switch mechanism, adapted for use in establishing connections, apparatus for causing said first switch mechanism to select terminals of an idle trunking circuit, an electromagnet for said switch, controlling such selection, apparatus for causing said second switch mechanism to select terminals of an idle trunking circuit, an electromagnet for said switch, controlling such selection, a conductor adapted to transmit currents controlled by said relay, normally connected with said electromagnet of said first switch mechanism, and apparatus for disconnecting said conductor from said magnet and connecting it through to said magnet of said second switch mechanism.

4. In an automatic telephone system, the combination with a telephone line connecting a substation with the exchange, calling mechanism at the substation controlled by the subscriber, an automatic switch at the ex-

change, adapted to be initially operated responsive to said mechanism, a single group of multiplied terminals of trunking circuits, adapted to be engaged by said switch, means
 5 for arresting the operation of said switch when engaging a terminal of an idle circuit, a relay at the exchange, adapted to be controlled responsive to said calling mechanism when connection is made with an idle circuit.
 10 a step-by-step switch mechanism at the exchange including movable contact arms, an operating magnet for said arms, a second step-by-step switch mechanism at the exchange including movable contact arms, an
 15 operating magnet for said arms, multiplied terminals of additional trunking circuits arranged in groups, associated with each switch mechanism, adapted to be used for establishing connections, a conductor adapted
 20 to transmit currents controlled by said relay, normally connected with the operating magnet of said first switch mechanism, and apparatus for disconnecting said conductor from said magnet and connecting it through
 25 to the operating magnet of said second switch mechanism.

5. In an automatic telephone system, the combination with a telephone line connecting a substation with the exchange, calling
 30 mechanism at the substation controlled by the subscriber, an automatic switch at the exchange, adapted to be initially operated responsive to said mechanism, a single group of multiplied terminals of trunking
 35 circuits, adapted to be engaged by said switch, means for arresting the operation of said switch when engaging a terminal of an idle circuit, a relay at the exchange, adapted to be controlled responsive to said
 40 calling mechanism when connection is made with an idle circuit, a step-by-step switch mechanism at the exchange including movable contact arms, an operating magnet for said arms, a second step-by-step switch
 45 mechanism at the exchange including movable contact arms, an operating magnet for said arms, multiplied terminals of additional trunking circuits arranged in groups, associated with each switch mechanism,
 50 adapted to be used for establishing connections, a conductor adapted to transmit currents controlled by said relay, normally connected with the operating magnet of said first switch mechanism, apparatus for
 55 disconnecting said conductor from said magnet and connecting it through to the operating magnet of said second switch mechanism, a second relay at the exchange adapted to be controlled responsive to said calling
 60 mechanism when connection is made with an idle circuit, apparatus for causing said first switch mechanism to select terminals of an idle trunking circuit, an electromagnet for said switch, controlling such selection,
 65 apparatus for causing said second switch

mechanism to select terminals of an idle trunking circuit, an electromagnet for said switch, controlling such selection, a conductor adapted to transmit currents controlled
 by said second relay, normally connected
 70 with said second electromagnet of said first switch mechanism and apparatus for disconnecting said conductor from said magnet and connecting it through to said second magnet of said second switch mechanism.

6. In an automatic telephone system, the combination with a telephone line connecting a substation with the exchange, calling
 mechanism at the substation controlled by the subscriber, an automatic switch at the
 80 exchange, adapted to be initially operated responsive to said mechanism, a single group of multiplied terminals of trunking circuits, adapted to be engaged by said switch, means
 85 for arresting the operation of said switch, when engaging a terminal of an idle circuit, a relay at the exchange, adapted to be controlled responsive to said calling mechanism when connection is made with an idle
 90 circuit, a step-by-step switch mechanism at the exchange including movable contact arms, a second step-by-step switch mechanism at the exchange including movable contact arms, multiplied terminals of additional trunking circuits arranged in groups,
 95 associated with each switch mechanism, adapted to be used for establishing connections, apparatus for causing said first switch mechanism to select terminals of an idle trunking circuit, an electromagnet for said
 100 switch, controlling such selection, apparatus for causing said second switch mechanism to select terminals of an idle trunking circuit, an electromagnet for said switch, controlling such selection, a conductor
 105 adapted to transmit currents controlled by said relay, normally connected with said electromagnet of said first switch mechanism, and apparatus for disconnecting said conductor from said magnet and connecting
 110 it through to said magnet of said second switch mechanism.

7. In an automatic telephone exchange system, the combination with a telephone
 115 line connecting a substation with the exchange, of an automatic switch individual to said line at the exchange including movable contact arms, multiplied terminals adapted to be engaged by said arms, means
 120 for causing said switch, when initially operated from the substation, to select idle terminals, relays connected with said idle terminals, adapted to be operated by currents transmitted over said line by said calling
 125 mechanism, a first selector switch normally in operative relation with said relays, movable contact arms for said switch, a plurality of groups of second selector switches having terminals adapted to be engaged by
 130 said arms, movable contact arms for each

second selector switch, a plurality of groups of connector switches having terminals adapted to be engaged by said contact arms, movable contact arms for each connector switch, other telephone lines and multiple terminals thereof, adapted to be engaged by the contact arms of said connector switches, and operating magnets for a first selector switch, a second selector switch, and a connector switch respectively, adapted to be operated one after the other by separate sets of current impulses transmitted by said relays to establish a desired connection.

8. In an automatic telephone exchange system, the combination with a telephone line connecting a substation with the exchange, of an automatic switch individual to said line at the exchange including movable contact arms, multiplied terminals adapted to be engaged by said arms, means for causing said switch, when initially operated from the substation, to select idle terminals, relays connected with said idle terminals, adapted to be operated by currents transmitted over said line by said calling mechanism, a first selector switch normally in operative relation with said relays, movable contact arms for said switch, a plurality of groups of second selector switches having terminals adapted to be engaged by said arms, movable contact arms for each second selector switch, a plurality of groups of connector switches having terminals adapted to be engaged by said contact arms, movable contact arms for each connector switch, other telephone lines and multiple terminals thereof, adapted to be engaged by the contact arms of said connector switches, operating magnets for a first selector switch, a second selector switch, and a connector switch respectively, adapted to be operated one after the other by separate sets of current impulses transmitted by said relays to establish a desired connection, and a central source of current and branches adapted to supply current therefrom to subscribers' lines for talking.

9. In an automatic telephone exchange system the combination with a telephone line connecting a substation with the exchange, of an automatic switch individual to said line at the exchange including movable contact arms, multiplied terminals adapted to be engaged by said arms, means for causing said switch, when initially operated from the substation, to select idle terminals, relays connected with said idle terminals, adapted to be operated by currents transmitted over said line by said calling mechanism, a first selector switch normally in operative relation with said relays, movable contact arms for said switch, a plurality of groups of second selector switches having terminals adapted to be engaged by said arms, movable contact arms for each second selector switch, a plurality of groups of connector

switches having terminals adapted to be engaged by said contact arms, movable contact arms for each connector switch, other telephone lines and multiple terminals thereof, adapted to be engaged by the contact arms of said connector switches, operating magnets for a first selector switch, a second selector switch, and a connector switch respectively, adapted to be operated one after the other by separate sets of current impulses transmitted by said relays to establish a desired connection, release magnets for said switches and means for operating said magnets at the will of the subscriber when connection exists, and a central source of current and branches adapted to supply current therefrom to subscribers' lines for talking.

10. In a telephone exchange system, the combination with a telephone line connecting a substation with the exchange, of calling mechanism for said line at the substation, an automatic switch at the exchange adapted to extend the circuit of said line, a single group of multiplied terminals adapted to be engaged by said switch, apparatus for causing said switch to automatically select idle terminals, relays connected with said terminals, adapted to be operated responsive to currents transmitted over said line by said calling mechanism, a first selector switch having operating magnets, a plurality of auxiliary switches having multiplied terminals adapted to be engaged by said first selector switches, operating magnets for said switches, means for energizing in succession the magnets of said first selector switch and the magnets of a selected one of said auxiliary switches by currents transmitted by said relays, and trunk circuits associated with said switches for continuing the circuit of said line to desired lines.

11. In a telephone exchange system, the combination with a telephone line connecting a substation with the exchange, of calling mechanism for said line at the substation, an automatic switch at the exchange adapted to extend the circuit of said line, a single group of multiplied terminals adapted to be engaged by said switch, apparatus for causing said switch to automatically select idle terminals, relays connected with said terminals adapted to be operated responsive to currents transmitted over said line by said calling mechanism, a first selector switch having operating magnets, a plurality of auxiliary switches having multiplied terminals adapted to be engaged by said first selector switches, operating magnets for said switches, means for energizing in succession the magnets of said first selector switch and the magnets of a selected one of said auxiliary switches by currents transmitted by said relays, trunk circuits asso-

ciated with said switches for continuing the circuit of said line to desired lines, and a central source of current and branches adapted to supply current therefrom to subscribers' lines for talking.

12. In a telephone exchange system, the combination with a telephone line connecting a substation with the exchange, of calling mechanism for said line at the substation, an automatic switch at the exchange adapted to extend the circuit of said line, a single group of multipled terminals adapted to be engaged by said switch, apparatus for causing said switch to automatically select idle terminals, relays connected with said terminals adapted to be operated responsive to currents transmitted over said line by said calling mechanism, a first selector switch having operating magnets, a plurality of auxiliary switches having multipled terminals adapted to be engaged by said first selector switches, operating magnets for said switches, means for energizing in succession the magnets of said first selector switch and the magnets of a selected one of said auxiliary switches by currents transmitted by said relays, trunk circuits associated with said switches for continuing the circuit of said line to desired lines, and release magnets for said switches and means controlled by said relays for operating said magnets at the will of the subscriber.

13. In a telephone exchange system, the combination with a telephone line connecting a substation with the exchange, of calling mechanism at the substation, relays at the exchange adapted to be operated responsive to said mechanism, other subscribers' lines and multiple terminals thereof, a selector switch and a connector switch adapted to be successively operated responsive to said relays in connecting said line with desired lines, an electromagnet at the exchange, switching mechanism controlled thereby, adapted to effect the release of the switches employed in a connection, and apparatus at the called substation, adapted at the will of the subscriber to control the operation of said electromagnet to secure such release when connection exists.

14. In a telephone exchange system, the combination with a telephone line connecting a substation with the exchange, of calling mechanism at the substation, relays at the exchange adapted to be operated responsive to said mechanism, other subscribers' lines and multiple terminals thereof, a selector switch and a connector switch adapted to be successively operated responsive to said relays in connecting said line with desired lines, trunk release circuits extending from switch to switch, including a release magnet for each switch, a differential release relay at the exchange adapted to control said circuits, and apparatus at the called

substation, adapted at the will of the subscriber, to control said relay to secure the release of said switches when connection exists.

15. In a telephone exchange system, the combination with a telephone line connecting a substation with the exchange, of calling mechanism for said line at the substation, movable contact arms individual to said line at the exchange, a single group of multiple terminals adapted to be engaged by said arms, means for initially operating said arms under substation control, apparatus for causing said arms to automatically select idle terminals, relays associated with said terminals adapted, when connection is made therewith, to be operated responsive to currents transmitted over said line by said calling mechanism, a selector switch having operating magnets adapted to be controlled by said relays, auxiliary switches having terminals adapted to be engaged by said selector switch, operating magnets for said switches, adapted to be controlled by currents transmitted by said same relays when their terminals are engaged by said selector switch, other subscribers' lines and multiple terminals therefor, apparatus for connecting said telephone line with multiple terminals of a desired one of said other lines, trunk release circuits extending from switch to switch, including a release magnet for each switch, and apparatus at each connected substation, adapted at will of the subscriber, to operate said circuits to release said switches, when connection exists.

16. In a telephone exchange system, the combination with a telephone line connecting a substation with the exchange, of calling mechanism for said line at the substation, movable contact arms individual to said line at the exchange, a simple group of multiple terminals adapted to be engaged by said arms, means for initially operating said arms under substation control, apparatus for causing said arms to automatically select idle terminals, relays associated with said terminals adapted, when connection is made therewith, to be operated responsive to currents transmitted over said line by said calling mechanism, a selector switch having operating magnets adapted to be controlled by said relays, auxiliary switches having terminals adapted to be engaged by said selector switch, operating magnets for said switches, adapted to be controlled by currents transmitted by said same relays when their terminals are engaged by said selector switch, other subscribers' lines and multiple terminals therefor, apparatus for connecting said telephone line with multiple terminals of a desired one of said other lines, normally open battery connections adapted, when closed, to supply current for conversational purposes, an electromagnet

controlling circuits for closing said connections, and apparatus at the exchange for securing, independently of subscribers, the proper operation of said electromagnet to effect closure of said connections when connection is made with an idle line.

17. In a telephone exchange system, the combination with a telephone line connecting a substation with the exchange, of calling mechanism for said line at the substation, movable contact arms individual to said line at the exchange, a single group of multiple terminals adapted to be engaged by said arms, means for initially operating said arms under substation control, apparatus for causing said arms to automatically select idle terminals, relays associated with said terminals adapted, when connection is made therewith, to be operated responsive to currents transmitted over said line by said calling mechanism, a selector switch having operating magnets adapted to be controlled by said relays, auxiliary switches having terminals adapted to be engaged by said selector switch, operating magnets for said switches, adapted to be controlled by currents transmitted by said same relays when their terminals are engaged by said selector switch, other subscribers' lines and multiple terminals therefor, apparatus for connecting said telephone line with multiple terminals of a desired one of said other lines, normally open battery connections adapted, when closed, to supply current for conversational purposes, an electromagnet controlling circuits for closing said connections, apparatus at the exchange for securing, independently of subscribers, the proper operation of said electromagnet to effect closure of said connections when connection is made with an idle line, trunk release circuits extending from switch to switch, including a release magnet for each switch, a differential release relay at the exchange adapted when connection exists to control said circuit, apparatus at the called substation, adapted at the will of the subscriber, to control said relay to secure the release of said switches, and apparatus at the calling substation, adapted at the will of the subscriber, to control said relay to secure the release of said switches.

18. In a telephone exchange system, the combination with a telephone line connecting a substation with the exchange, of calling mechanism for said line at the substation, movable contact arms individual to said line at the exchange, a single group of multiple terminals adapted to be engaged by said arms, means for initially operating said arms under substation control, apparatus for causing said arms to automatically select idle terminals, relays associated with said terminals adapted, when connection is made therewith, to be operated responsive

to currents transmitted over said line by said calling mechanism, a selecting switch mechanism having movable contact arms, a plurality of auxiliary switches having multiple terminals, associated with said arms, arranged in groups, an operating magnet for said arms adapted, responsive to currents transmitted by one of said relays, to elect a desired group of said terminals, movable contact arms for said auxiliary switches, other auxiliary switches having multiplied terminals associated with said arms, arranged in groups, operating magnets for said arms, adapted, responsive to currents transmitted by said one of said relays, to elect a group of said last mentioned terminals, multiple terminals of subscribers' lines, adapted to be engaged by said other auxiliary switches, means for operating said switches by currents transmitted by said relays to elect desired terminals, an electromagnet for causing said selecting switch mechanism to select idle terminals of an elected group, adapted to be controlled by current transmitted by another of said relays, electromagnets for causing said auxiliary switches to select idle terminals of an elected group, adapted to be controlled by said other relay, an electromagnet having switching contacts for supplying current from a central source in metallic circuit of the calling subscriber's line adapted to be operated when connection is made with an idle line, trunk release circuits extending from switch to switch, including a release magnet for each switch, and apparatus at each connected substation, adapted at will of the subscriber when connection exists to operate said circuits to release said switches.

19. In a telephone exchange system, the combination with a telephone line connecting a substation with the exchange, of calling mechanism for said line at the substation, movable contact arms individual to said line at the exchange, a single group of multiple terminals adapted to be engaged by said arms, means for initially operating said arms under substation control, apparatus for causing said arms to automatically select idle terminals, relays associated with said terminals adapted, when connection is made therewith, to be operated responsive to currents transmitted over said line by said calling mechanism, a selecting switch mechanism having movable contact arms, a plurality of auxiliary switches having multiple terminals, associated with said arms, arranged in groups, an operating magnet for said arms adapted, responsive to currents transmitted by one of said relays, to elect a desired group of said terminals, movable contact arms for said auxiliary switches, other auxiliary switches having multiplied terminals associated with said arms, arranged in groups, operating magnets

for said arms, adapted, responsive to currents transmitted by said one of said relays, to elect a group of said last mentioned terminals, multiple terminals of subscribers' lines, adapted to be engaged by said other auxiliary switches, means for operating said switches by currents transmitted by said relays to elect desired terminals, an electromagnet for causing said selecting switch mechanism to select idle terminals of an elected group, adapted to be controlled by current transmitted by another of said relays, electromagnets for causing said auxiliary switches to select idle terminals of an elected group, adapted to be controlled by said other relay, an electromagnet at the exchange, switching mechanism controlled thereby, adapted to effect the release of the switches employed in a connection, and apparatus at the called substation, adapted to control the operation of said electromagnet to secure such release, when connection exists, at the will of the subscriber.

20. In a telephone exchange system, the combination with a telephone line connecting a substation with the exchange, of calling mechanism for said line at the substation, relays at the exchange adapted to be operated by currents transmitted over said line by said calling mechanism, a selector switch having electromagnets adapted to be operated responsive to currents transmitted by said relays, auxiliary switches having terminals adapted to be engaged by said selector switch, electromagnets for said switches adapted to be operated by currents transmitted by said same relays when their terminals are engaged by said selector switch, other subscribers' lines and multiple terminals therefor, apparatus for connecting said telephone line with multiple terminals of a desired line, an electromagnet at the exchange, switching mechanism controlled thereby, adapted to effect the release of the switches employed in a connection, and apparatus at the called substation, adapted to control the operation of said electromagnet to secure such release, when connection exists.

21. In a telephone exchange system, the combination with a telephone line connecting a substation with the exchange, of calling mechanism for said line at the substation, relays at the exchange adapted to be operated by currents transmitted over said line by said calling mechanism, a selector switch having electromagnets adapted to be operated responsive to currents transmitted by said relays, auxiliary switches having terminals adapted to be engaged by said selector switch, electromagnets for said switches adapted to be operated by currents transmitted by said same relays when their terminals are engaged by said selector

switch, other subscribers' lines and multiple terminals therefor, apparatus for connecting said telephone line with multiple terminals of a desired line, normally open battery connections for each line, adapted, when closed, to supply current to the respective substations to energize the transmitters for talking, and an electromagnet controlling circuits for securing the closure of said connections, adapted to render the supply of said current effective when connection is made with an idle line, and then only.

22. In an automatic telephone exchange system, the combination with two subscribers' lines connected for conversation, of a plurality of electromagnetically driven step-by-step switching mechanisms, having switching contacts through which the conversational circuit extends, a release control relay and apparatus at each substation adapted to be operated at the will of the subscribers, respectively, to secure the operation of said relay.

23. In an automatic telephone exchange system, the combination with two subscribers' lines connected for conversation, of a plurality of electromagnetically driven step-by-step switching mechanism, successively operative each to complete its movement in the establishment of such connection and having switching contacts through which the conversational circuit extends, an electromagnet at the exchange, switching mechanism controlled thereby, adapted to effect the release of the switches employed in a connection, and apparatus at the called substation adapted to control the operation of said electromagnet to secure such release.

24. In an automatic telephone exchange system, the combination with two subscribers' lines connected for conversation, of a plurality of electromagnetically driven step-by-step switching mechanisms, having switching contacts through which the conversational circuit extends, trunk release circuits extending from switch to switch, including a release magnet for each switch, a differential release relay at the exchange adapted to control said circuits, apparatus at the called substation, adapted at the will of the subscriber, to control said relay to secure the release of said switches, and apparatus at the calling substation, adapted at the will of the subscriber, to control said relay to secure the release of said switches.

25. A telephone system including a telephone line, a selective switch connected therewith, electrically controlled adjustable contact members for said switch, an electromagnet controlling the circuit of said switch members, a restoring circuit for said switch operable from the substation, a switch shifted on initial operation of said restoring circuit to control said magnet, and an

off-normal switch shifted on the complete restoration of said selective switch to alter the condition of said magnet.

26. A telephone system including a telephone line, a selective switch connected therewith, electrically controlled adjustable contact members for said switch, a relay adapted when energized to place said members on open circuit, a release magnet for said selective switch controllable from the substation, a switch shifted on operation of said magnet to energize said relay, and an off-normal switch shifted on complete restoration of said selective switch to deenergize said relay.

27. In a selective switch for electrical exchanges, passive contacts, contact wipers, a relay for placing said wipers on open circuits while passing over contacts, means for closing the circuits of said wipers on selection made, a release circuit including means for energizing said relay when the switch is restored, and an off-normal switch for deenergizing said relay.

28. In an automatic telephone exchange system, a calling subscriber's line, calling mechanism at the substation, a called subscriber's line, a plurality of electromagnetically driven step-by-step switching mechanisms at the exchange adapted to be successively operated responsive to said calling mechanism in completing connection between said lines, a release control relay, and apparatus at each substation adapted to be operated at the will of the subscribers, respectively, to secure the operation of said relay, when said lines are connected.

29. In an automatic telephone exchange system, a calling subscriber's line, calling mechanism at the substation, a called subscriber's line, a plurality of electromagnetically driven step-by-step switching mechanisms at the exchange adapted to be successively operated responsive to said calling mechanism in completing connection between said lines, trunk release circuits extending from switch to switch, including a release magnet for each switch, and apparatus at each connected substation, adapted at will of the subscriber, to operate said circuits to release said switches, when said lines are connected.

30. In an automatic telephone exchange system, a calling subscriber's line, calling mechanism at the substation, a called subscriber's line, a plurality of electromagnetically driven step-by-step switching mechanisms at the exchange adapted to be successively operated responsive to said calling mechanism in completing connection between said lines, an electromagnet at the exchange, switching mechanism controlled thereby, adapted to effect the release of the switches employed in a connection, and ap-

paratus at the called substation, adapted, when connection exists, to control the operation of said electromagnet to secure such release.

31. In an automatic telephone exchange system, a calling subscriber's line, calling mechanism at the substation, a called subscriber's line, a plurality of step-by-step switching mechanisms at the exchange adapted to be successively operated responsive to said calling mechanism in completing connection between said lines, trunk release circuits extending from switch to switch, including a release magnet for each switch, a differential release relay at the exchange adapted to control said circuits, apparatus at the called substation, adapted at the will of the subscriber, when connection exists, to control said relay to secure the release of said switches, and apparatus at the calling substation, adapted at the will of the subscriber, when connection exists, to control said relay to secure the release of said switches.

32. An automatic telephone system including a calling line and a called line, a circuit connecting said lines, a link-circuit included therein having normally open contacts, means responsive to the removal of the receiver at the calling substation for connecting said link circuit to the calling line, a central source of current, an electromagnet sensitive to the idle condition of the called line for automatically closing said contacts to supply current to the calling line, a second electromagnet, and means at a substation for controlling said second magnet to open said contacts.

33. An automatic telephone system including a calling line and a called line, a circuit connecting said lines, a link-circuit included therein having normally open contacts, means responsive to the removal of the receiver at the calling substation for connecting said link circuit to the calling line, a central source of current, an electromagnet sensitive to the idle condition of the called line for automatically closing said contacts to supply current to the calling line, mechanism at a substation for causing the disconnection of said circuit from said line, a second electromagnet, central office apparatus responsive to said substantial mechanism for controlling said second magnet to effect the restoration of said contacts to normal.

34. A telephone system including a calling line and a called line, terminal contacts for said called line, switch members, a lever normally holding said members in a certain position, a catch to maintain the normal position of said lever, an electromagnet adapted to operate said catch to release said lever whereby said members move to another

position, a device for testing the called line and placing a busy potential on contacts thereof when said line is found idle, and means for controlling said electromagnet to operate said catch responsive to the placing of said busy potential.

35. A telephone system including telephone lines having test terminals adapted to be differently connected according to the busy or idle condition of the lines, a test wiper for engaging said test terminals, a switch in circuit with said wiper and adapted to establish connections dependent upon the busy or idle condition of the encountered line, an electromagnet sensitive to the busy or idle condition of the tested line for controlling said switch, a circuit controlling relay adapted to be cut in circuit by said switch only if the encountered line is idle, means responsive to said relay for applying ringing current to the line connected with, and a second electromagnet for releasing said switch.

36. A telephone system including a calling and a called line, a source of calling current, a relay having switch contacts operatively connected with said source, an electrically controlled selective switch adapted to connect with the called line, test means for said switch differently operative according to the busy or idle condition of the called line, means for applying said test means to a contact of the called line on connection therewith, and a circuit for said relay under the control of said test means and operative thereby to actuate said relay to include said source in circuit with the called line.

37. In an automatic telephone exchange system, the combination with a calling subscriber's line, of calling mechanism at the substation, a called subscriber's line, a plurality of step-by-step "selector" and "connector" switches at the exchange, adapted to be successively operated responsive to said calling mechanism to connect the calling line with the called line, apparatus for ringing the bell of the called subscriber, an electromagnet adapted, when energized, to include said apparatus in circuit with a called line, means at the exchange for automatically, or without the will of the calling subscriber, energizing said electromagnet when connection is made with an idle line, a second electromagnet adapted, when energized, to exclude said apparatus from the circuit of the called subscriber's line, and means associated with the called subscriber's line actuated when the subscriber answers a call, adapted to cause the energization of said second electromagnet.

38. In an automatic telephone exchange system, the combination with a calling subscriber's line, of calling mechanism at the substation, a called subscriber's line, a plurality of step-by-step switches at the ex-

change, adapted to be successively operated responsive to said calling mechanism to connect the calling line with the called line, signaling means at the substation of the called line, a source of electrical energy at the exchange adapted, when included in circuit with said line, to actuate said signaling means, an electromagnet at the exchange, switching mechanism controlled thereby for including said source in circuit with said called line when said magnet is energized, apparatus at the exchange for energizing said electromagnet when connection is made with an idle line, a second electromagnet at the exchange, switching mechanism controlled thereby for deenergizing said first electromagnet when said second magnet is energized, and apparatus at the called substation, actuated on the response of the subscriber to cause the energization of said second electromagnet.

39. In an automatic telephone exchange system, the combination with a calling subscriber's line, of calling mechanism at the substation, a called subscriber's line, a plurality of step-by-step "selector" and "connector" switches at the exchange, adapted to be successively operated responsive to said calling mechanism to connect the calling line with the called line, apparatus for ringing the bell of the called subscriber, an electromagnet adapted, when energized, to include said apparatus in circuit with a called line, means at the exchange for automatically, or without the will of the calling subscriber, energizing said electromagnet when connection is made with an idle line, a second electromagnet adapted, when energized, to exclude said apparatus from the circuit of the called subscriber's line, means associated with the called subscriber's line actuated when the subscriber answers a call, adapted to cause the energization of said second electromagnet, and a locking circuit therefor, rendered effective by the response of the called subscriber.

40. In a telephone exchange system, the combination with a calling subscriber's line connecting a substation with the exchange, of a called subscriber's line connecting substation with the exchange, "selector" and "connector" connective means at the exchange adapted to interconnect said lines, signaling mechanism at the called substation, a source of electrical energy at the exchange adapted, when included in circuit with said called line, to actuate said signaling mechanism, an electromagnet at the exchange, sensitive to the idle or busy condition of the called line, adapted to be actuated, when connection is made with said line in its idle condition, to include said source in circuit therewith, a second electromagnet at the exchange, sensitive to the response of the called subscriber to exclude said source

from the circuit of said line, and a locking circuit for said electromagnet, actuated on said response to maintain said source excluded during conversation.

41. An automatic telephone system including telephone lines, electrically directive controlled switches capable of directive operation of a plurality of classes, means at the substations for transmitting sets of current impulses in adjusting a switch of each class to complete a desired connection, and a plurality of relays for repeating current impulses in completing such connection, said relays totaling a number equal to the number of the switches of one class.

42. An automatic telephone system including telephone lines, link-circuits at the exchange less in number than said telephone lines, means at the substations for transmitting directive impulses over said telephone lines, automatic means for interchangeably connecting said link-circuits with calling lines, selectors and connectors for operation responsive to said impulses in establishing desired connections, electromagnets for repeating said impulses in the establishment of such connections, said magnets totaling a number equal to said link-circuits, and means for enabling said magnets to control said selectors and connectors.

43. An automatic telephone system including a telephone line, means for transmitting directive currents thereover, a selector and a connector for operation in completing each connection, and a single relay operated by said directive currents to repeat them to said switches in completing each connection.

44. In an automatic telephone system, a calling line, means for transmitting three or more sets of directive impulses over said line in completing a connection, each set representing a digit or digits of the called number, and one relay only for repeating said impulses in completing said connection.

45. An automatic telephone exchange system including telephone lines, an electrically controlled switch for selecting the first digit of the called number, a second electrically controlled switch for selecting the last digit or digits of the called number, means for transmitting impulses representing said digits over said line, and one relay only operated for each completed connection by all impulses representing digits of the called number.

46. In a telephone system, a telephone circuit, a source of calling current, multiple terminals, an electromagnet for said circuit adapted for connection with said terminals, means for energizing said magnet and thereafter rendering said magnet inert on connection to idle terminals, and a switch for including said source in connection with said circuit responsive to said magnet on connection made with idle terminals.

47. In a telephone system, a calling line and a called line, a link-circuit connecting said lines, a test relay for said circuit sensitive to the idle or busy condition of the called line, a source of calling current, a switch for applying said source to the called line, and means for operating said switch responsive to a flow of current over the calling line automatically effected responsive to said relay on connection made with the called line when idle.

48. A telephone system including a calling subscriber's line and a called subscriber's line, a link-circuit for connecting said lines, a test relay associated with said circuit, multiple contacts of said called line having a definite electrical character when idle, a switch at the calling station for connecting said relay with one of said contacts and energizing said relay, a source of calling current, and a switch at the exchange automatically operated on connection of said relay with said contact in its idle condition to deenergize said relay and include said source in circuit with the called line.

49. An automatic telephone system including a connection terminal adapted to be electromagnetically adjusted, a called line capable of selection thereby, a test relay for said terminal, means for energizing said relay, a source of calling current and means responsive to the connection of said terminal with the called line when idle to automatically deenergize said relay and to connect said source with the called line.

50. A telephone system including a calling line and a called line, a link-circuit connecting said lines, multiple contacts for said called line having a definite electrical character when said line is idle, a test relay associated with said circuit, means for connecting said relay with a contact of the called line on connection of said circuit to said line, a switch controlled by said relay operating responsive to the idle condition of said terminal to disconnect the relay therefrom, a source of calling current and a switch for applying the same to the called line sensitive to current changes produced in the calling line responsive to the operation of said relay.

51. A telephone system including a calling line and a called line, a link-circuit, relays therefor adapted to be operated by currents flowing over a calling telephone line, talking conductors therefor having normally open contacts, an electromagnet for closing said contacts, means for operating said magnet controlled by the idle or busy condition of the called line, and means automatically effective on the initiation of a call at the substation for connecting said link-circuit to the calling line.

52. A telephone system including a calling line and a called line, a link-circuit com-

mon to a plurality of lines, relays therefor adapted to be operated by currents flowing over a calling telephone line, talking conductors therefor having normally open contacts, an electromagnet for closing said contacts, a ringing relay, and means for operating said magnet and said relay automatically controlled by the idle or busy condition of the called line.

53. A telephone system including a calling line and a called line, a link-circuit common to a plurality of lines, relays therefor adapted to be operated by currents flowing over a calling telephone line, talking conductors therefor having normally open contacts, an electromagnet for closing said contacts, means for energizing said magnet controlled by the normal idle condition of the called line, and electromagnetically adjusted switching mechanism for connecting said link-circuit with the calling line.

54. A telephone system including a calling line and a called line, a link-circuit common to a plurality of lines, relays therefor adapted to be operated by currents flowing over a calling telephone line, talking conductors therefor having normally open contacts, an electromagnet for closing said contacts, a ringing relay, means for automatically operating said relay and said magnet sensitive to the idle condition of the called line, and electromagnetically adjusted switching mechanism for connecting said link-circuit with the calling line.

55. An automatic telephone system including a calling line and a called line, talking terminals for said lines, an electrically controlled selective switch adapted to be connected to the talking terminals of the calling line for directive operation in extending a call therefrom to the terminals of the called line, and means associated with said selective switch for automatically supplying calling current to the called line effective only in case said line is idle.

56. An automatic telephone system including a calling line and a called line, an electrically controlled selective switch adapted for directive operation in connecting the calling to the called line, a ringing control relay adapted to include a source of calling current in circuit with the called line, a disconnect relay, a locking circuit therefor, mechanism automatically responsive to the idle condition of the called line to energize said ringing relay, and means for operating said disconnect relay for excluding said source from the called line during conversation.

57. An automatic telephone system including a calling line and a called line, an electrically controlled selective switch adapted for directive operation in connecting the calling to the called line, a ringing control relay adapted to include a source of

calling current in circuit with the called line, a disconnect relay, a locking circuit therefor, a hook switch at the called substation, and apparatus automatically responsive thereto for operating said disconnect relay for excluding said source from the circuit of the called line.

58. An automatic telephone system including a calling line and a called line, an electrically controlled selective switch adapted for directive operation in connecting the calling to the called line, a test relay at the exchange, a ringing control relay thereat, means for initially energizing said relays, apparatus for holding said relays energized, and means sensitive to the busy or idle condition of the called line for determining which of said relays be held energized.

59. An automatic telephone system including a calling line and a called line, an electrically controlled selective switch adapted for directive operation in connecting the calling to the called line, a ringing control relay, a disconnect relay, a locking circuit therefor, a test relay at the exchange sensitive to the idle condition of the called line for causing the operation of said ringing relay, and means controlled over the called line for operating the disconnect relay.

60. An automatic telephone system including a calling line and a called line, talking terminals for said lines, an electrically controlled selective switch adapted to be connected to said calling line for directive operation in extending a connection from the talking terminals of the calling line to the said talking terminals of the called line, a ringing control relay at the exchange, means sensitive to the idle condition of the called line for energizing the said relay, and apparatus controlled by said relay for sending a call signal over the called line when said relay is energized.

61. An automatic telephone system including a calling line and a called line, an electrically controlled selective switch adapted for directive operation in connecting the calling to the called line, a test relay at the exchange, and means sensitive to the busy condition of the called line for locking said relay, apparatus controlled by said relay for sending a busy signal over the calling line while said relay is locked, a ringing control relay at the exchange, means sensitive to the idle condition of the called line for energizing said relay, and apparatus controlled by said relay for sending a call signal over the called line when said relay is energized.

62. A telephone system comprising a plurality of telephone lines extending from substations to an exchange, link-circuits for interconnecting calling and called lines,

electrically operated "selector" switching mechanism for establishing connection between the calling line and one end of an idle link-circuit, switch contacts for rendering said circuit discontinuous, means for connecting the other end of said link-circuit to a called line, and an electromagnet as 83 associated with said "selector" switching mechanism and under the control of the called party for rendering the connected link-circuit continuous to complete the talking circuit between the calling and called stations.

63. A telephone system comprising a plurality of telephone lines extending from substations to an exchange, link-circuits for interconnecting calling and called lines, electrically operated "selector" switching mechanism for establishing connection between a calling line and one end of an idle link-circuit, means for connecting the other end of said link-circuit to a called line, an electromagnet as 83 associated with said "selector" switching mechanism, means for energizing said electromagnet during the operation of establishing said connection, means under the control of the called party for energizing said electromagnet, and switching contacts actuated upon the deenergization of said electromagnet to render the connected link-circuit continuous to complete the talking circuit between the calling and called stations.

64. An automatic telephone system comprising a plurality of telephone lines, interconnecting link-circuits, "selector" and "connector" switches operative initially to unite a calling and a called line by said link-circuits into a talking circuit interrupted at a definite point, and a control switch associated with one of said "selector" switches and under the control of the called party for completing the talking circuit at said interrupted point.

65. An automatic telephone system comprising a plurality of telephone lines, interconnecting link-circuits, "selector" and "connector" switches operative initially to unite a calling and a called line by said link-circuits into a talking circuit interrupted at a definite point, an electromagnet associated with one of said "selector" switches, means for energizing said electromagnet in response to the movements of a connected "connector" switch, means under the control of the called party for deenergizing said electromagnet, and switching means actuated upon the deenergization of said electromagnet to complete the talking circuit at said interrupted point.

66. An automatic telephone system comprising a plurality of lines extending from substations to an exchange, fixed and movable switch contacts in which each of said

lines terminates at the exchange, link-circuits and electrically operated switching mechanism for establishing a connection between the movable contacts of a calling line and the fixed contacts of an idle called line, a relay for destroying the normal connection of said called line with its movable switch contacts, a relay for completing a portion of a talking circuit between the connected substations, and means operative upon the engagement of said switching mechanism with said called line contacts to actuate said relays by completing a circuit through one of the engaged called line contacts.

67. An automatic telephone system comprising a plurality of lines extending from substations to an exchange, fixed and movable switch contacts for said lines at the exchange, the latter contacts being normally connected to said lines, link-circuits and electrically operated switching mechanism for establishing a talking circuit between the movable contacts of a calling line and the fixed contacts of an idle called line, a relay for destroying the normal connection of each line with its movable switch contacts, means operative upon the engagement of said switching mechanism with said called line contacts to actuate the relay of said line by completing a circuit through one of the engaged called line contacts, a relay included in said circuit for connecting the calling line to the called line, and means for preventing the completion of such a circuit through the corresponding relay of the calling line.

68. An automatic telephone system comprising a plurality of lines extending from substations to an exchange, fixed and movable switch contacts for said lines at the exchange, the latter contacts being normally connected to said lines, link-circuits and electrically operated switching mechanism for establishing a talking circuit between the movable contacts of a calling line and the fixed contacts of an idle called line, a relay for destroying the normal connection of each line with its movable switch contacts, means operative upon the engagement of said switching mechanism with said called line contacts to actuate the relay of said line by completing a circuit through one of the engaged called line contacts, a relay included in said circuit for connecting the calling line to the called line, and means, operative after the initial movement of said switching mechanism toward establishing said talking circuit, to prevent the completion of such a circuit through the corresponding relay of the calling line.

69. An automatic telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the ex-

change, link-circuits and electrically operated switching mechanism for establishing connection from the calling contacts of a calling line to the called contacts of an idle line, a relay for destroying the normal operative relation of said called line with its calling contacts, means operative upon the engagement of said switching mechanism with said called line contacts to actuate said relay and to automatically supply ringing current to said called line by completing a circuit through one of the engaged called line contacts.

70. An automatic telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the exchange, link-circuits and electrically operated switching mechanism for establishing connection from the calling contacts of a calling line to the called contacts of an idle line, a relay for destroying the normal operative relation of said called line with its calling contacts, means operative upon the engagement of said switching mechanism with said called line contacts to actuate said relay and to automatically supply ringing current to said called line by completing a circuit through one of the engaged called line contacts, and means under the control of the called party to discontinue the supply of ringing current.

71. An automatic telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the exchange, link-circuits and electrically operated switching mechanism for establishing connection from the calling contacts of a calling line to the called contacts of an idle line, a relay for destroying the normal operative relation of said called line with its calling contacts, means for supplying ringing current, a relay for controlling the application of said ringing current to said called line, means operative upon the engagement of said switching mechanism with said called line contacts to actuate said relays by completing a circuit through one of the engaged called line contacts.

72. An automatic telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the exchange, link-circuits and electrically operated switching mechanism for establishing connection from the calling contacts of a calling line to the called contacts of an idle line, a relay for destroying the normal operative relation of said called line with its calling contacts, means for supplying ringing current, a relay for controlling the application of said ringing current to said called line, means operative upon the engagement of

said switching mechanism with said called line contacts to actuate said relays by completing a circuit through one of the engaged called line contacts, and a relay under the control of the called party for disconnecting the current ringing supply.

73. An automatic telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the exchange, link-circuits and electrically operated switching mechanism for establishing connection from the calling contacts of a calling line to the called contacts of an idle line, a relay for destroying the normal operative relation of said called line with its calling contacts, a source of ringing current, a second relay for controlling the application of said ringing current to said called line, a third relay for controlling the energization of said second relay, and means operative upon the engagement of said switching mechanism with said called line contacts to actuate said third relay and said first-mentioned relay by completing a circuit through one of the engaged line contacts.

74. An automatic telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the exchange, link-circuits and electrically operated switching mechanism for establishing connection from the calling contacts of a calling line to the called contacts of an idle line, a relay for destroying the normal operative relation of said called line with its calling contacts, a source of ringing current, a second relay for controlling the application of said ringing current to said called line, a third relay for controlling the energization of said second relay, means operative upon the engagement of said switching mechanism with said called line contacts to actuate said third relay and said first-mentioned relay by completing a circuit through one of the engaged line contacts, and means under the control of the called party for disconnecting the ringing current supply and completing the talking circuit between the lines.

75. A telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the exchange, the former contacts being normally connected to said lines, link-circuits for interconnecting calling and called lines, electrically operated switching mechanism for establishing a connection between the calling contacts of a calling line and one end of an idle link-circuit, means for connecting the other end of said link-circuit to the called contacts of an idle called line, a relay for destroying the normal connection of said called line with its calling

contacts, means operative upon the connection of said link-circuit to said called line contacts to actuate said relay by completing a circuit through one of the engaged contacts of said line, and a relay included in said circuit for connecting the calling line to the called line.

76. A telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the exchange, normally discontinuous link-circuits for interconnecting calling and called lines, electrically operated switching mechanism for establishing connection between the calling contacts of the calling line and one end of an idle link-circuit, means for connecting the other end of said link-circuit to the called contacts of an idle line, a relay for destroying the normal connection of said called line with its calling contacts, a relay for completing a portion of the connected normally discontinuous link-circuit, and means operative upon the connection of said link-circuit to said called line contacts to actuate said relays by completing the circuit through one of the engaged called line contacts.

77. A telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the exchange, the latter contacts being normally connected to said lines, normally discontinuous link-circuits for interconnecting calling and called lines, electrically operated switching mechanism for establishing connection between the calling contacts of the calling line and one end of an idle link-circuit, means for connecting the other end of said link-circuit to the called contacts of an idle line, a relay for destroying the normal operative relation and connection of each line with its calling contacts, means operative upon the connection of said link-circuit to said called line contacts to actuate the relay of said line by completing a circuit through one of the engaged called line contacts, and means operative, after the initiation of a call over the calling line, to prevent the completion of such a circuit through the corresponding relay of the calling line.

78. A telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the exchange, link-circuits for interconnecting calling and called lines, electrically operated switching mechanism for establishing a connection between the calling contacts of the calling line and one end of an idle link-circuit, means for connecting the other end of said link-circuit to the called contacts of an idle line, a relay for destroying the normal operative relation of said called line with its calling contacts, means operative upon the connection of said link-

circuit to said called line contacts to actuate said relay and to automatically supply ringing current to said called line responsive to the completion of a circuit through one of the engaged called line contacts.

79. A telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the exchange, link-circuits for interconnecting calling and called lines, electrically operated switching mechanism for establishing a connection between the calling contacts of a calling line and one end of an idle link-circuit, means for connecting the other end of said link-circuit to the called contacts of an idle line, a relay for destroying the normal operative relation of said called line with its calling contacts, means operative upon the connection of said link-circuit to said called line contacts to actuate said relay and to automatically supply ringing current to said called line responsive to the completion of a circuit through one of the engaged called line contacts, and means under the control of the called party to discontinue the supply of ringing current.

80. A telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the exchange, link-circuits for interconnecting calling and called lines, electrically operated switching mechanism for establishing a connection between the calling contacts of a calling line and one end of an idle link-circuit, means for connecting the other end of said link-circuit to the called contacts of an idle line, a relay for destroying the normal operative relation of said called line with its calling contacts, means for supplying ringing current, a relay for controlling the application of said ringing current to said called line, and means operative upon the connection of said link-circuit to said called line contacts to actuate said relays by completing a circuit through one of the engaged called line contacts.

81. A telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the exchange, link-circuits for interconnecting calling and called lines, electrically operated switching mechanism for establishing a connection between the calling contacts of a calling line and one end of an idle link-circuit, means for connecting the other end of said link-circuit to the called contacts of an idle line, a relay for destroying the normal operative relation of said called line with its calling contacts, means for supplying ringing current, a relay for controlling the application of said ringing current to said called line, and means operative upon the connection of said link-circuit to said called line contacts to actuate said relays by completing a circuit through one

of the engaged called line contacts, and a relay under the control of the called party for disconnecting the ringing current supply.

82. A telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the exchange, link-circuits for interconnecting calling and called lines, electrically operated switching mechanism for establishing a connection between the calling contacts of a calling line and one end of an idle link-circuit, means for connecting the other end of said link-circuit to the called contacts of an idle line, a relay for destroying the normal operative relation of said called line with its calling contacts, a source of ringing current, a relay for controlling the application of said ringing current to said called line, an additional relay for controlling the energization of said latter relay, and means operative upon the connection of said link-circuit to said called line contacts to actuate said additional relay and said first-mentioned relay by completing a circuit through one of the engaged line contacts.

83. A telephone system comprising a plurality of lines extending from substations to an exchange, calling and called contacts for said lines at the exchange, link-circuits for interconnecting calling and called lines, electrically operated switching mechanism for establishing a connection between the calling contacts of a calling line and one end of an idle link-circuit, means for connecting the other end of said link-circuit to the called contacts of an idle line, a relay for destroying the normal operative relation of said called line with its calling contacts, a source of ringing current, a relay for controlling the application of said ringing current to said called line, an additional relay for controlling the energization of said latter relay, means operative upon the connection of said link-circuit to said called line contacts to actuate said additional relay and said first-mentioned relay by completing a circuit through one of the engaged line contacts, and means under the control of the called party for disconnecting the ringing current supply and rendering the connected link-circuit continuous to complete the talking circuit between the connected stations.

84. A telephone system comprising telephone lines extending from substations to an exchange, terminal contacts for each of said lines, an automatic switch adapted to be connected to the terminal contacts of the calling line and then operated to extend a call to the terminal contacts of a called line, an interrupter for generating a busy signal, a relay for controlling the connection of said signal to the calling line circuit, a source of ringing current, a relay for controlling the application of said ringing current to the called line, and means dependent

upon the electrical condition of the called line contacts for rendering effective the interrupter control relay upon one electrical condition of said contacts and for rendering effective the ringing current control relay only upon another condition of said contacts.

85. A telephone system comprising telephone lines extending from substations to an exchange, terminal contacts for each of said lines, a link-circuit for interconnecting the said contacts of calling and called lines to establish a talking circuit therethrough, an interrupter for controlling the busy signal, a relay for controlling the connection of said interrupter to the calling line circuit, means for momentarily energizing said relay, and means for maintaining said relay in its actuated position when connection has been made to a busy called line.

86. A telephone system comprising telephone lines extending from substations to an exchange, terminal contacts for each of said lines, a link-circuit for interconnecting the said contacts of calling and called lines to establish a talking circuit therethrough, an interrupter for causing a busy signal, a relay for controlling the connection of said interrupter to the calling line circuit, means for momentarily energizing said relay to cause its actuation, and means for completing a locking circuit for said relay through one of the contacts of said called line.

87. A telephone system comprising telephone lines extending from substations to an exchange, terminal contacts for each of said lines, a link-circuit for interconnecting the said contacts of calling and called lines to establish a talking circuit therethrough, an interrupter for causing a busy signal, a relay for controlling the connection of said interrupter to the calling line circuit, means for momentarily energizing said relay to cause its actuation, means for maintaining said relay in its actuated position if connection has been made to a called line, and means actuated upon the release of said relay to apply ringing current to the called line.

88. A telephone system comprising telephone lines extending from substations to an exchange, terminal contacts for each of said lines, a link-circuit for interconnecting the said contacts of calling and called lines to establish a talking circuit therethrough, an interrupter for causing a busy signal, a relay for controlling the connection of said interrupter to the calling line circuit, means for momentarily energizing said relay to cause its actuation, means for completing a locking circuit for said relay through one of the contacts of said called line if said called line is busy, a source of ringing current, a relay for controlling the application of said ringing current to the called line,

and means actuated upon the release of said interrupter control relay to complete a circuit for said ringing current control relay through one of the contacts of said called line.

89. A telephone system comprising telephone lines extending from substations to an exchange, terminal contacts for each of said lines, a link-circuit for interconnecting the said contacts of calling and called lines to establish a talking circuit therethrough, an interrupter for causing a busy signal, a relay for controlling the connection of said interrupter to the calling line circuit, means for momentarily energizing said relay to cause its actuation, means for maintaining said relay in its actuated position if connection has been made to a busy called line, a source of ringing current, a relay for controlling the application of said ringing current to the called line, and means actuated upon the release of said interrupter control relay to actuate said ringing current control relay.

90. A telephone system comprising telephone lines extending from substations to an exchange, a pair of terminal contacts for each of said lines, a normally discontinuous link-circuit for interconnecting the said contacts of calling and called lines to establish a talking circuit therethrough, an interrupter for causing a busy signal, a relay for controlling the connection of said interrupter to the calling line circuit, a source of ringing current, a relay for controlling the application of said ringing current to the line, means dependent upon the electrical condition of the said connected called line contacts for automatically actuating the interrupter control relay upon one condition of said contacts and for automatically actuating the ringing current control relay upon another condition of said contacts, and means under the control of the called party for discontinuing the application of ringing current to the line and completing a portion of said normally discontinuous link-circuit.

91. A telephone system comprising telephone lines extending from substations to an exchange, terminal contacts for each of said lines, a link-circuit for interconnecting the said contacts of calling and called lines to establish a talking circuit therethrough, an interrupter for causing a busy signal, a relay for controlling the connection of said interrupter to the calling line circuit, means for momentarily energizing said relay to cause its actuation, means for maintaining said relay in its actuated position if connection has been made to a busy called line, means actuated upon the release of said relay to apply ringing current to the called line, and means under the control of the

called party for discontinuing the application of ringing current to the line.

92. A telephone system comprising telephone lines extending from substations to an exchange, terminal contacts for each of said lines, a link-circuit for interconnecting the said contacts of calling and called lines to establish a talking circuit therethrough, an interrupter for causing a busy signal, a relay for controlling the connection of said interrupter to the calling line circuit, means for momentarily energizing said relay to cause its actuation, means for maintaining said relay in its actuated position if connection has been made to a busy called line, a source of ringing current, a relay for controlling the application of said ringing current to the called line, means actuated upon the release of said interrupter control relay to actuate said ringing current control relay, and means under the control of the called party for discontinuing the application of ringing current to the line.

93. A telephone system comprising telephone lines extending from substations to an exchange, terminal contacts for each of said lines, a normally discontinuous link-circuit for interconnecting the said contacts of calling and called lines to establish a talking circuit therethrough, an interrupter for causing a busy signal, a relay for controlling the connection of said interrupter to the calling line circuit, means for momentarily energizing said relay to cause its actuation, means for maintaining said relay in its actuated position if connection has been made to a busy called line, a source of ringing current, a relay for controlling the application of said ringing current to the called line, means actuated upon the release of said interrupter control relay to actuate said ringing current control relay, and means under the control of the called party for discontinuing the application of ringing current to the called line and for completing a portion of said normally discontinuous link-circuit.

94. In a telephone system, a first selector, a repeater, individual thereto for adjusting the same, auxiliary selectors, means for connecting said repeater to an auxiliary selector, said repeater then serving to adjust said auxiliary selector.

95. A telephone system including a telephone line, a pair of relays adapted to be bridged across the limbs of said line, a first selector, said relays being normally individual to said selector and adapted to adjust the same, auxiliary selectors, means effective in the adjustment of said first selector to connect said relays with an auxiliary selector, said relays then serving to adjust such auxiliary selector.

96. A telephone system including a plu-

ality of first selectors and auxiliary selectors, a repeater circuit for each first selector for adjusting the same, means operated in the adjustments of said first selectors to connect their respective repeater circuits respectively with auxiliary selectors, said circuits then serving to control adjustment of the connected auxiliary selectors.

97. A telephone system including telephone lines, a plurality of first selectors, means for interchangeably connecting said selectors with calling lines, auxiliary selectors, a repeater circuit for each first selector for adjusting the same, means operated in the adjustments of said first selectors to connect their respective repeater circuits respectively with auxiliary selectors, said circuits then serving to control adjustment of the connected auxiliary selectors.

98. A telephone system including a first selector, a repeater individual thereto for adjusting the same, auxiliary selectors, circuit connections whereby said first selector operates to connect said repeater with an idle auxiliary selector, said repeater then serving to adjust said auxiliary selector, and a trunk release circuit for restoring said auxiliary selector.

99. A telephone system including selectors divided into several classes, a relay at the exchange, means for employing said relay to transmit a plurality of sets of current impulses, distributing means for dividing said sets, one set to a selector of each different class to adjust the same, a talking circuit adapted to be completed by said adjustments, wiper contacts and trunk release circuits for some of said selectors, said release circuits extending over said wiper contacts.

100. A telephone system including a calling line and a called line to be switched to connection, a plurality of independently adjustable selectors for inclusion in the connection, each said selector having its individual switch adjusting magnet, and a common relay for transmitting currents to said magnets in succession.

101. A telephone system including a calling line and a called line to be switched to connection, a plurality of independently adjustable selectors for inclusion in the talking circuit, each such selector having a pair of switch adjusting magnets; and a pair of relays common to said selectors for effecting the operations of said magnets.

102. In a telephone system, first selectors, second selectors and connectors, said first selectors being provided with relays for receiving directive impulses, and means for employing said relays of said first selectors for adjusting said second selectors and connectors.

103. In a telephone system, a first selector, a second selector and a connector, and a re-

lay at the exchange, said relay serving to repeat directive impulses to adjust said first selector, second selector and connector.

104. In a telephone system, a combined first selector and repeater circuit, and a second selector adapted to be adjusted by impulses transmitted from said repeater circuit.

105. A telephone system comprising a plurality of lines extending from substations to an exchange, fixed and movable contacts for said lines at the exchange, normally discontinuous link-circuits for interconnecting calling and called lines, electrically operated switching mechanism for establishing a connection between the movable contacts of a calling line and one end of an idle link-circuit, means for connecting the other end of said link-circuit to the fixed contacts of an idle called line, a relay for destroying the normal connection of said called line with its movable switch contacts, a relay for uniting the parts of the connected normally discontinuous link-circuit at its normally disconnected points, and means operative upon the connection of said link-circuit to said called line contacts to actuate said relays by completing a circuit through one of the engaged called line contacts.

106. In a telephone exchange, the combination with a connector adapted to make connection with a telephone line, of a relay adapted to apply ringing current to a line with which the connector has united, a second relay operated in case such line is free to complete a circuit for the first-named relay, and a third relay in the ringing circuit operated upon the response of the called subscriber for opening the circuit of the first-named relay.

107. In a telephone exchange, the combination with an automatic connector adapted to unite with a telephone line, of a relay adapted to apply ringing current to a line with which the connector unites, a second relay, an operating circuit therefor completed by the connector if the called line is free, a circuit for the first-named relay closed by the second relay when energized, and means actuated when the called subscriber responds for rendering the first-named relay inoperative.

108. In a telephone system, a relay, a circuit therefor, a plurality of stationary contacts, a traveling contact normally engaging one of said stationary contacts and included with it in said relay circuit, means for advancing said traveling contact out of engagement with the above named stationary contact by changing the condition of said relay, and for automatically continuing its advance until some one of the other stationary contacts in a predetermined condition is encountered and the condition of said

relay is again changed, and a trunk release circuit including the said selected stationary contact.

109. In a telephone system, a relay, a circuit over which said relay is initially energized, a selector switch having a plurality of stationary contacts, and a traveling contact normally engaging one of said stationary contacts and included with it in said relay circuit, means for advancing said traveling contact started into operation by closing the above named relay circuit but continued in operation by maintaining said relay energized over an independent circuit including other of said stationary contacts until a desired one of said contacts is reached, and a trunk release circuit including the desired one of said stationary contacts.

110. In a telephone system, a relay having an initial circuit and an independent holding circuit, a selector switch having a plurality of stationary terminals and a pair of traveling contacts one of which normally engages one of the stationary terminals and is included with it in said initial circuit, and the other of which is included in said holding circuit, means for advancing said traveling contacts into started operation by the energization of said relay over its initial circuit and continued in operation until a stationary contact in a predetermined electrical condition is encountered by the second of the above mentioned traveling contacts, the said initial and holding circuits both including the same winding of said relay.

111. In a telephone system, the combination with a telephone line, of a line switch for said line having a traveling contact normally connected with a limb of said line, a line relay, a stationary contact of said line switch normally engaged by said traveling contact to complete a circuit between the said line limb and the coil of said line relay, whereby said relay may be initially actuated over said line, means controlled by said line relay for advancing said movable contact out of engagement with said stationary contacts to disconnect said relay from said line limb, a plurality of additional stationary contacts any one of which may be engaged by said traveling contact to extend the circuit of said line limb, and a test circuit including the said coil for selecting an idle one of the additional contacts.

112. In a telephone system, a calling and a called subscriber's line provided with terminal contacts, automatic means adapted to be connected to the terminal contacts of the calling line for extending a connection to the terminal contacts of said called line, and means associated with said automatic means for automatically connecting a characteristic signal to the line of the called subscriber or for connecting a different char-

acteristic signal to the line of the calling subscriber depending upon the idle or busy condition of the said called terminal contacts.

113. In a telephone system, a calling and a called subscribers' line, a connection terminal for said called line, automatic means adapted to be connected to the calling line and then operated to extend a call from said calling line to said called line, and electromagnetic means included in said automatic means for connecting a characteristic signal to the line of the calling subscriber or for connecting a different characteristic signal to the line of the called subscriber dependent upon the busy or idle condition of said connection terminal.

114. In a telephone system, a called subscriber's line, automatic means for establishing a connection with said called line, signaling means associated with said automatic means, automatic means for connecting said signaling means to the said called line, a cut-off relay responsive to the removal of the receiver at the called substation for disconnecting the said signaling means, and a locking winding for said last relay for preventing the reapplication of said signaling means.

115. In a telephone system, a called subscriber's line, an automatic switch for extending a call in the direction of said called line, signaling means associated with said automatic switch, a relay through which said signaling means is applied to the called line, and means for energizing said relay to disconnect said signaling means.

116. In a telephone system, a called subscriber's line, an automatic switch for extending a call in the direction of said called line, signaling means associated with said automatic switch, a relay through which said signaling means is applied to the called line, means for energizing said relay to disconnect said signaling means, and a locking circuit for said relay to prevent the reapplication of said signaling means.

117. In a telephone system, a calling and a called subscriber's line, an automatic switch adapted to be connected to the calling line for extending a call therefrom to the said called line, means controlled upon the completion of the connection with the called line for automatically applying signaling current to the said called line, and means responsive to the removal of the receiver at the called subscriber's substation for automatically disconnecting the said signaling current.

118. In a telephone system, a called subscriber's line, a substation thereon provided with a signal receiving device, an automatic switch adapted to be connected to a calling line and then operated to extend a call therefrom in the direction of the called line, signaling means associated with said automatic

switch, automatic means for applying said signaling means to the line of the called subscriber to operate said signal receiving device, and means controlled by the response of the called subscriber for immediately disconnecting the signaling means from the said called line.

119. In a telephone system, a called subscriber's line, an automatic switch for extending a call in the direction of the said line, signaling means associated with said switch, automatic means for connecting the said signaling means to the said called subscriber's line, a battery, means for connecting the said battery to the called subscriber's line in series with the said signaling means, and means responsive to a flow of current from the said battery for disconnecting the said signaling means from the called subscriber's line.

120. In a telephone system, a called subscriber's line, an automatic switch for extending a call in the direction of the said called line, a battery, signaling means connected to one terminal of said battery, means for connecting said signaling means and said battery to the called subscriber's line, and means controlled by the response of the called subscriber for disconnecting the said signaling means from the called subscriber's line.

121. In a telephone system, a called subscriber's line, an automatic switch for extending a call in the direction of said line, a battery, a ringing current generator having one terminal connected to said battery, means for applying signaling current from said current generator to the called line, and electromagnetic means responsive to a flow of current from said battery when the called subscriber responds to disconnect the said ringing current from the called subscriber's line.

122. In a telephone system, a called subscriber's line provided with a substation thereon, a condenser normally in series with said line, an automatic switch adapted to extend a call in the direction of said called line, a current generator having one of its terminals connected to a battery, means for

applying current from said generator to said called subscriber's line, means for removing the said condenser from the subscriber's line, and means responsive to said removal for disconnecting the said ringing current.

123. In a telephone system, a called subscriber's line, an inductive bridge connected across said line, an automatic switch for extending a call in the direction of the called line, a ringing current generator associated with said switch, means for applying current from said generator to the said called line, means for replacing said inductive by a conductive bridge, and means responsive to said replacement for automatically disconnecting the ringing current from the said called subscriber's line.

124. In a telephone system, a called subscriber's line, an automatic switch for extending a call in the direction of said called line, a ringing current generator, means responsive to the completion of a connection to the called line for connecting ringing current from the said ringing current generator to the said called line, means controlled by the removal of the receiver at the called subscriber's substation for automatically disconnecting the ringing current therefrom, and a locking device for preventing the reapplication of said ringing current until said automatic switch has been released.

125. In a telephone system, an automatic switch for extending a call in the direction of a called line, a ringing current generator, a relay for connecting current from said generator to the said called line, means controlled by the called subscriber for disconnecting the said ringing current, and a relay for preventing the reconnection of the said current to the said line until the said automatic switch has been restored to normal.

In witness whereof, I hereunto subscribe my name, this 28th day of October, A. D., 1905.

ALFRED H. DYSON.

Witnesses:

H. W. DUNBAR,
G. E. MUELLER.

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

Corrections in Letters Patent No. 1,184,932.

It is hereby certified that in Letters Patent No. 1,184,932, granted May 30, 1916, upon the application of Alfred H. Dyson, of Chicago, Illinois, for an improvement in "Automatic Telephone Systems," errors appears in the printed specification requiring correction as follows: Page 15, line 107, claim 16, for the word "simple" read *single*; page 18, line 72, claim 31, after the word "of" insert the words *electromagnetically driven*; same page, line 117, claim 33, for the word "substantial" read *substation*; page 22, line 28, claim 63, for the word "energizing" read *deenergizing*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 18th day of July, A. D., 1916.

[SEAL.]

R. F. WHITEHEAD,

Acting Commissioner of Patents.

Cl. 179—18.