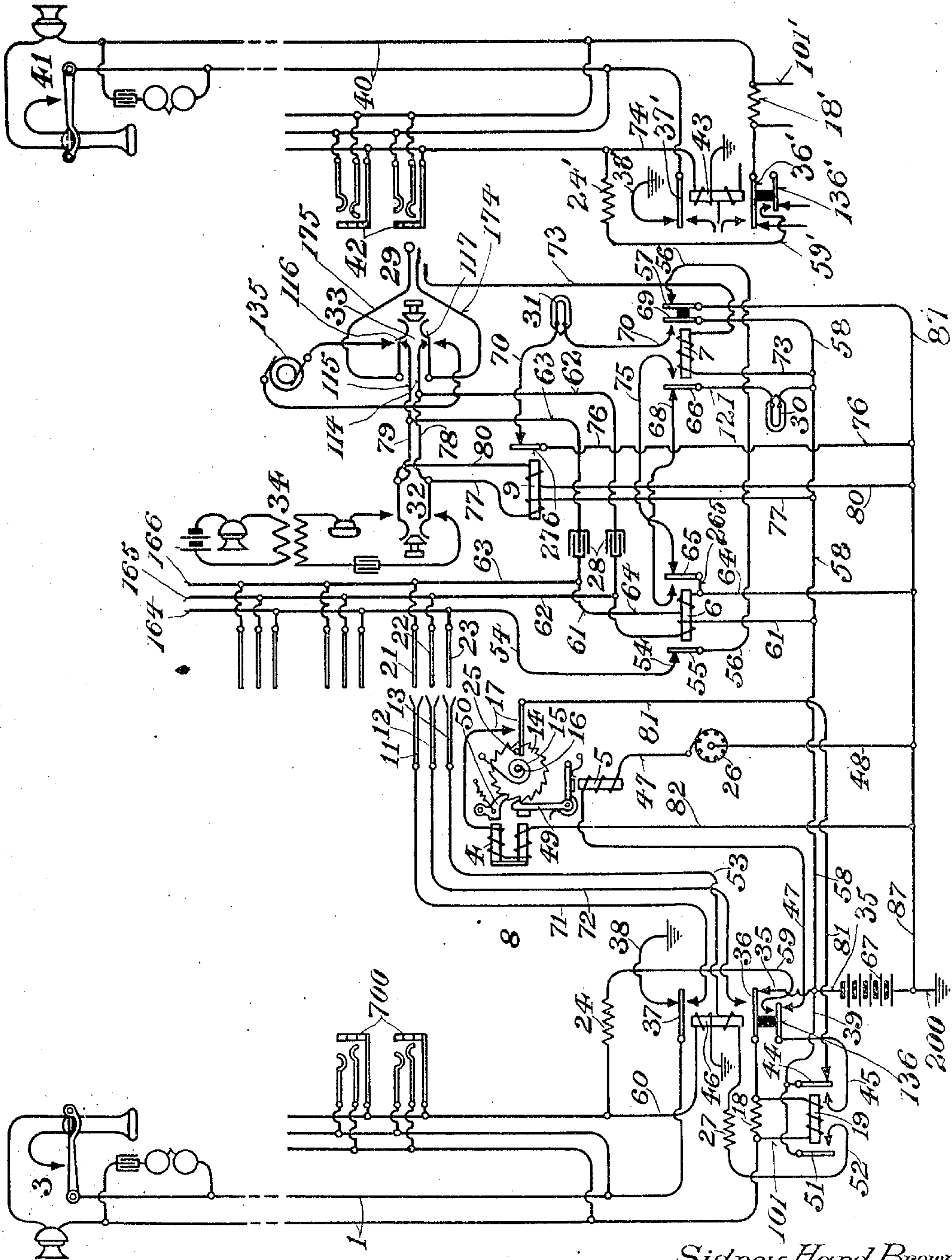


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CALL DISTRIBUTING TELEPHONE EXCHANGE SYSTEM.
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UNITED STATES PATENT OFFICE.

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CALL-DISTRIBUTING TELEPHONE-EXCHANGE SYSTEM.

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To all whom it may concern:

Be it known that I, SIDNEY HAND BROWNE, a citizen of the United States of America, and resident of Pittsburg, county of Allegheny, and State of Pennsylvania, have invented a new and useful Improvement in Call-Distributing Telephone-Exchange Systems, of which the following is a specification.

My invention pertains to call distributing telephone exchange systems.

In the general system, for which the improvements constituting my present invention are particularly designed, the entire exchange may be said to be built up of two classes of units, line units and trunk units. Each line unit consists of a telephone line having at its substation end a telephone, and at its central office end two switching elements which I will designate respectively as a "connecting element" and a "call receiving element". The connecting element is an automatic switch which is thrown into movement by the removal of the substation telephone receiver and travels consecutively over waiting contacts of a plurality of trunks which it tests until it arrives at the contacts of a trunk not already in use; upon finding such a non-busy trunk, the automatic switch connects its line with that trunk and maintains the connection until the hanging up of the receiver at the calling substation. The call receiving elements at the central office end of the telephone line consist of switchboard jacks, one at each section of the switchboard. Each trunk unit consists generally of a speech transmitting portion terminating at one end in waiting contacts, which latter are multiplied to the automatic switches of a plurality of telephone lines; said trunk unit terminates at its other end in a connecting element consisting of a plug adapted to be inserted in a switchboard jack at the called telephone line.

A central operator's telephone, busy test connections whereby the switchboard jacks of engaged telephone lines afford a busy signal when tested with a trunk plug, and supervisory signaling means, are provided. It will therefore be understood that in such a system the removal of the receiver at a telephone substation originates a call; that in response to this removal of the receiver the automatic switch of said telephone line will automatically connect the line with a disengaged trunk; that an operator in attendance

upon that trunk takes the calling subscriber's order in the usual way and thereupon completes the connection by inserting the trunk plug in a switchboard jack of the called telephone line.

The improvements constituting my present invention relate to the construction, combinations and arrangements of apparatus and circuits (particularly at the central office) of systems such as outlined above, with the object principally of simplifying and minimizing the electrical devices, instrumentalities and circuits constituting the system, at the same time affording maximum efficiency of operation under the varying and exacting conditions of commercial telephonic service.

These improvements may be readily understood from the detailed description which follows, wherein reference is made to the accompanying drawing illustrating what I believe to be the preferred embodiment of the invention.

Referring to the drawing, and in order to afford at the outset a general idea of the structure illustrated, a line unit is shown (at the left) the principal parts thereof being the telephone line conductors 1, substation telephone 3, switchboard jacks 700 connected in multiple, and automatic switch 8; with these parts there are associated various relays, resistances, circuits and connections (shown at the left-hand side of the drawing) fully explained hereafter. The battery 67 and interrupter 26 are common to all lines terminating at the central office. A trunk unit (shown between the line unit at the left and another line unit at the extreme right) has as its principal parts, waiting contacts 21, 22 and 23 of switch 8, and similar contacts at other similar switches of other lines, a plug 29, and conductors leading from the plug to the waiting contacts; with these parts are associated various relays, lamps, keys, condensers, and circuit connections, all fully explained hereafter. Battery 67 and call signal generator 135 are common to all of the trunks of the exchange.

The mechanical details of the automatic switch 8 form no part of the present invention, and hence general reference thereto will suffice. There are upon the market many forms of step-by-step switches, and some forms of continuous-motion switches, in which movable terminals are propelled from

contact to contact, or from set to set of contacts, by electrical or mechanical action; the mechanisms of many, if not all, of such switches are suitable for and may be readily employed in a system such as herein described.

In all such switches, when a set of movable contacts reaches a set of fixed contacts the individual movable contacts make electrical connection with the respectively located individual contacts of the fixed set reached, there being a plurality of fixed sets waiting to be wiped over by the movable contacts. From this relation existing between the fixed and movable contacts, the term "wipers" is a convenient one for the movable terminals and the term "waiting contacts" is a convenient one for the fixed points. In such switches an electromagnet moves the wipers or causes them to be moved, and another electromagnet restores them or causes them to assume their original position of rest.

The automatic electric switch, shown at 8, consists of ratchet wheel 14 on a shaft 16 under tension of volute spring 15, adapted to be advanced step by step through an angle of one step by driving pawl 49 upon each energization of magnet 5, and to be returned to its position of rest upon the energization of magnet 4. Holding pawl 50 retains the switch in its advanced positions. Magnet 4, when energized, withdraws both pawls 49 and 50 from engagement with ratchet wheel 14 permitting spring 15 to return the pawl to position of rest. The shaft 16 carries a set of three wipers 11—12—13, and the frame of the switch carries a plurality of sets of waiting contacts of which one set is shown at 21—22—23. The interrupter 26 is shown in the circuit of magnet 5, the purpose of the interrupter being to alternately deenergize and reenergize the magnet 5 when the circuit through that magnet is closed at all other points, thus propelling the shaft 16 through successive steps. Pin 25 attached to a moving part of the automatic switch engages one member of the electrical switch 17 and separates the two members in that switch when the shaft 16 and other moving parts are in their normal positions of rest (as shown in the drawing), the switch 17 being closed at the first step of the moving part and remaining closed until broken by the restoration of the switch to normal.

To the waiting contacts 21—22—23, are connected conductors 54—62—63 having a trunk equipment as shown, and having also extensions 164—165—166 reaching to sets of waiting contacts (similar to 21—22—23) of other automatic switches similar to that herein described, but serving other telephone lines, thus making each trunk accessible to a plurality of telephone lines in addition to having a plurality of trunks accessible to each telephone line. The multiple switchboard jacks 700 for telephone line 1, are

located one at each section of the multiple switchboard.

42 are similar jacks for telephone line 40. One conductor of telephone line 1 leads to an armature 37 normally resting against its back contact connected to ground by conductor 38. The other conductor of said line leads through a resistance 18 to the upper member 36 of a double armature which member normally rests against its back contact; a shunt connection 101, leading from said left-hand conductor 1 around resistance 18, includes the winding of a line relay 19. The conductors of telephone line 40 have similar connections; one leads to an armature 37' which normally rests against its back contact, and from the latter a conductor 38' leads to ground; the other leads through a resistance 18' to the upper member 36' of a double armature which member normally rests against its back contact, and a shunt connection 101' around resistance 18' includes the winding of a relay not shown. A conductor 71 leads from the front contact of armature 37 to wiper 11, and a conductor 72 leads from front contact of armature 36 to wiper 12.

46 is a cut-off and connecting relay for telephone line 1, having one of its two windings connected in a conductor 60 leading from the sleeve contacts of jacks 700 to ground; when energized this relay attracts its armatures 37, 36 away from their back contacts into engagement with their front contacts. By this same movement a lower member 136 of the double armature of this magnet is moved from its back contact into engagement with its front contact.

43 is a similar cut-off and connecting relay for telephone line 40; conductor 74 leads from the sleeve contacts of jacks 42 through one of the two windings of said relay, to ground. Relay 43 when energized attracts its armature 37', and the two members 36' and 136' of its double armature away from their back contacts into engagement with their front contacts. A conductor 35 leads from the back contact of armature 36 to one pole of the common battery 67, the other pole of which is connected to ground by conductor 200. A branch 39 from conductor 35 leads to armatures 44 and 51 of relay 19, which armatures are normally retracted from engagement with their front contacts. When thus retracted armature 44 engages a back contact from which conductor 81 leads to switch 17. From the front contact of armature 44, conductor 45 leads to armature 136, and from back contact of the latter conductor 47 leads through winding of magnet 5 to interrupter 26. Conductor 48 from the latter joins conductor 87 from one pole of battery 67. A conductor 52 leads from the front contact of armature 51 through resistance 27, one winding of relay 46 and thence by conductor 53 to testing wiper 13. Conductor 59

leads from the front contact of armature 136 through resistance 24 and joins conductor 60. A similar conductor 59' (at the right-hand side of the drawing) leads from the front contact of armature 136' through resistance 24' to conductor 74. A conductor 58 branching from conductor 35, leads to mechanism of the trunk, as hereafter explained.

Having thus described the circuit connections and mechanism at the central station end of the telephone line 3, I will next explain the circuit connections and mechanism of the central station trunks, only one of which is shown in the drawing. From waiting contact 23, or the testing terminal of the trunk, as it may be called, conductor 54 leads to the back contact of an armature 55 of a relay 6. A conductor 56 extends from said armature and relay to the back contact of one member 57 of a double armature of relay 7. Armature 55 is normally, *i. e.*, when its trunk is not busy, retracted into engagement with its back contact.

From the waiting contact 22, a conductor 62 leads through a condenser 28 to a contact 114 of a key 33. A branch 61, from conductor 62, leads through one of two windings of relay 6 to conductor 58. From the waiting contact 21, conductor 63 leads through condenser 28 to contact 115 of key 33. Branch 64 leads from conductor 63 through a second winding of relay 6 to conductor 87.

32 is a key, the movable contacts of which are connected to branches 78, 79 of conductors 62 and 63 respectively, by which key the central operator may connect her telephone set 34 with the calling subscriber's line for the purpose of ascertaining the party with whom connection is desired, and by which said central operator may, should it be desired, also converse with a subscriber even if not called by another subscriber.

The switch plug 29 at one end of the trunk has three plug contacts, one connected by conductor 175 to a movable switch member 116 of a key 33; another connected by conductor 174 to a second movable switch member 117 of said key; and a third contact connected by a conductor 73, which extends through the winding of a relay 7, to conductor 58. The poles of signal current generator 135 are connected with back contacts adapted to be engaged by movable switch members 116 and 117 respectively, upon operation of the signaling key 33.

265 is a branch leading from conductor 64 to armature 65 of relay 6; said armature is normally retracted into engagement with its back contact, from which conductor 75 leads to the front contact of an armature 66 of relay 7. A conductor 68 leads from the front contact of armature 65 to the back contact of armature 66, and a conductor 121 leads from the latter through signal lamp 30 to conductor 58.

A branch 76 leads from conductor 87 to armature 276 of relay 9; said armature is normally retracted into engagement with its back contact, from which a conductor 70 leads through a signal lamp 31 to the front contact of armature 69. Conductor 58, heretofore referred to, connects to armature 69, while conductor 87 connects to the other armature 57 of this double armature. Relay 9 has two windings, one connected in a conductor 77 extending between conductors 58 and 78, and the other connected in conductor 80 extending between conductors 87 and 79.

Having thus described the mechanism and circuits in their normal inactive positions in which they are shown in the drawing. I will now describe the operation of the system in responding to a call, initiated by the subscriber at substation 3 by the removal of his receiver from its switch hook. The removal of this receiver from its hook closes circuit through the electrical contacts of that hook and current flows from grounded battery 67 through elements 35—36; at this point the current divides, the major portion flowing through resistance 29, and the minor portion through element 101 and winding of 19; continuing, the full current flows through elements 1—3—1—37—38— to ground, energizing relay 19. Relay 19 attracts its armatures 51 and 44 and current flows from battery 67 through elements 35—39—44—45—136—47 and winding of magnet 5—26—48—87—200— to the other pole of the battery, energizing magnet 5, when circuit is closed through interrupter 26, and deenergizing magnet 5 when circuit is open at interrupter 26, thus alternately energizing and deenergizing magnet 5, and stepping the wipers 11, 12 and 13 forward until they make contact with waiting contacts 21, 22 and 23 of a non-busy trunk line (a non-busy line being one, as more fully explained hereafter, in which the armature 55 of relay 6 and the armature 57 of relay 7 both rest against their back contacts, the position shown in the drawing), when circuit is established for current from battery 67 through elements 35—39—51—52—27— one winding of relay 46—53—13—23—54—55—56—57—87—200— back to the battery, thus energizing relay 46. This energization of relay 46 causes it to attract its armatures, the movement of armature 136 interrupting the circuit through magnet 5, thereby preventing further stepping of wipers 11, 12, 13; said relay 46 by moving armature 136 into engagement with its front contact thereby furnishes localized path for current from battery 67 through elements 35—39—44—45—136—59—24—60— the other winding of relay 46 to ground, thus continuing the energization of relay 46 irrespective of the passage of current through its other winding connected to conductor 53, and providing busy test conditions

upon the test rings of the jacks 700 by producing upon them a potential above the earth equal to a portion of the potential of the battery 67. Relay 46 by attracting its armatures 36, 37 against their front contacts makes connection with conductors 72 and 71 to wipers 12, 11, respectively, which wipers are now in electrical engagement with waiting contacts 22 and 21, respectively; thus path is furnished for current from one pole of battery 67 through elements 35—58—61 and one winding of relay 6—62—22—12—72—36—101 and winding of relay 19—1—3—1—37—71—11—21—63—64 and the other winding of relay 6—87—200—to the other pole of the battery, thereby maintaining the energization of relay 19, by a path of current different from that by which said relay was originally energized, and also energizing relay 6 causing it to attract its armatures 55 and 65. By the attraction of armature 65 signal lamp 30 is caused to glow by current from one pole of battery through elements 35—58—121 and lamp 30—66—68—265—64—87—200—back to the other pole of the battery; and by the attraction of armature 55, conductor 54, its branch conductor 164 and waiting contacts connected with the latter conductor at the automatic switches of other telephone lines, are disconnected and isolated from the connection to one pole of the battery by way of said armature 55, which connection is necessary to permit the original energization of the relay 46 of any other line which may institute a call while this particular trunk is engaged. Energization of relay 7 in the manner hereafter explained, and the consequent withdrawal of armature 57 from its back contact will also disconnect and isolate conductor 54 from its said ground connection, the completion of which latter requires that armatures 55 and 57 shall simultaneously engage their back contacts. By this attraction of either or both armatures 55 and 57 away from their back contacts, a busy test, to wit, that condition in which said relays, or either of them, hold their said armatures attracted, is thus placed upon the waiting contacts (particularly upon the testing contact 23) of the selected trunk, to prevent the automatic selection of that trunk by the automatic switch of any other calling line.

It will thus be seen that the act of the calling subscriber at 3 in lifting his receiver from its hook-lever, automatically effects, by a rapid succession of operations, the connection of the calling line with a non-busy trunk, and the establishment of conditions whereby said calling line and the trunk selected will both test "busy", making it impossible for any other calling line to connect with said trunk during the maintenance of the busy test condition established in the trunk, and also establishing conditions whereby said

calling line will test busy at all sections of the switch-board. This act of the subscriber also causes lamp 30 to glow, notifying the central operator in charge of the particular trunk to which connection has been effected, that a calling telephone line has been connected to that trunk. This condition will remain as long as the receiver at substation 3 remains off its hook-lever, and until the central-office operator responds to the call.

The central-station operator answers the call in the well-known way by depressing her key 32, thereby connecting her telephone outfit 34 with the calling subscriber's telephone over the following path: from the upper movable contact of key 32, elements 79—63 and 28—21—11—71—37—1—3—1—18—36—72—12—22—62 and 28—to the lower movable contact of key 32; one side of this connection is joined to one pole of the battery through elements 77 and one winding of relay 9—58—35, while the other side of said connection is joined to the other pole of the battery by element 80 and the other winding of relay 9—87—200. Talking connections are thus established by which the central operator takes the calling subscriber's order. The central operator thereupon selects and tests jack 42 of the called telephone line, and finding the line not busy inserts her plug 29 in said jack. A circuit is thus completed from one pole of grounded battery 67, elements 35—58—73 and winding of relay 7—74—one winding of relay 43 to ground. This circuit energizes relays 7 and 43, the former attracting its armature 66, thereby opening the circuit which caused lamp 30 to glow, and the relay 43 attracting both its armatures 36' and 37', thereby isolating line 40 from its automatic switch equipment, not shown. Relay 7 also attracts its armatures or double armature 69 and 57, thereby establishing path for current through lamp 31 by the following elements—from one pole of battery 67—35—58—69—70 and lamp 31—276—76—87—200 to the other pole of said battery, thereby causing lamp 31 to glow as a signal to the operator that the telephone-receiver at substation 41 is on its hook-lever. The operator then actuates her key 33, thereby connecting signaling generator 135 with the line of the called subscriber and ringing the signal-bell at the telephone substation 41.

The central operator having released her ringing-key 33, and the called subscriber having removed his receiver from its hook-lever, circuit is closed for current from one pole of battery 67, through elements 35—58—77 and one winding of relay 9—78—114—117—174—40—41—40—175—116—115—79—80—and the other winding of relay 9—87—200—to the other pole of said battery; relay 9 is thereby energized and by attracting its armature 276 opens the circuit through lamp 31 and extinguishes the latter, thus indicat-

ing to the central operator that the called subscriber has removed his receiver to answer the call. Lamps 30 and 31 being thus both darkened, and the calling and called parties being connected for conversation, the central operator gives the connection no further attention until the glowing of those lamps for disconnection. The conversation circuit between the calling and called subscribers may be traced by the following elements: from calling subscriber's telephone 3, elements 1—18—36—72—12—22—62 and 28—114—117—174—40—through the telephone 41 of the called subscriber—40—175—116—115—63 and 28—21—11—71—37—1—back to the telephone 3 of the calling subscriber. The sides of this connection are connected to the respective poles of common battery 67; from one pole of said battery by elements 35—58—from which latter there are two paths, one path by element 61 and one winding of relay 6 to conductor 62 at one side of condenser 28, and the other path by element 77 and one winding of relay 9 to conductor 62 at the other side of said condenser. From the other pole of said battery the connection extends by elements 200—87—from which latter there are two paths, one by element 64 and winding of relay 6 to conductor 63 at one side of condenser 28, and the other path by element 80 and winding of relay 9 to conductor 63 at the other side of condenser 28.

Conversation having been completed, the hanging up of the telephone-receiver at substation 41 interrupts the circuit heretofore traced through the windings of relay 9, thereby deenergizing said relay, which releases its armature to again close the previously traced circuit by which lamp 31 was caused to glow. Upon the hanging up of the telephone-receiver at substation 3, the circuit previously traced through the windings of relay 6 is interrupted, thereby deenergizing said relay, which releases its armatures, armature 65 acting to again establish the previously traced circuit by which lamp 30 was caused to glow. The opening of circuit at substation 3 breaks the circuit previously described as having continued the energization of relay 19, and the release of armature 44 completes a path for current from one pole of the battery 67 through elements 35—39—44—81—17—magnet 4—82—87—200—to the other pole of said battery, thereby energizing release magnet 4 (switch 17 being closed by the off-normal position of automatic switch 8) and releasing the moving part of automatic switch 8, which is thereupon actuated by spring 15 to return it to the position shown in the drawing. Upon reaching this normal position the pin 25 acts upon the moving part of the switch 17 to open the latter, thereby interrupting the circuit last traced above, and deenergizing magnet 4.

The release of armature 44 above referred to, also opens the circuit from said armature to conductor 45, by which relay 46 was energized, thereby deenergizing said relay. The hanging up of the receiver at substation 3 therefore acts automatically to restore to their normal positions (illustrated in the drawing) all parts of the central office equipment individual to line 1. But following the replacement upon their hook-levers of the receivers of both the calling and called lines, whereby both lamps 30 and 31 are caused to glow as signals to the central-station operator, a brief interval of time will necessarily elapse before the central operator removes her plug 29 from the switch-board jack of the called line. During this interval, the busy-test, preventing connection of other calling telephone lines with this particular trunk, should be maintained, otherwise confusion may result from connecting such a calling line with a trunk whose plug is inserted in the jack of a telephone subscriber who is not the one desired by the calling party. The means for the maintenance of the busy-test upon the trunk during this period is an important part of the present invention. At this stage of the operation the deenergization of relay 6 has caused it to release its armature 55, thereby closing at that point the previously traced path from conductor 54 to ground; but as relay 7 is still energized, attracting its armatures, said path to ground is still open at armature 57. The armature 57 is thus held out of contact with conductor 56, and continues the busy-test upon the trunk until the energizing circuit of relay 7 is interrupted by removal of plug 29 from jack 42. It will be remembered that the signal lamps 30 and 31 are now glowing before the central operator as a signal for removal of her plug 29; in response to these signals said operator removes this plug, whereby relay 43 is deenergized releasing its armatures, which restore connection of line 40 with its automatic switch-equipment, not shown. Removal of the plug also breaks the energizing circuit of relay 7, which, by releasing its armatures, permits armature 57 to engage its back-contact, thus restoring the trunk to its non-busy condition and establishing conditions whereby the automatic switch of any calling telephone line may effect connection with said trunk.

The establishment of the busy-test by armature 57, while a plug such as 29 is in a jack, such as 42, attains another desirable and necessary result in permitting the central operator, attendant upon plug 29, to use that plug to communicate by means of her key 32, with any telephone line for which no call has been received, without danger of interruption from a calling telephone line. This is effected by simply inserting her plug 29 into a jack 42 of the line of the subscriber