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CALL DISTRIBUTING TELEPHONE EXCHANGE SYSTEM.

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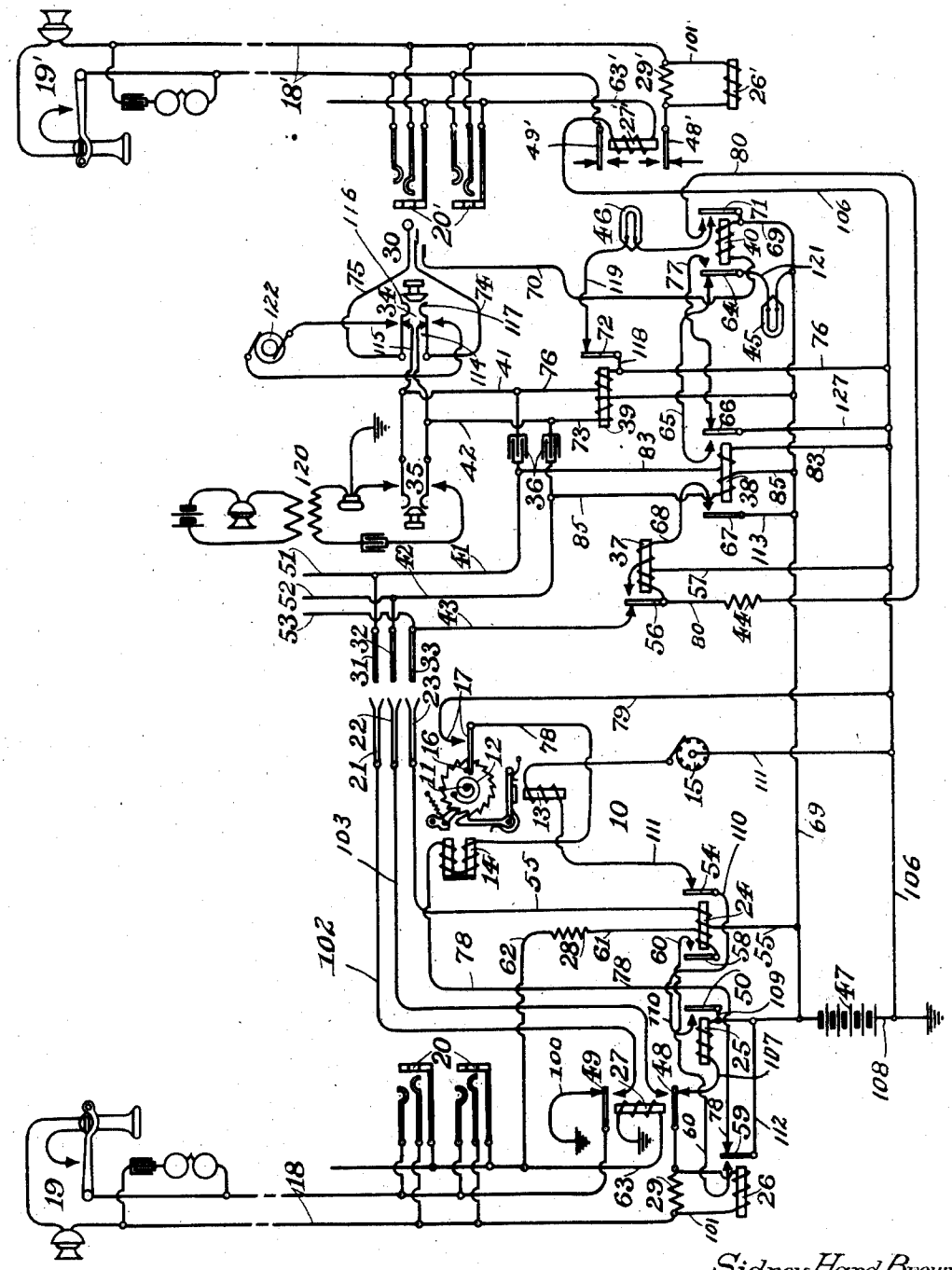
927,025. Patented July 6, 1909.



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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 received 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 element at the central office end of the telephone line consists 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 multipled 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 particularly to the construction, combinations and arrangements of apparatus and circuits (particularly at the central office) of systems such as outlined above, with the object of 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 18, substation telephone 19, switchboard jacks 20 connected in multiple, and automatic switch 10; 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 47 and interrupter 15 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 31, 32 and 33 of switch 10, and similar contacts at other similar switches of other lines, a plug 30, 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 47 and call signal generator 122 are common to all of the trunks of the exchange.

The mechanical details of the automatic switch 10 need 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 "wiper" 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 10 consists of shaft 11 under tension of volute spring 12, adapted to be advanced step by step through an angle of one step upon each energization of magnet 13 and to be returned to its position of rest, upon the energization of magnet 14. The shaft 11 carries a set of three wipers 21—22—23, and the frame of the switch carries a plurality of sets of waiting contacts of which one set is shown at 31—32—33. An interrupter 15 is shown in the circuit of magnet 13; the purpose of the interrupter being to alternately deënergize and reënergize the magnet 13 when the circuit through that magnet is closed at all other points, thus, propelling the shaft 11 through successive steps. Pin 16 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 11 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 31—32—33, are connected conductors 41—42—43 having a trunk equipment as shown, and having also extensions 51—52—53 reaching to sets of waiting contacts (similar to 31—32—33) 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.

20 are multiple switchboard jacks for telephone line 18, one jack being located at each section of the multiple switchboard. 20′ are similar jacks for telephone line 18′. One conductor of telephone line 18 leads to an armature 49 normally resting against its back contact connected to ground by conductor 100. The other conductor of said line leads through a resistance 29 to armature 48 which normally rests against its back contact; a shunt connection 101, leading from said conductor around resistance 29, includes the winding of a line relay 26. The conductors of telephone line 18′ have similar connections; one leads to an armature 49′ which normally rests against its back contact, and from the latter a conductor (not shown) leads to ground; the other leads through a resistance 29′ to armature 48′ which normally rests against its back contact, and a shunt connection 101′ around resistance 29′ includes the winding of a line relay 26′. A conductor 102 leads from the front contact of armature 49 to wiper 21, and a conductor 103 leads from front contact of armature 48 to wiper 22.

27 is a cut-off and connecting relay for telephone line 18, having its winding connected in a conductor 63 leading from the sleeve contacts of jacks 20 to ground; when energized this relay attracts its armatures 48, 49, away from their back contacts into engagement with their front contacts. 27′ is a similar cut-off and connecting relay for telephone line 18′; conductor 63′ leads from the sleeve contacts of jacks 20′ to one end of the winding of said relay, while a conductor 106 leads from the other end of said winding to ground at battery 47. Relay 27′ when energized attracts its armatures 48′, 49′, away from their back contacts into engagement with their front contacts. A relay 25 has its winding connected in a conductor 107 which leads from the back contact of armature 48 to one pole of the common battery 47, the other pole of which is connected to ground by conductor 108. A branch 109 from conductor 107 leads to an armature 50, normally retracted from engagement with its front contact, from which latter a conductor 110 leads to an armature 54 which normally engages its back contact. A conductor 111 leads from the latter through the winding of magnet 13, and interrupter 15 to conductor 106. A branch 112 leads from conductor 107 to an armature 59 of relay 26, normally retracted against its back contact, from which latter a conductor 78 leads through the windings of magnet 14 to the movable member of switch 17. Conductor 79 leads from the fixed member or back contact of said switch to conductor 106. A conductor 60, performing important functions in connection with the present invention, leads from the front contact of armature 59 to the front contact of an armature 58 of a testing and connecting relay 24; from said armature 58, conductor 61 leads through one winding of relay 24 to a resistance 28, and from the latter by conductor 62 to conductor 63. A conductor 69 branching from conductor 107, leads to mechanism of the trunk, as hereafter explained. A branch conductor 55 from conductor 69 leads through a second winding of relay 24 to testing-wiper 23.

Having thus described the circuit connections and mechanism at the central station end of the telephone line 19, 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 33, or the testing terminal of the trunk, as it may be called, conductor 43 leads to the back contact of an armature 56 of a relay 37. A conductor 80 extends from said armature and relay through a resistance 34 to one of two front contacts of an armature 71 of a relay 40, this connection forming an important part of the present invention by reason of its functions fully explained hereafter. Another conductor 57 leads from armature 56 through one winding of relay 37 to conductor 106. Armature 56 is normally retracted into engagement with its back contact and out of engagement with its front contact; from the latter, conductor 68 leads through a second winding of relay 37 to the front contact of an armature 67 which is normally retracted from engagement with said contact, and from said armature a conductor 113 leads to conductor 69. A branch 53 from conductor 43, leads to waiting contacts 33 of the automatic switches of other telephone lines. From the waiting contact 32, a conductor 42 leads through a condenser 36 to a contact 114 of a key 34. A branch 85, from conductor 42, leads through one of two windings of a relay 38 to conductor 69. A branch 52, from conductor 42, leads to waiting contacts 32 of the automatic switches of other telephone lines. Branch 73 from conductor 42 leads through one of two windings of a relay 39 to conductor 69. From the waiting contact 31, conductor 41 leads through condenser 36 to contact 115 of key 34. Branch 83 leads from conductor 41 through a second winding of relay 38 to conductor 106. Branch 51 from conductor 41 leads to waiting contacts 31 of the automatic switches of other telephone lines. Branch 76 from conductor 41 leads through a second winding of relay 39 to conductor 106.

35 is a key, the movable contacts of which are connected to conductors 41 and 42 respectively, by which key the central operator may connect her telephone set 120 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 30 at one end of the trunk has three plug contacts, one connected by conductor 75 to a movable switch member 116 of a key 34; another connected by conductor 74 to a second movable switch member 117 of said key; and a third contact connected by a conductor 70, which extends through the winding of a relay 40, to conductor 69. The poles of signal current generator 122 are connected with back contacts adapted to be engaged by movable switch members 116 and 117 respectively, upon operation of the signaling key 34.

127 is a branch leading from conductor 106 to armature 66 of relay 38; said armature is normally retracted into engagement with its back contact, from which conductor 77 leads to the front contact of an armature 64 of a relay 40. A conductor 65 leads from the front contact of armature 66 to the back contact of armature 64, and a conductor 121 leads from the latter through signal lamp 45 to conductor 69. A branch 118 leads from conductor 76 to armature 72 of relay 39; said armature is normally retracted into engagement with its back contact, from which a conductor 119 leads through a signal lamp 46 to a second front contact of armature 71. As has already been explained, the latter armature, which is normally retracted from its front contacts, has a front contact connected to conductor 80.

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 19 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 47 through elements 107— winding of 25—48— at this point the current divides, the major portion flowing through resistance 29, and the minor portion through 101 and winding of 26; continuing, the full current flows through elements —18—19—18—49—100— to ground, energizing relays 25 and 26. Relay 25 attracts its armature 50 and current flows from battery 47 through element 107—109—50—110—54—111 and windings of magnet 13—15—111—106—108— to the other pole of the battery, energizing magnet 13, when circuit is closed through interrupter 15, and deënergizing magnet 13 when circuit is open at interrupter 15, thus alternately energizing and deënergizing magnet 13, and stopping the wipers 21, 22 and 23 forward until they make contact with waiting contacts 31, 32 and 33 of a non-busy trunk line (a non-busy line being one, as more fully explained hereafter, in which the armature 56 of relay 37 rests against its back contact, the position shown in the drawing), when circuit is established for current from battery 47 through elements 107—69—55 and winding of relay 24—23—33—43—56—57 and one winding of relay 37—106— back to the battery, thus energizing relays 24 and 37. This energization of relay 24 causes it to attract its armature 54, interrupting the circuit through magnet 13, thereby preventing further stepping of wipers 21, 22, 23; said re-

lay 24 also attracts its armature 58 and thereby furnishes localized path for current from battery 47 through elements 107—112—59—60—58— one winding of relay 24—61—28—62—63— winding of relay 27 to ground, thus continuing the energization of relay 24 irrespective of the passage of current through its other winding connected in conductor 55. Relay 27 is also energized and attracts its armatures 48, 49 against their front contacts into connection with conductors 102 and 103 to wipers 21, 22, respectively, which wipers are now in electrical engagement with waiting contacts 31 and 32, respectively; thus path is furnished for current from one pole of battery 47 through elements 107—69—85 and one winding of relay 38—42—32—22—103—48—101 and winding of relay 26—18—19—18—49—102—21—31—41—83 and the other winding of relay 38—106—108— to the other pole of the battery, thereby maintaining the energization of relay 26 by a path of current different from that by which said relay was originally energized, and also energizing relay 38 causing it to attract its armatures 66 and 67. By the attraction of armature 66 signal lamp 45 is caused to glow by current from one pole of battery through elements 107—69—121 and lamp 45—64—65—66—127—106—108— back to the other pole of the battery; and by the attraction of armature 67 path is given for current from battery through elements 107—69—113—67—68 and one winding of relay 37—56— the other winding of relay 37—57—106— to the other pole of the battery, thus continuing the energization of relay 37 by a path of current different from the path by which said relay was at first energized, as heretofore explained, thus also continuing the isolation of conductor 43 from armature 56 so long as this particular trunk is engaged, and thereby also isolating said conductor 43, its branch conductor 53 and waiting contacts connected with the latter conductor at the automatic switches of other telephone lines, from the connection to one pole of the battery by way of armature 56, which connection is necessary to permit the original energization of the relay 24 of any other line which may institute a call; a busy test, to wit, that condition in which the relay 37 holds its armature 56 attracted against the front contact of said armature, is thus placed upon the waiting contacts (particularly upon the testing contact 33) of the selected trunk, to prevent the automatic selection of that trunk by the automatic switch of any other calling line.

The completion of the circuit last described above, by which energization of relay 37 is maintained, involves, as was seen, the engagement of armature 56 with its front contact, which latter is connected to conductor 68; this contact originally resulted by movement of armature 56 under influence of current over the previously traced circuit from one pole of battery 47—107—69—55 and one winding of relay 24—23—33—56—one winding of relay 37—57—106— to the other pole of said battery. If at the instant the armature 67 of relay 38 moves into engagement with its front contact, the armature 56 should happen not to be in engagement with its front contact, then armature 56 having fallen back into engagement with its back contact will again close the circuit from conductor 43 through one winding of the relay 37, thus again energizing the latter, causing it to attract its armature 56 against its front contact, and thereby establishing the second above-traced path for energizing current of relay 37, which thereupon holds its armature 56 in engagement with the front contact connected to conductor 68; this energizing circuit of magnet 37 will remain complete, to maintain the busy test condition of the trunk line, until said circuit is disrupted as hereinafter explained.

The energization of relay 24 and the consequent circuit from one pole of battery 47 through elements 107—112—59—60—58—one winding of relay 24—61—28—62—63—winding of relay 27— to ground (which circuit has already been explained as having energized relay 27 to attract its armatures 48 and 49), connects the test rings of switchboard jacks 20 of the calling line 19, with battery 47 in such manner that a busy test will be received by the operator at any section of the multiple switchboard when she tests at her section, the jack 20 of the calling line 19, such testing being effected with a plug 30 in the manner well-known in switchboard service. It will thus be seen that the act of the calling subscriber at 19 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 45 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 19 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 35, thereby connecting her telephone

outfit 120 with the calling subscriber's telephone over the following path: from the upper movable contact of key 35, elements 41 and 36—31—21—102—49—18—19—18—29—48—103—22—32—42 and 36— to the lower movable contact of key 35; one side of this connection is joined to one pole of the battery through elements 85 and one winding of relay 38—69—107, while the other side of said connection is joined to the other pole of the battery by element 83 and the other winding of relay 38—106—108. Talking connections are thus established by which the central operator takes the calling subscriber's order. The central operator thereupon selects and tests jack 20′ of the called telephone line, and finding the line not busy inserts her plug 30 in said jack. A circuit is thus completed from one pole of battery 47, elements 107—69— winding of relay 40—70—63′— winding of relay 27′—106—108— to the other pole of the battery. This circuit energizes relays 40 and 27′, the former attracting its armature 64, thereby opening the circuit which caused lamp 45 to glow, and the relay 27′ attracting both its armatures 48′ and 49′, thereby isolating line 18′ from its automatic switch equipment, not shown. Relay 40 also attracts its armature 71, thereby establishing path for current through lamp 46 by the following elements— from one pole of battery 47—107—69—71—119 and lamp 46—72—118—76—106—108— to the other pole of said battery, thereby causing lamp 46 to glow as a signal to the operator that the telephone-receiver at substation 19′ is on its hook-lever. The operator then actuates her key 34, thereby connecting signaling generator 122 with the line of the called subscriber and ringing the signal-bell at the telephone substation 19′.

The central operator having released her ringing-key 34, and the called subscriber having removed his receiver from its hook-lever, circuit is closed for current from one pole of battery 47, through elements 107—69—73 and one winding of relay 39—42—114—117—74—18′—19′—18′—75—116—115—41—76 and the other winding of relay 39—106—108—to the other pole of said battery; relay 39 is thereby energized and by attracting its armature 72 opens the circuit through lamp 46 and extinguishes the latter, thus indicating to the central operator that the called subscriber has removed his receiver to answer the call. Lamps 45 and 46 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 19, elements 18—29—48—103—22—32—42 and 36—114—117—74—18′—through the telephone 19′ of the called subscriber—18′—75—116—115—41 and 36—31—21—102—49—18—back to the telephone 19 of the calling subscriber. The sides of this connection are connected to the respective poles of common battery 47; from one pole of said battery by elements 107—69—from which latter there are two paths, one path by element 85 and one winding of relay 38 to conductor 42 at one side of condenser 36, and the other path by element 73 and one winding of relay 39 to conductor 42 at the other side of said condenser. From the other pole of said battery the connection extends by elements 108—106—from which latter there are two paths, one by element 83 and winding of relay 38 to conductor 41 at one side of condenser 36, and the other path by element 76 and winding of relay 39 to conductor 41 at the other side of condenser 36. Conversation having been completed, the hanging up of the telephone-receiver at substation 19′ interrupts the circuit heretofore traced through the windings of relay 39, thereby deënergizing said relay, which releases its armature to again close the previously traced circuit by which lamp 46 was caused to glow.

Upon the hanging up of the telephone receiver at substation 19, the circuit previously traced through the windings of relay 38 is interrupted, thereby deënergizing said relay, which releases its armatures, armature 66 acting to again establish the previously traced circuit by which lamp 45 was caused to glow. The opening of circuit at substation 19 breaks the circuit previously described as having continued the energization of relay 26, and the release of armature 59 completes a path for current from one pole of the battery 47 through elements 107—112—59—78 and magnet 14—17—79—106—108—to the other pole of said battery, thereby energizing release magnet 14 (switch 17 being closed by the off-normal position of automatic switch 10) and releasing the moving part of automatic switch 10, which is thereupon actuated by a spring 12 to return it to the position shown in the drawing. Upon reaching this normal position the pin 16 acts upon the moving part of the switch 17 to open the latter, thereby interrupting the circuit last traced above, and deënergizing magnet 14. The release of armature 59 above referred to, also opens the circuit from said armature to conductor 60, by which relays 24 and 27 were energized, thereby deënergizing said relays. The hanging up of the receiver at substation 19 therefore acts automatically to restore to their normal positions (illustrated in the drawing) all parts of the central office equipment individual to line 18. But following the replacement upon their hook-levers of the receivers of both the call-

ing and called lines, whereby both lamps 45 and 46 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 30 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 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 deënergization of relay 38 has caused it to release its armature 67, thereby breaking at that point the previously traced circuit by which the energization of relay 37 was continued; but the energization of relay 37 is continued until removal of the plug by a circuit through the following elements, to wit—one pole of battery 47—107—69—71—80—44—one winding of relay 37—57—106—108—to the other pole of the battery. This circuit may be called an "auxiliary busy-test circuit." The armature 56 is thus held out of contact with conductor 43, and continues the busy-test upon the trunk until this last-traced circuit is interrupted in the manner about to be described. It will be remembered that the signal lamps 45 and 46 are now glowing before the central operator as a signal for removal of her plug 30; in response to these signals said operator removes this plug, whereby relay 27′ is deënergized releasing its armatures 48′ and 49′, which restore connection of line 18′ with its automatic switch-equipment not shown. Removal of the plug also breaks the energizing circuit of relay 40, which, by releasing its armature 71, opens the circuit last traced above as energizing magnet 37, thereby permitting armature 56 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 auxiliary busy-test circuit referred to above attains another desirable and necessary result in permitting the central operator, attendant upon plug 30, to use that plug to communicate by means of her key 35, 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 30 into a jack 20′ of the line of the subscriber with whom she wishes to converse, which act results in the energization of relay 40 and the completion of the auxiliary busy-test circuit heretofore traced, the armature 56 being attracted, thereby placing upon the trunk the busy-test already referred to. The circuit which energizes relay 40 also energizes relay 27′, isolating telephone 19′ from its automatic switch equipment in the manner heretofore explained.

As will be understood from the preceding description, the automatic switch 10 in selecting a trunk continues the movement of wipers 21, 22, 23, from trunk to trunk, until the wiper 23 makes contact with a waiting terminal 33 from which circuit is closed to one pole of the battery by armature 56 occupying the position shown in the drawing; in other words, the movement of the wipers continues until relay 24 is energized. The relay 24 also performs the function of connecting the telephone line to a trunk by stopping the moving wipers upon the waiting contacts of a non-busy trunk. In view of these functions of the relay 24 it has been designated a "testing connecting relay". The wiper 23, by reason of its function, has been designated a "testing wiper". The waiting terminal 33, by reason of its function, has been designated a "test terminal".

The testing circuit may be referred to as being made up of two limbs, a primary limb from battery through elements 107—69—55 and winding of relay 24—to wiper 23, and a secondary limb from waiting contact 33 through elements 43—56— winding of relay 37—57—106—108—to battery; or through element 53 in addition if connection of the primary limb be made with some other waiting testing contact in multiple with 33.

As already explained, the relay 27 performs the functions of the cut-off relay of the ordinary wholly manual switchboard, as it isolates the call-forwarding element from the line when the latter is connected with its call-receiving element. This relay has therefore been designated a "cut-off" relay, although it has also the further function of connecting the line to the conductors 102 and 103 and through the latter to the trunk conductors 41 and 42, thus completing the conversation circuit from the telephone 19 to the trunk. In respect to this latter function, relay 27 may be called a "line connecting relay".

The relay 26 has been designated a "line relay" because of its intimate association with the line conductors, and because it responds at all times to the control of the line circuit by the substation telephone-hook switch.

What is claimed is:

1. In a call distributing telephone exchange system, the combination of an automatic switch having a moving testing-wiper; a testing relay connected with said wiper; an armature contact of said relay adapted to stop the movement of said testing wiper; and a local circuit controlled by an armature con-

tact of said testing relay by which circuit the energization of said testing relay may be continued independently of said testing wiper, substantially as described.

2. In a call distributing telephone exchange system, an automatic switch having a movable testing wiper; waiting contacts adapted to be connected with by said wiper; a source of current; a circuit connecting said waiting contacts to said source; means for isolating said contacts from said source of current; a testing relay with its windings connected between said source of current and said testing wiper, and adapted to be energized when said testing wiper engages a waiting contact connected to said source; and a local circuit controlled by an armature contact of said testing relay whereby the energization of said testing relay may be continued independently of the isolation of said engaged waiting contact from the current source, substantially as described.

3. In a call distributing telephone exchange system, a telephone line; automatic selecting equipment connected with said line; a plurality of trunks; a connecting relay adapted to connect said telephone line to one of said trunks selected by the selecting equipment; a testing relay; a series line relay; a circuit including armature contacts of said series line relay; armature contacts and helical conductor turns of said testing relay, the winding of said line connecting relay, and a source of electrical potential, whereby the energization of said line connecting relay is attained upon the simultaneous energization of said series line relay and said testing relay, substantially as described.

4. In a call distributing telephone exchange system, the combination of a cut-off relay; a line relay; a locking testing relay; and a circuit by which said locking testing relay controls the energization of said cut-off relay, and by which said locking testing relay is deënergized by the deënergization of said line relay, substantially as described.

5. In a call distributing telephone exchange system, the combination of a cut-off relay; a line relay; a testing relay; a testing circuit by which said testing relay is energized upon engagement with a non-busy trunk; and a circuit by which the energization of said testing relay results in the energization of said cut-off relay and in the continuance of the energization of said testing relay independently of the said testing circuit, said latter circuit being subject to rupture by the deënergization of said line relay, substantially as described.

6. In a call distributing telephone exchange system, the combination of a cut-off relay; a line relay; a testing relay; a circuit by which said testing relay controls the energization of said cut-off relay, and by which said testing relay is deënergized by the deënergization of said line relay; a trunk having waiting contacts; and a test circuit including one of said waiting contacts and providing for the initial energization of said testing relay when said trunk is not in use, substantially as described.

7. In a call distributing telephone exchange system, the combination of a cut-off relay; a line relay; a testing relay; and a circuit by which said testing relay controls the energization of said cut-off relay, and by which said testing relay is deënergized by the deënergization of said line relay; a trunk having a plurality of waiting contacts, including a waiting test contact; a testing wiper adapted to make connection with said waiting contacts; a primary test-circuit limb extending from a source of current to said test wiper, and including said testing relay, said source of current being adapted to energize said testing relay when an external circuit or secondary limb forms a closed circuit from said testing wiper to said source; a secondary normally-closed test-circuit limb extending between said waiting test contact and the source of current; and means whereby said secondary test-circuit limb is opened when said trunk is busy, substantially as described.

8. In a call distributing telephone exchange system, the combination of a line relay; a testing relay; a primary test-circuit limb including said testing relay; a trunk; a secondary test-circuit limb associated with said trunk and providing for the initial energization of said testing relay only when said trunk is not busy; and a circuit whereby said testing relay may be deënergized by the deënergization of said line relay, substantially as described.

9. In a call distributing telephone exchange system, the combination of a trunk having multiple terminals for connection and multiple terminals for busy test; a relay (as 37) for causing said busy-test terminals to give a busy test; switching devices (as 30 and 20) for connecting said trunk with a selected line; a relay (as 40) energized incident to the connection of said trunk with a selected line; and a circuit whereby the energization of said latter relay (as 40) will cause the energization of said former relay (as 37), substantially as described.

10. In a call distributing telephone exchange system, the combination of an automatic switch; a trunk having busy-test condition when the trunk is busy differing from its busy test condition when the trunk is non-busy; a testing relay; testing circuits adapted to energize said testing relay upon connection with the non-busy trunk; armature contacts of said testing relay to interrupt the motion of said automatic switch; and armature contacts of said testing relay to continue the energization of said testing

relay independently of said testing circuits, substantially as described.

11. In a call distributing telephone exchange system, the combination of an automatic switch; a trunk having busy-test condition when the trunk is busy differing from its busy-test condition when the trunk is non-busy; a testing relay; testing circuits adapted to energize said testing relay upon connection with the non-busy trunk; armature contacts of said testing relay to interrupt the motion of said automatic switch; armature contacts of said testing relay to continue the energization of said testing relay independently of said testing circuits; and a line relay adapted to deënergize said testing relay, substantially as described.

12. In a call distributing telephone exchange system, the combination of an automatic switch; a trunk having busy-test condition when the trunk is busy differing from its busy-test condition when the trunk is non-busy; a testing relay; testing circuits adapted to energize said testing relay upon connection with the non-busy trunk; armature contacts of said testing relay to interrupt the motion of said automatic switch; armature contacts of said testing relay to continue the energization of said testing relay independently of said testing circuits; a cut-off relay controlled by armature contacts on said testing relay; and a line relay adapted to deënergize said testing relay, substantially as described.

Signed by me at Pittsburg, county of Allegheny, State of Pennsylvania, in the presence of two witnesses.

SIDNEY HAND BROWNE.

Witnesses:
A. H. MORAWECK,
ALICE M. GODFREY.