

March 24, 1925.

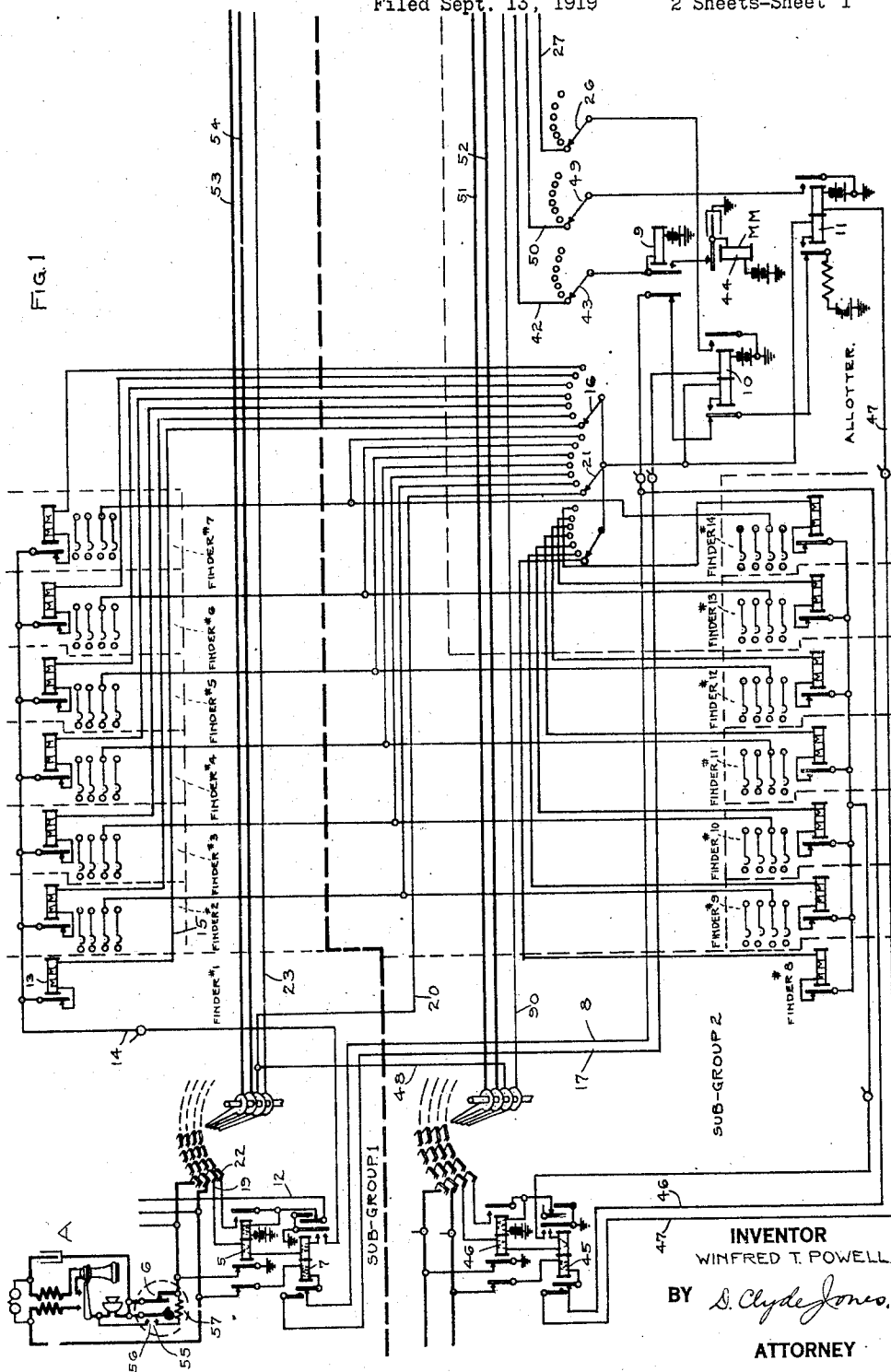
1,531,218

W. T. POWELL

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 13, 1919

2 Sheets-Sheet 1



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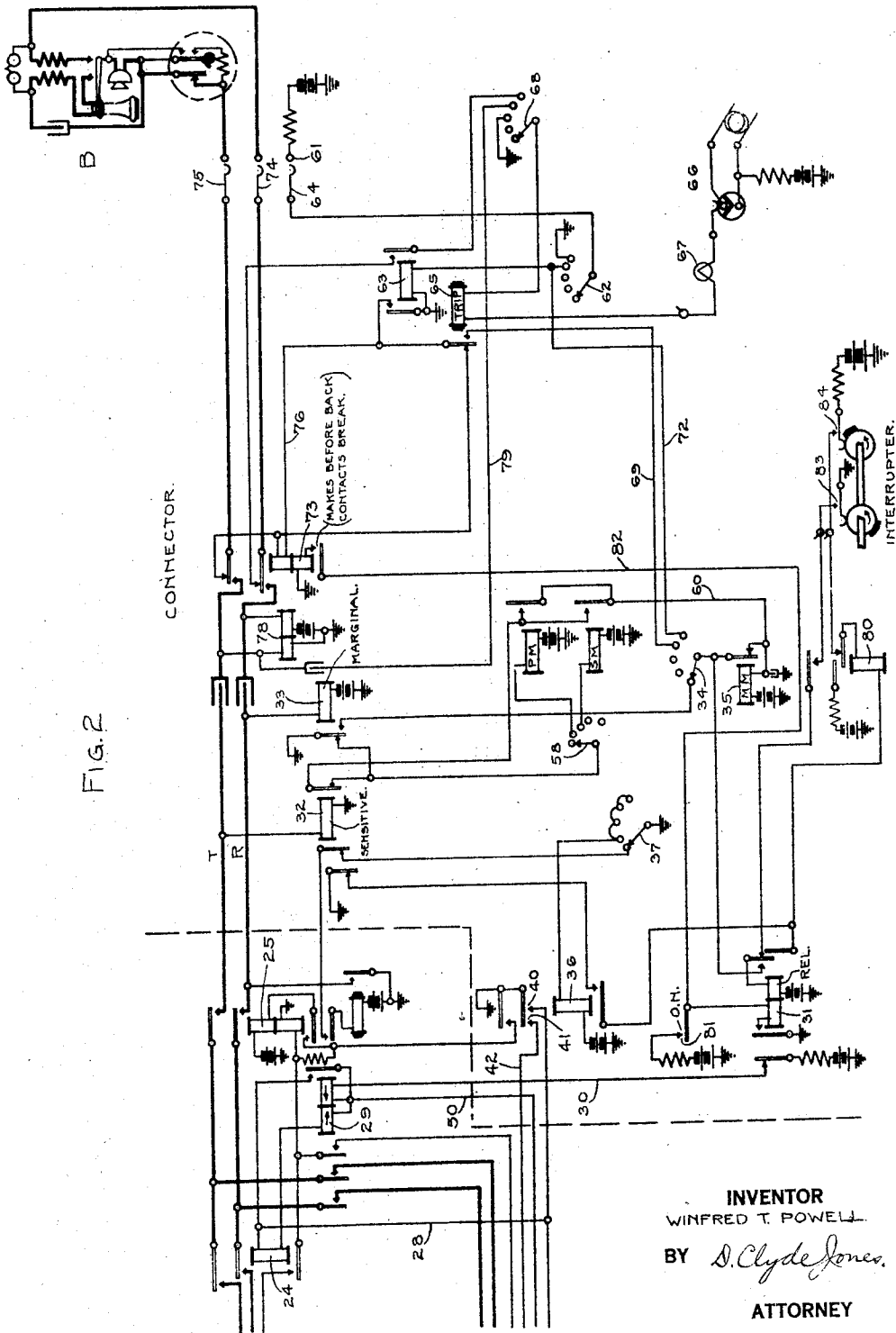
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

Application filed September 13, 1919. Serial No. 323,582.

To all whom it may concern:

Be it known that I, WINFRED T. POWELL, a citizen of the United States, residing at Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone systems, and more particularly to telephone systems employing automatic switches for establishing connections between calling and called lines.

In such systems, especially where line finder switches are employed, it is desirable to have each trunk common to a large number of lines. This arrangement, however, has had this great disadvantage in previous systems, since in order to have a trunk common to a large number of lines, the finder switch individual to this trunk must be of large capacity and therefore the time required in completing a connection from a calling line to a trunk is unduly prolonged.

In accordance with one feature of the present invention it is proposed to use finder switches of relatively small capacity and provide two of these switches for each trunk leading to the first numerical switch in the system. In this arrangement means are provided whereby each group of lines is divided into two sub-groups, the lines of one sub-group appearing at one finder switch, and the lines of the second sub-group appearing only at the second finder switch, and other means are provided for determining which of the finder switches will operate in establishing the call.

In accordance with an additional feature of the present invention, the well known arrangement of fast and slow relays has been replaced by other means for controlling the so-called "change-over" from the primary to the secondary operations of the numerical switches and in the control of the release of said switches.

Other features not specifically enumerated will appear from the detailed description and the claims.

The drawings with Fig. 1 placed at the left of Fig. 2 diagrammatically represent a portion of a telephone system employing the present invention. The portion above the

heavy dotted line of Fig. 1 diagrammatically represents seven finder switches of which the operating circuit of the finder designated #1 is shown completely, for connecting any one of seven idle trunks to any calling line of the sub-group #1 of fifteen lines. The portion of the drawing below the heavy dotted line also represents seven finder switches for connecting any one of the same group of seven trunks to a calling line of the sub-group #2 of fifteen lines. At the lower right hand corner of Fig. 1 there is shown an allotter switch for assigning any one of the seven trunks for use and for performing other functions which will appear from the following description. At the right of the dotted line of Fig. 2 there is shown the operating circuits of a connector switch, while at the left of this dotted line there is shown another part of the equipment for connecting one or the other of the two branches of the trunk to the numerical switch in which it terminates.

The finder switches employed in this system are of the uni-directional rotary type and may be similar in structure to the switch disclosed in the patent to Clement, #1,107,153. It will, however, be understood that the present invention is not limited to a uni-directional or a rotary type of switch, but may employ a switch having group and line selecting movements, such as the well known two movement switch of the vertical and rotary type.

The numerical switches employed in this system may be of a type substantially like that disclosed in the patent to Keith et al, #815,176, patented Mar. 13th, 1906, when modified to operate in a two wire system.

The dial sender or impulse transmitter may be of the usual type, except that its shunting springs and impulse springs are so adjusted that at the time of the opening of the impulse springs on the last impulse of a series the shunting springs will also be opened, the purpose of which will appear from the following description.

In the present invention the telephone lines are divided into groups of thirty lines each for the individual use of which seven trunks are provided. Each trunk terminates at one end in a numerical switch, and at its other end in two finder switches. The lines of a group are arbitrarily divid-

ed into two sub-groups, the lines of one sub-group being multiplied at the contacts of seven finder switches, and the lines of the other sub-group being multiplied at the contacts of the seven other finder switches. In this disclosure fifteen of the lines of the group terminate in sub-group #1, and the other fifteen lines of the group terminate in the sub-group #2. It will be understood, however, that the number of lines in a group as well as the number of trunks serving them, may be increased or diminished in number without departing from the present invention.

It is believed that this invention will best be understood by describing the method of establishing a connection from a calling substation indicated at A, to a called substation indicated at B. Let it be assumed that the calling line belongs to the sub-group #1. When the calling subscriber at A removes his receiver from its switchhook, a circuit is closed from ground, inner armature and back contact of cut-off relay 5, contact 6 of the dial, through the substation circuits, back contact and armature of the cut-off relay, left hand winding of the line relay 7, left hand continuity spring and contact of this relay, conductor 8, outer armature and contact of the relay 9, left hand back contacts and armatures of the relays 10 and 11, and resistance to grounded battery. The line relay 7 attracts its armature, and at its armature and continuity spring applies ground to the test conductor 12 to prevent the calling line being seized as a called line. At the left hand armature and continuity spring of the line relay 7 a substitute circuit for that just described is closed over conductor 17, and right hand winding of relay 10 to grounded battery. At the right hand armature and front contact of relay 7 an operating circuit for the motor magnet 13 of the finder is closed from ground, conductor 14, armature, back contact and winding of the motor magnet 13, conductor 15, brush 16 of the allotter, left hand winding, front contact and armature of relay 10, back contact and armature of relay 11, and through the resistance to grounded battery.

Under the control of the circuit just described, the motor magnet 13 advances the brushes of the finder until its test brush encounters the test contact 19 of the calling line at which time a circuit is closed from ground, inner right hand armature and front contact of the line relay, right hand winding of this relay, left hand winding of the cut-off relay, test contact 19, test brush of the finder, conductor 20, controller brush 21, left hand winding, front contact and armature of relay 10, back contact and armature of relay 11 and resistance to grounded battery, to shunt magnet 13 and stop finder

1 on the calling line. The cut-off relay 5 is energized in this circuit and at its left hand armatures disconnects the line relay from the calling line. As soon as the relay 10 attracts its right hand armature, a circuit is closed from ground, allotter brush 26, conductors 27 and 28, winding of relay 24, through both windings in series of the differential relay 29, conductor 30, left hand back contact and armature of release magnet 31, and resistance to grounded battery. The relay 24 is operated in this circuit, but the differential relay remains inactive as its opposing windings are energized. At its right hand armature and front contact the cut-off relay closes a locking circuit for itself through its right hand winding from grounded battery, holding contact 22 of the calling line, brush of the finder, conductor 23, lower front contact and armature of relay 24, lower winding of relay 25 to ground, energizing relay 25.

As soon as the relays 24 and 25 are energized, the calling line is extended to a sensitive relay 32 and marginal relay 33 of the connector switch. These relays attract their armatures and at the left hand armature and front contact of the relay 33, a circuit is closed from ground, through the controller brush 34, armature, back contact and winding of the motor magnet 35 of the controller, to grounded battery. The motor magnet interrupts its own circuit and advances the brushes of the controller into their second positions. A circuit is thereupon closed for energizing the relay 36, from grounded battery, through controller wiper 37 in its second position to ground. The relay 36 attracts its armature, and at its lower armature closes a break point in the release circuit of the connector switch, and at its uppermost armature and front contact, a circuit is closed through the innermost lower front contact, and winding of relay 25 to grounded battery to maintain this relay energized until disconnection. At its innermost upper armature and contact 40 of relay 36, a circuit is closed from ground over conductor 28, winding of relay 24, through both windings in series of the differential relay 29, conductor 30, back contact and armature of release magnet 31, and resistance to grounded battery. The relay 24 is thereby held energized during conversation to render the talking conductors continuous. At the innermost upper armature and contact 41 of relay 36, ground is applied over conductor 42, allotter brush 43, and winding of relay 9 to grounded battery. The relay 9 is operated in this circuit, and at its outer armature and back contact interrupts the starting circuit of the finder switches of the group to prevent the starting of any finder switch of the group during the operation of the allotter. At the innermost ar-

mature and front contact of the relay 9 a multiple circuit is closed from grounded battery, winding, armature and back contact of the motor magnet 44 of the allotter, front contact and armature of relay 9, to ground through contact 41 at the armature of relay 36. Under the control of this and similar circuits, the motor magnet 44 of the allotter advances its brushes until an idle trunk is found, which condition is indicated by the absence of ground potential on a conductor similar to 42.

Let it be assumed that the call had originated in that group of lines designated sub-group #2. Under this assumption on the initiation of a call, the line relay 45 will be operated in a circuit completed from ground, inner armature and back contact of its cut-off relay 46, through the substation circuits, outer back contact and armature of the cut-off relay, left hand winding, continuity spring and contact of line relay 45, conductor 46, armature and back contact of relay 9, back contacts and armatures of relays 10 and 11, and resistance to grounded battery. The line relay 45 attracts its armatures and closes a substitute locking circuit for itself through its continuity spring and left hand armature, conductor 47, right hand winding of relay 11 to grounded battery. Relay 11 is energized in this circuit and attracts its armatures. At the left hand armature and front contact of relay 11, battery potential is applied through the allotter brush 21, conductors 20 and 48 to the test brush of the allotted finder switch of sub-group #2. The test conductor of the calling line, as in the first case described, is characterized by the presence of ground potential, so that when the calling line is reached, cut-off relay 46 is operated and a locking circuit is closed through conductor 90. As soon as the relay 11 is actuated, a circuit is closed from ground, through its right hand armature and front contact, controller brush 49, conductor 50, right hand winding of the differential relay 29, conductor 30, left hand back contact and armature of release magnet 31, and resistance to grounded battery. Since only one winding of the differential relay 29 is energized, this relay will attract its armatures and the conductors 51 and 52 will be extended to the connector switch. At this time the circuit of switching relay 24 is open, so that the branches 53 and 54 of the trunk are open at this time. In this, as in the previous instance, the extension of the calling line to the connector energizes the sensitive relay 32 and the marginal relay 33, and the operation of this last mentioned relay causes the motor magnet 35 of the controller to move the controller brushes into their second position. In this position the relay 36 is operated for the

purposes previously set forth. Now 24 is short circuited.

The apparatus is now in condition to receive impulses from the impulse transmitter at the calling station. Since the only numerical switch shown is a connector switch, it is necessary for the calling subscriber to transmit only two series of impulses corresponding to the tens and units digit of the wanted number. In operating his impulse transmitter the calling subscriber first causes the shunting spring to engage the contacts 55 and 56, the latter contact engaging the shunting spring to short circuit the transmitter during the transmitting of impulses. In the course of the operation of the impulse transmitter, the contact 6 will disengage its spring a number of times corresponding to the first digit of the wanted number. When the contact 6 disengages its impulse spring, resistance 57 is then included in the signaling circuit extending serially through the sensitive relay 32 and the marginal relay 33. The relay 32 is so designed that it will not release in series with the resistance 57, but the marginal relay 33 is designed to deenergize when in series with the last mentioned resistance. It will therefore be seen that each time that the impulse springs are operated, the resistance 57 is included in the signaling circuit and that the marginal relay 33 deenergizes once for each impulse of the series corresponding to the digit of the wanted number. In response to each operation of the marginal relay 33, a circuit is closed for the primary motor magnet PM of the connector from grounded battery, winding of this magnet, controller wiper 58 in its second position, back contact and armature of relay 33 to ground. In response to each retraction of the armature of the marginal relay 33, the primary motor magnet advances the brushes of the connector one step in its primary or group selecting movement. At the close of the tens series of impulses, the signaling circuit is interrupted since the impulse and shunting springs are so adjusted that they are simultaneously opened at the time that the last impulse is transmitted. At this time both the sensitive relay 32 and the marginal relay 33 are deenergized and a circuit will be closed for the motor magnet 35 of the controller from grounded battery, winding of this magnet, conductor 60, armature and front contact of the primary magnet PM now energized in response to the last impulse of the tens series from the impulse sender, right hand armature and back contact of the sensitive relay 32, back contact and armature of the marginal relay 33 to ground. The motor magnet 35 of the controller is energized in this circuit, and when the impulse transmitter at the calling substation has been

restored to normal, the signaling circuit serially including the relays 32 and 33 is again completed, causing these relays to attract their armatures. The circuit just described for the motor magnet is interrupted and the controller wipers are moved into their third position.

At this time the calling subscriber operates his impulse transmitter to send impulses corresponding to the units digit of the wanted number. The marginal relay 33 again vibrates its armature and thereby closes a circuit from ground, its armature and back contact, controller brush 58 in its third position, winding of the secondary motor magnet SM to grounded battery. Under the control of this circuit the secondary motor magnet advances the brushes of the connector in their line selecting movement. At the close of the units series of impulses, the signaling circuit is again momentarily interrupted so that relays 32 and 33 again simultaneously retract their armatures. The motor magnet 35 of the controller is again operated in a circuit now traced from grounded battery, winding of the motor magnet, conductor 60, armature and front contact of the secondary motor magnet SM, right hand armature and back contact of relay 32, back contact and armature of relay 33 to ground. The signaling circuit is almost immediately completed, so that the relays 32 and 33 again attract their armatures. The circuit just described for the motor magnet 35 of the controller is interrupted and this magnet moves the controller brushes into their fourth or testing position.

If the called line is idle this condition will be indicated by the presence of full battery potential on its test contact 61, so that when the controller brush 62 moves into its fourth position a circuit is closed for the relay 63 from ground, winding of this relay, controller brush 62, connector brush 64, test contact 61, resistance corresponding to the cut-off relay of the wanted line to grounded battery. While the controller wipers were in position three, the marginal slow-releasing trip relay 65 was energized over a circuit traceable from grounded battery, through the ringing machine generally designated 66, lamp 67, winding of the trip relay 65, controller wiper 68 in its third position to ground. The trip relay 65 is energized, and since it was slow to release it holds its armatures attracted even after the controller wipers have moved into position four. With the relays 63 and 65 thus operated, a circuit is closed from ground, left hand armature and front contact of relay 63, armature and front contact of relay 65, conductor 69, controller wiper 34, armature, back contact and winding of the motor magnet 35 of the controller to grounded battery.

Shortly after the motor magnet 35 is energized, the trip relay 65 retracts its armature, interrupting the operating circuit of the motor magnet 35 and causing it to move the controller wipers into their fifth or ringing and talking positions. The relay 63 is now maintained energized in a circuit extending from ground, winding of this relay, conductor 72, controller wiper 34, armature, back contact and winding of the motor magnet 35 to grounded battery. It should here be stated that the wipers 34 and 62 of the controller are so adjusted that wiper 34 engages its fifth contact shortly before the wiper 62 disengages its fourth contact thus insuring that the relay 63 will be maintained energized in positions 4 and 5 of the controller wipers.

In position 5 of the controller ringing current is transmitted to the called substation over a circuit traced from grounded battery, resistance, through the ringing machine 66, lamp 67, ringing trip relay 65, controller wiper 68, right hand armature and front contact of relay 63, inner-most back contact and armature of relay 73, connector brush 74, through the called substation circuits and bell, connector brush 75, upper-most armature and back contact of relay 73, back contact and armature of trip relay 65, front contact and armature of relay 63 to ground. When the called party at substation B responds by removing his receiver from its switchhook, the trip relay 65 is energized and removes the short circuit which existed about the upper winding of the switching relay 73. This switching relay 73 is thereupon actuated in a circuit similar to the ringing circuit, except that the upper winding of the relay 73 is included and the circuit is completed over conductor 76 to ground at the front contact and armature of relay 63. Relay 73 when operated locks itself energized in a circuit including its lower winding, conductor 82 and off normal spring, and contact 81 to grounded battery.

Talking battery is supplied to the calling party through the windings of the relays 32 and 33, and to the called party through the windings of the impedance coil 78.

Let it be assumed that the called party is busy when the test brush 64 of the connector engages its test terminal 61. In this event, its terminal 61 will be characterized by reduced battery potential, so that the relay 63 will not be energized even when the controller wiper 62 is in position four. The busy signal is then transmitted to the calling subscriber from the ringing machine 66, lamp 67, ringing trip relay 65, side switch wiper 68 in its fourth position, conductor 79, through the condenser and thence to the calling substation.

The release of the connector switch is controlled in part by a constantly operating interrupter shown at the bottom of Fig. 2. This interrupting device may be of any form in which the contacts 83 and 84 engage their springs at predetermined time intervals. As shown this device consists of a shaft mounted for continuous rotation at constant speed which has secured to it two cam disks so disposed that a circuit will not be closed through contact 83 and its spring until a predetermined interval after contact 84 engaged its spring.

When the calling subscriber restores his receiver to its switchhook, the relay 32 de-energizes and closes a circuit from ground, through its outer left hand armature and contact, lower front contact and armature of relay 36, winding of relay 80, its continuity spring and contact, and contact 84 and its spring, and resistance to grounded battery. Relay 80 is energized in this circuit and attracts its armatures. At its inner armature and continuity spring it closes a locking circuit for itself from grounded battery to ground at the outer left hand armature of relay 32 over the remainder of the circuit previously described. It should here be noted that the relay 32 deenergizes momentarily at the conclusion of each series of impulses, but that it almost immediately is again energized so that if relay 80 is energized at this time, this interval will not be long enough for the circuit of the release magnet 31 to be closed at interrupter 83. However, at the termination of the call, relay 32 will be deenergized for a relatively long time after the relay 80 has been energized, so that contact 83 will engage its spring and close a circuit from ground, through the upper front contact and armature of relay 80, contact and continuity spring and right hand winding of the release magnet 31 to grounded battery. The release magnet 31 is thus energized and closes a locking circuit from ground, its inner left hand armature, front contact and winding, off normal spring and contact 81, resistance to grounded battery. At the outer left hand armature and back contact of release magnet 31, the conductor 30 is interrupted to prevent the closure of trunk conductors 51 and 52 or 53 and 54 to the connector during the release of this switch. At the right hand armature and front contact of the release magnet also a circuit is closed from ground, left hand armature and back contact of relay 32, lower front contact and armature of relay 36, right hand armature and front contact of release magnet 31, armature, back contact and winding of the motor magnet 35 of the controller to grounded battery. Under the control of this circuit, the motor magnet restores its wipers to normal posi-

tion permitting the relay 36 to deenergize, and this relay in turn removes the guarding potential from the trunk used and releases relays 24 and 25. When relay 24 deenergizes, the holding conductor 23 is opened causing the cut-off relay 5 to reconnect the line relay 7 to its telephone line.

It will be understood that although only a connector switch has been disclosed, in a larger system one or more selector switches operating in a manner similar to the connector switch herein shown, will be used in establishing connections.

What I claim is:

1. In a telephone system, telephone lines, trunk lines for extending said telephone lines, each trunk terminating at one end in a numerical switch, and at its other end in two mechanically independent non-numerical switches, a single allotter for said trunk lines for assigning the same for use and means for determining which of said non-numerical switches will connect said trunk line to a calling telephone line.
2. In a telephone system, groups of telephone lines, a plurality of trunks individual to each group of telephone lines, a single allotter assigning trunks for use, each of said trunks terminating in two mechanically independent non-numerical switches, and means for determining which of said non-numerical switches, will connect a calling line to an assigned trunk.
3. In a telephone system, groups of telephone lines, a plurality of trunks individual to each group of telephone lines, a single allotter for assigning the trunks of a group for use in succession, each of said trunks terminating in two mechanically independent non-numerical switches, and means for determining which of said non-numerical switches will connect a calling line to an assigned trunk.
4. In a telephone system groups of telephone lines, a plurality of trunks individual to each group of telephone lines, a single progressively movable allotter for assigning the trunks of a group in succession, each of said trunks terminating in two mechanically independent non-numerical switches, and means for determining which of said non-numerical switches will connect a calling line to an assigned trunk.
5. In a telephone system, groups of lines divided into sub-groups, trunks individual to each group of lines, each trunk having a branch individual to each sub-group of lines, a separate automatic switch for each branch, a single allotter individual to each group of trunks for assigning the same for use and means controlled by the sub-group in which a calling line is located for extending one of said branches of a trunk to a calling line and for rendering the other branches of said trunk ineffective.

6. In a telephone system, a plurality of groups of lines, each divided into sub-groups, a group of trunks individual to each group of telephone lines, each trunk having a plurality of branches, each branch being individual to each sub-group of lines, a separate automatic switch for each branch, a single allotter for assigning the trunks of a group for use, and means controlled by the sub-group in which a calling line is located for extending one of the branches of an assigned trunk to the calling line, and for rendering the other branches of said trunk ineffective.
7. In a telephone system, a group of telephone lines divided into sub-groups, a trunk line individual to said group of lines, said trunk having a branch individual to each sub-group of lines, mechanically independent switches in which said branches terminate, a switching relay controlling a break point in each branch of said trunk, means controlled by the initiation of a call in one of said sub-groups for extending a calling telephone line to one of the branches of said trunk and for operating the switching relay of the connected branch.
8. In a telephone system, a group of telephone lines divided into sub-groups, a trunk individual to said group of lines, said trunk having a branch individual to each sub-group of lines, mechanically independent switches in which said branches terminate, a differential relay for rendering continuous one or another of said branches, and means controlled by the initiation of a call on one of said telephone lines for extending said line to said trunk by way of one of said branches and for controlling the operation of said differential relay.
9. In a telephone system, an incoming line, a plurality of outgoing lines, an automatic switch operating through group and line selecting movements for selecting a desired outgoing line, a controlling circuit for said automatic switch serially including two sides of the incoming line in series, means whereby said automatic switch is adjusted in response to current variations in said controlling circuit while said circuit is closed, means controlled by the opening of said controlling circuit for causing said automatic switch to change from its group to its line selecting movement and a mechanical timing device common to a plurality of switches for controlling the release of said automatic switch.
10. In a telephone system, an incoming line, a plurality of outgoing lines, an automatic switch operating through group and line selecting movements to extend said incoming line to a desired outgoing line, a controlling circuit for said automatic switch serially including two sides of said incoming line in series, two relays which are unequally sensitive including in said controlling circuit, means for causing current variations in said controlling circuit while it is continuous whereby one of said relays causes said automatic switch to be moved through its group and line selecting movements, means for interrupting said controlling circuit to govern the other relay, means controlled thereby for causing said automatic switch to change from its group to its line selecting movement, releasing mechanism for said switch, and timing mechanism common to a plurality of lines, cooperating with said last mentioned relay to operate said releasing mechanism.
11. In a telephone system, incoming circuits, an outgoing circuit having branches, a separate non-numerical switch having no fixed normal position individual to each one of said branches, and means for operating one or the other of said switches to extend said outgoing circuits to one of said incoming circuits.
12. In a telephone system, incoming circuits, a plurality of outgoing circuits, an allotter for assigning an outgoing circuit for use, each of said outgoing circuits having branches each of which is provided with a non-numerical switch having no fixed normal position, and means for operating one or the other of said non-numerical switches of an allotted outgoing circuit for extending the same to one of said incoming circuits.
13. In a telephone system, incoming circuits, a plurality of outgoing circuits, a rotary allotter for assigning an outgoing circuit for use, each of said outgoing circuits having branches each of which is provided with a non-numerical switch having no fixed normal position, and means for operating one or the other of said non-numerical switches of an allotted outgoing circuit for extending the same to one of said incoming circuits.
14. In a telephone system, a plurality of automatic switches, each automatic switch having sets of terminals arranged in a semi-circular terminal bank and a set of brushes for engagement with said set of terminals; means including a motor magnet for advancing a set of said brushes progressively over its associated terminal bank; a plurality of telephone lines terminating in said terminals; a trunk circuit terminating in each set of switch brushes, means for allotting an idle trunk for use; a cut-off relay individual to each telephone line; said cut-off relay being provided with two sets of springs arranged to be closed on its deenergization; a conductor for connecting each cut-off relay to the multiple terminals individual to its telephone line appearing at said automatic switches; a line relay for each telephone line provided with a set of springs arranged to be closed on its opera-

tion; a circuit for said line relay extending through its winding, through the two sets of springs of the cut-off relay and both sides of the calling telephone line in series; a circuit for the motor magnet of the switch associated with the allotted trunk, said circuit extending through a set of springs of the line relay, through the winding of said motor magnet and through said allotting means; a stopping circuit in shunt of the operating circuit of the motor magnet extending through a brush of the allotted switch, a terminal of the calling line and through the operated springs of said line relay, said last described circuit functioning to stop the operation of the motor magnet; and means responsive to the location of the calling line

for maintaining the cut-off relay operated.

15. In a telephone system, a group of telephone lines divided into sub-groups, trunk lines individual to said group of lines, each trunk having a branch individual to each sub-group of lines, mechanically independent hunting switches in which each of said branches terminates, means controlled by the initiation of a call in one of said sub-groups for causing the switch of one of said branches to hunt for the calling line and means for preventing more than one switch hunting in a group at any one time.

In witness whereof, I hereunto subscribe my name this 12th day of September A. D. 1919.

WINFRED T. POWELL.