Nov. 10, 1925. 1,560,725

W. T. POWELL

AUTOMATIC TELEPHONE SYSTEM

Filed Jan. 25, 1922 2 Sheets-Sheet 1

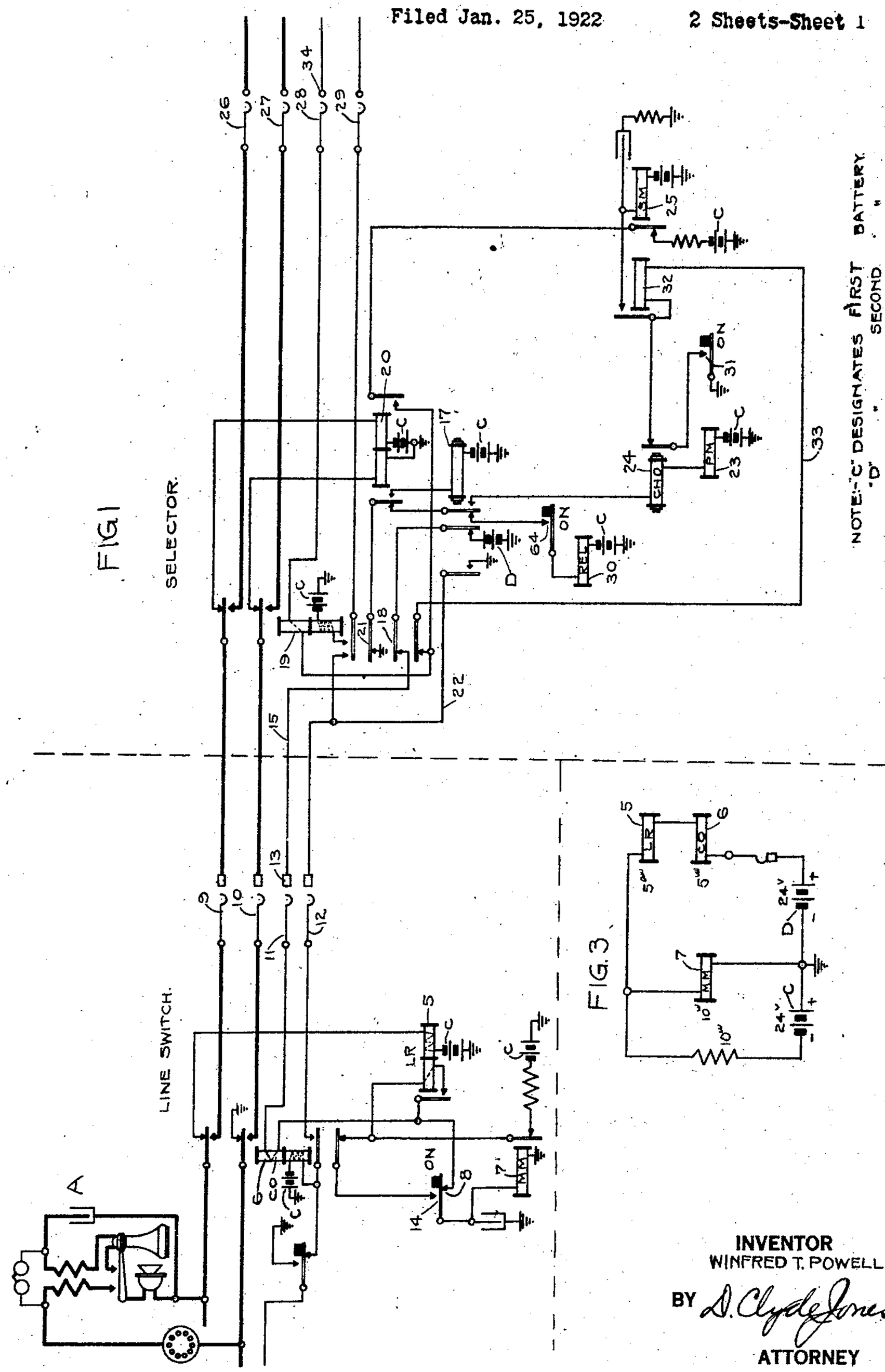

FIG 1

FIG. 3.

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2 Sheets-Sheet 2

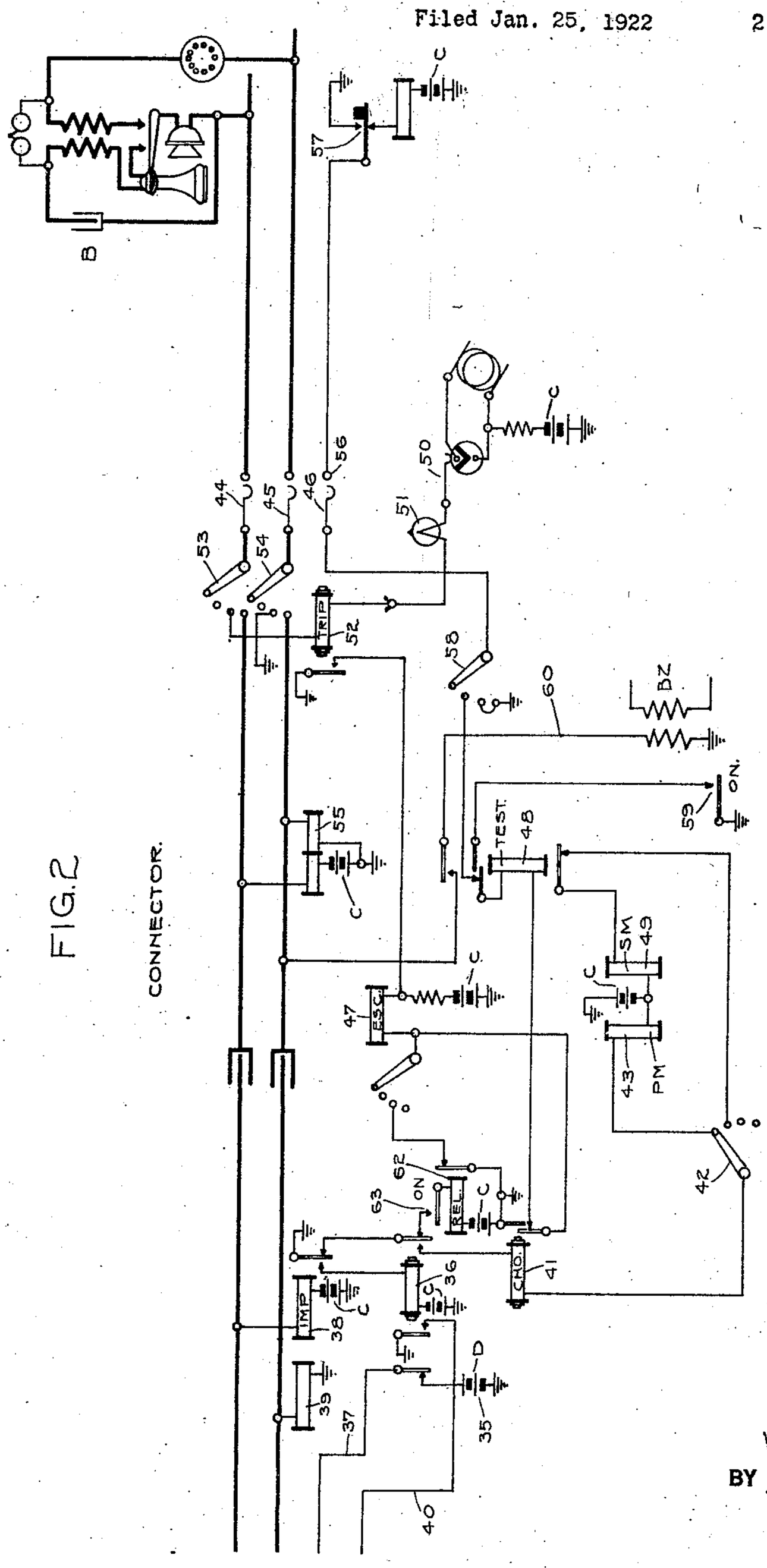

FIG.2

CONNECTOR.

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UNITED STATES PATENT OFFICE.

WINFRED T. POWELL, OF ROCHESTER, NEW YORK, ASSIGNOR TO THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

AUTOMATIC TELEPHONE SYSTEM.

Application filed January 25, 1922. Serial No. 531,571.

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 in completing a telephone connection.

In automatic telephone systems it is necessary that reliable means be provided for causing the trunk hunting switches thereof to pass over busy trunks but to seize idle trunks and guard them against intrusion all of which must be done in a rapid and reliable manner.

The main feature of this invention is the arrangement of circuits by which trunk hunting switches may test and seize idle trunks with rapidity and accuracy.

The drawings with Fig. 2 placed at the right of Fig. 1 diagrammatically represent a portion of a telephone system including the present invention. At the upper left hand corner of Fig. 1 there is represented a calling line and the circuits of a trunk hunting switch individual to this line while at the right of the dotted line there are represented the operating circuits of a selector switch incorporating the present invention. Fig. 2 diagrammatically represents the operating circuits of a connector switch and a called telephone line. Fig. 3 is a theoretical showing of the testing circuits of the line switch of Fig. 1 at the time when the idle trunk is being tested. The mechanical structure of the line switch may be substantially similar to that disclosed in the patent to Clement #1,107,153 issued August 11, 1914, while the connector and selector switches may be of the structure substantially similar to that disclosed in the patent to Keith, Erickson and Erickson #815,321 and #815,176 both issued March 13, 1906.

After this brief description of the invention and of the mechanical structure of the switches it is believed that the invention will best be understood by describing the method of establishing a telephone connection from a calling substation indicated at A to a called substation indicated at B. When the subscriber at A removes his receiver from its switch hook the line relay 5 will be energized in a circuit completed from grounded battery, right hand winding of this relay, uppermost back contact and armature of the cut-off relay 6, over the upper side of the calling line and through substation circuits in series, over the lower side of the calling line, innermost upper armature and back contact of the cut-off relay to ground. The line relay is energized in this circuit and immediately closes a circuit for operating the motor magnet 7, extending from ground, winding of the motor magnet, normally closed off-normal contacts 8, armature, front contact and left hand winding of relay 5, armature and back contact of the magnet 7, resistance to grounded battery. The motor magnet 7 is operated in this circuit and advances the line switch brushes 9, 10, 11 and 12 one step from their normal position into engagement with the terminals of the first trunk circuit appearing in this switch. Let it be assumed that this trunk circuit is busy at this time, a condition which is indicated by the absence of potential on the test terminal 13 of this trunk. As soon as the line switch is thus advanced, the normally open off-normal contacts 14 will be closed and the motor magnet 7 will now be operated in a circuit traceable from ground, its winding, contacts 14, armature and back contact of cut-off relay 6, armature and back contact of magnet 7, resistance, to grounded battery. Under the control of this circuit the motor magnet 7 continues to advance the brushes 9, 10, 11 and 12 of the line switch until the test brush 11 encounters a test terminal such as 13 of an idle trunk which is characterized by the presence of potential. This potential on test terminal 13 is applied from the second battery D which is distinct from the other operating battery diagrammatically represented and designated C at several places in Figs. 1 and 2. The batteries C and D are of the same voltage and each has a positive pole and a negative pole connected to ground as shown in Fig. 3. When this idle trunk is reached, a circuit is closed from the second battery D, middle contact and armature of relay 17, armature 18 and back contact of relay 19, conductor 15, test ter-

minal 13, test brush 11, upper winding of the cut-off relay 6, armature, front contact and winding of relay 5, armature and back contact of magnet 7, resistance to grounded battery. By reference to Fig. 3 it will be noted that the motor magnet 7 will be deprived of operating current since it will be in the neutral wire of an arrangement which is analogous to the Edison three-wire system of current transmission. The cut-off relay is energized in the circuit just described and immediately attracts its armatures to disconnect the line relay 5 from the control of the calling line and to extend this line through its upper armatures and front contacts to the line switch brushes 9 and 10. At the lowermost armature of this relay, the operating circuit of the motor magnet 7 is opened. As soon as the calling line is extended to the line switch brushes in the manner described, the impulse relay 20 of the selector switch is energized in a circuit traceable from grounded battery, right hand winding of this relay, uppermost back contact and armature of relay 19, through line switch brush 9, front contact and armature of relay 6, over the upper side of the calling line and substation circuits in series, over the lower side of the calling line, armature and front contact of relay 6, brush 10, inner upper armature and back contact of relay 19, left hand winding of relay 20 to ground. The impulse relay is energized in this circuit and completes an operating circuit for the slow releasing relay 17 from grounded battery winding of this relay, left hand front contact and armature of relay 20, armature 21 and back contact of relay 19 to ground. As soon as relay 17 is operated it closes a locking circuit for the cut-off relay 6 extending from grounded battery, lower winding, armature and front contact of relay 6, holding brush 12, conductor 22, outer armature and contact of relay 17 to ground.

The apparatus and the circuits are now in condition to receive the series of impulses corresponding to the first digit of the wanted number. In response to each of these impulses the impulse relay 20 vibrates its armatures and thereby completes an operating circuit for the primary motor magnet 23, from grounded battery, winding of this magnet, change over relay 24 innermost contact and armature of relay 17, back contact and armature of impulse relay 20, armature 21 and contact of relay 19 to ground. When this circuit is first completed the change-over relay 24 is operated and holds its armature attracted during the remainder of the series of impulses to open the operating circuit of the secondary magnet 25. In response to each closure of the operating circuit of the primary magnet it advances the selector brushes 26, 27, 28 and 29 one step in their primary direction. It should be noted at this time that the operating circuit of the release magnet 30 is held open at the innermost back contact and armature of relay 17 to prevent the release of the selector switch.

At the close of the first series of impulses, the impulse relay 20 will hold its armatures attracted for a relatively long period, with the result that the operating circuit for the change-over relay 24 will be interrupted and this slow releasing relay will eventually retract its armature, at which time a circuit is closed from ground, off-normal contacts 31 (now closed), armature and back contact of the change-over relay 24, winding of the interrupter relay 32, conductor 33, lowermost armature and back contact of relay 19, right hand contact and armature of relay 20, armature and back contact of the secondary motor magnet 25, resistance, to grounded battery. Relay 32 is energized in this circuit, and closes an energizing circuit for the secondary motor magnet 25 from grounded battery winding of this magnet, front contact and armature of relay 32, back contact and armature of relay 24, off normal contacts 31 to ground. Under the control of this circuit the secondary motor magnet 25 advances the selector switch brushes one step in their secondary direction into engagement with the first trunk circuit of the selected group of trunks. It will be noted that secondary magnet 25 on energization opens the operating circuit of the relay 32 which immediately deenergizes to interrupt the operating circuit of the secondary motor magnet 25.

Let it be assumed that the first trunk of the selected group is busy at the time when test brush 28 engages its test terminal similar to 34. Such busy condition is indicated by the absence of potential on its test terminal. The relay 32 will then be again energized in its operating circuit already described and when it attracts its armature, it will complete an actuating circuit for the secondary motor magnet 25 in the manner already described, which will advance the selector switch brushes into engagement with the second trunk of the selected group of trunks.

Let it be assumed that the first idle trunk tested by the test brush 28 is the trunk appearing in Figs. 1 and 2. When this trunk is tested it will be characterized by the presence of battery potential thereon applied from the positive pole of the secondary battery 35, outer back contact and armature of relay 36, conductor 37, terminal 34, test brush 28, upper winding of relay 19, right hand contact and armature of relay 20, armature and back contact of the secondary motor magnet 25 to the negative pole of the first battery to ground. It will thus be

seen that the interrupter relay 32 is in the neutral wire of the circuit arrangement analogous to that schematically shown in Fig. 3. The relay 32 does not receive sufficient current to energize and holds open the operating circuit of the secondary motor magnet. The relay 19 will be energized in the circuit already described and at its upper armature and back contacts removes the windings of the impulse relay 20 from the control of the calling line. At the uppermost armature and front contacts of relay 19 the calling line is extended through the selector brushes 26 and 27 and over the two sides of the selected trunk, through the winding of impulse relay 38 to grounded battery and through the winding of the impedance coil 39 to ground. Under the control of this circuit the relay 38 is energized to close a circuit which operates the slow releasing relay 36. This last mentioned relay when operated closes a holding circuit for relay 19 which circuit is traceable from ground, armature and front contact of relay 36, conductor 40, holding brush 29, innermost lower armature, front contact and winding of relay 19 to grounded battery.

The connector switch circuits are now in condition to receive the first series of impulses coresponding to the tens digit of the wanted number, in response to each of these impulses the impulse relay 38 vibrates its armature. At each retraction of its armature a circuit is closed from ground, armature and back contact of the impulse relay, armature and front contact of relay 36, winding of the change-over relay 41, side-switch wiper 42 in its first position, winding of the primary motor magnet 43 to grounded battery. The magnet 43 is energized in this circuit and advances the connector switch brushes 44, 45 and 46 one step in their primary direction to select the group of lines including the wanted line. On the energization of the change-over relay 41, the escape magnet 47 is operated but at the close of this series of impulses the impulse relay 38 will hold its armature attracted for a relatively long interval which will cause the change-over relay 41 to deenergize and thereby open the operating circuit of the escape magnet 47. This magnet thereupon deenergizes and advances the idle switch wipers into their second position.

The subscriber at A thereupon operates his dial sender to transmit a series of impulses corresponding to the units digit of the wanted number. In response to each of these units impulses, the impulse relay 38 again vibrates its armature and on each retraction thereof completes a circuit from ground, armature and back contact of relay 38, armature and front contact of relay 36, winding of the change-over relay 41, side switch wiper 42 in its second position, lower contact and armature of test relay 48, winding of the secondary motor magnet 49 to grounded battery.

The change-over relay 41 is energized in this circuit and remains energized during the units series of impulses. On the energization of this relay the escape magnet 47 is again operated in a circuit extending from grounded battery, resistance, winding of this magnet, continuity spring and armature of relay 41 to ground. In response to each impulse the circuit just described for the secondary motor magnet 49 is completed and it advances the connector switch brushes step by step over the terminals of the lines of the selected group until the terminals of the wanted line are reached. On the completion of this series of impulses, the change-over relay 41 deenergizes in the manner already described, and if the wanted line is idle the escape magnet 47 will deenergize and advance the side switch wipers into their third position.

At this time ringing current is applied to the called line through the ringing machine, generally designated 50, resistance lamp 51, trip magnet 52, side switch wiper 53, connector brush 44, upper side of the called line and called substation circuits, through the lower side of the called line, connector brush 45 and the side switch wiper 54 in its third position to ground. Ringing current is applied over this circuit until the called party responds, whereupon the trip relay 52 receives sufficient current to be energized and attracts its armature, this shunts the escape magnet 47 to effect its deenergization and the consequent advance of the side switch wipers into their fourth or talking position.

Talking current for the calling party is supplied through the windings of the impedance coil 39, and winding of the impulse relay 38, while talking battery is applied to the called substation through the windings of the impedance coil 55.

If the called line is busy at the time when the test brush 46 engages its test terminal 56, this terminal will be characterized by ground potential applied through the off-normal contacts 57 of the line switch individual to the called line. It will be recalled that the test of the called line is made when the side switch wipers are in their second position, so that when the change-over relay 41 deenergizes, the escape magnet 47 is held operated in a circuit traceable from grounded battery, resistance, winding of this magnet, continuity spring and back contact of relay 41, winding of the relay 48, its continuity spring and back contact, side switch wiper 58 in its second position, test brush 46 and test terminal 56 to ground over the remainder of the circuit already described if the wanted line has originated a

call or through a multiple terminal of 56, a connector brush similar to 46, side switch wiper 58, at the connector that has already seized the wanted line.

The escape magnet 47 is held operated in this circuit and the test relay 48 is operated in series therewith to close a locking circuit including a portion of the circuit already described, winding of this relay, its continuity spring and inner armature, off-normal contacts 59 to ground. The escape magnet 47 is thus held energized to maintain the side switch wipers in their second position to prevent the signaling of the busy called line. The test relay 48 is also held operated until the connection is released and applies a source of busy current from the source B Z over the conductor 60, armature and front contact of the test relay 48 to the calling line to inform the subscriber thereat that the called line cannot be seized.

The release of the connection is effected by the restoration of the receiver to the switch hook of the calling station. This interrupts the energizing circuit of the impulse relay 38, which deenergizes and shortly afterwards causes the slow releasing relay 36 to retract its armatures. The connector switch will thus be released due to the energization of the release magnet 62 in a circuit closed from grounded battery, winding of this magnet, off-normal contacts 63, back contacts and armatures of relays 36 and 38 to ground. Also when relay 36 deenergizes it opens the holding circuit for the relay 19 which it has completed over conductor 40, relay 19, therefore, deenergizes and closes an operating circuit for the release magnet 30 of the selector from grounded battery, winding of this magnet, off normal contacts 64, innermost back contact and armature of relay 17, back contact and armature of relay 20, armature 21 and back contact of relay 19 to ground. The release magnet 30 is operated in this circuit and effects the release of the selector switch in the well known manner. Also when relay 36 of Fig. 2 deenergizes it effects the release of the line switch, since the cut off relay 6 of this switch has been held operated in a circuit in multiple with that of the relay 19. Cut-off relay 6, therefore, deenergizes and the motor magnet 7 of the line switch operates to advance the brushes of the line switch until they reach their normal position. The operating circuit of the motor magnet 7 may be described as extending from ground, winding of this magnet, off-normal contacts 14, lowermost armature and back contact of relay 6, armature and back contact of magnet 7, resistance, to grounded battery. It will thus be seen that the motor magnet 7 has a self interrupting operating circuit which is intermittently completed until the line switch is in its normal position, at which time the off-normal contacts 14 will be open and the contacts 8 will be closed. The apparatus and circuits are now in condition to complete a second connection.

What is claimed is:—

1. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch for extending said incoming circuit to any of said outgoing circuits, a motor magnet for operating said automatic switch, a plurality of separate batteries with connections therefor, means including said motor magnet, one of said batteries and one of said connections for operating said automatic switch, and means including both of said batteries and their connections for disabling said motor magnet.

2. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch for extending said incoming circuit to any of said outgoing circuits, a motor magnet for said switch, means including one battery for operating said motor magnet, and means including a second battery co-operating with said first battery to disable said motor magnet.

3. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch for extending said incoming circuit to any of said outgoing circuits, a motor magnet for operating said automatic switch, means including one battery and a circuit for operating said motor magnet, a relay controlled over the two sides of said incoming circuit in series to complete the mentioned operating circuit of said motor magnet, and a second battery arranged to be connected in series with said first battery for disabling said motor magnet.

4. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch for extending said incoming circuit to any of said outgoing circuits, a motor magnet for advancing said automatic switch, means including a circuit and one battery for operating said motor magnet and means including a second battery and a conductor connected to said first circuit for stopping said motor magnet with its automatic switch in engagement with a desired outgoing circuit.

5. In an automatic telephone system, an incoming line, a plurality of outgoing lines, an automatic switch for interconnecting said incoming line with any of said outgoing lines, a motor magnet for advancing said switch, a circuit for said motor magnet, a line relay operated over said incoming circuit to complete an operating circuit for said motor magnet, a second battery distinct from the first, and a cut-off relay initially energized from said batteries in series for disabling said line relay.

6. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch for interconnecting said incoming circuit with any of said outgoing circuits, a motor magnet for advancing said switch, means including a circuit and a first battery for operating said motor magnet to advance said switch, a second battery, a cut-off relay for controlling the disabling of said motor magnet, and an initial operating circuit for said cut-off relay serially including said first and second batteries.

7. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch connecting said incoming circuit with any of said outgoing circuits, a motor magnet for advancing said automatic switch, means including a first battery and a circuit for operating said motor magnet to advance said switch, a second battery, a cut-off relay for discontinuing the operation of the motor magnet when a certain outgoing circuit is seized by said switch, an operating circuit for said cut-off relay serially including said first and second batteries, and a holding circuit for said cut-off relay.

8. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch for interconnecting said incoming circuit with any of said outgoing circuits, a motor magnet for advancing said automatic switch, means including a first battery and a circuit for operating said motor magnet to advance said switch, a second battery, a cut-off relay for discontinuing the operation of the motor magnet when a certain outgoing circuit is seized by said switch, an operating circuit for said cut-off relay serially including said first and second batteries, and a holding circuit for said cut-off relay including only one battery.

9. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch for interconnecting said incoming circuit with any of said outgoing circuits, a motor magnet for advancing said switch to any outgoing circuit, a first battery, means including a circuit and the first battery for operating said motor magnet, a line relay energized over said incoming circuit for completing said operating circuit, a cut off relay for deenergizing said line relay, and means including a second battery for effecting the operation of said cut-off relay.

10. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch for interconnecting said incoming circuit with any of said outgoing circuits, a motor magnet for advancing said switch to any outgoing circuit, a first battery, means including a circuit and the first battery for operating said motor magnet, a line relay energized over said incoming circuit for completing said operating circuit, a cut-off relay for deenergizing said line relay, means including a second battery for effecting the operation of said cut-off relay, and a holding circuit for said cut-off relay including only one battery.

11. In an automatic telephone system, an incoming circuit, a plurality of trunks, an automatic switch for extending said incoming circuit to idle trunks, a motor magnet for causing said automatic switch to hunt for idle trunks, means including a circuit and a first battery for operating said motor magnet, means including a second battery for characterizing the trunks as idle, and testing means operated from the second battery associated with an idle trunk and in series with said first battery for disabling said motor magnet and for stopping said automatic switch in engagement with an idle trunk.

12. In an automatic telephone system, an incoming circuit, a trunk hunting switch individual to said incoming circuit, a group of trunks terminating in said trunk hunting switch, means including a first battery and a motor magnet for advancing the automatic switch, means including a second battery for characterizing trunks as idle, testing means successively connected to said trunks in the operation of said trunk hunting switch, said testing means being effective on the testing of an idle trunk to discontinue the operation of said motor magnet, a secondary trunk hunting switch for each of said trunks, secondary trunks terminating in said secondary trunk hunting switches, means for operating each secondary switch including a secondary motor magnet and said first battery, and means for stopping each secondary switch in engagement with an idle secondary trunk, said last mentioned means including said first and second batteries.

13. In an automatic telephone system, an incoming circuit, a trunk hunting switch individual to said incoming circuit, a group of trunks terminating in said trunk hunting switch, means including a first battery and a motor magnet for advancing the automatic switch, means including a second battery for characterizing trunks as idle, testing means successively connected to said trunks in the operation of said trunk hunting switch, said testing means being effective on the testing of an idle trunk to discontinue the operation of said motor magnet, a secondary trunk hunting switch for each trunk, secondary trunks terminating in said secondary trunk hunting switches, means for operating each secondary switch including a secondary motor magnet and said first battery, and secondary means for

stopping each secondary switch in engagement with an idle secondary trunk, said last mentioned means serially including said first and second batteries.

14. In an automatic telephone system, an incoming circuit, a primary trunk hunting switch individual to said incoming circuit, primary trunks terminating in said primary switch, a motor magnet for advancing said primary switch over said trunks, means including a circuit and a first battery for operating said motor magnet, a second battery for characterizing trunks as idle, testing means responsive to the location of an idle trunk by said switch for disabling said motor magnet and for seizing said idle trunks, a secondary trunk hunting switch for each primary trunk, secondary trunks terminating in each secondary switch, means controlled over said incoming circuit and a selected trunk for directively operating its secondary switch, means including a secondary motor magnet for automatically operating said secondary switch to seize an idle trunk, operating means for said secondary motor magnet, including said first battery, and means including said first and second batteries for causing said secondary switch to seize an idle secondary trunk.

15. In an automatic telephone system, an incoming line, a plurality of outgoing lines, an automatic switch for interconnecting said incoming line with any of said outgoing lines, mechanism for controlling the advance of said switch, a first battery and a second battery, a circuit independent of said second battery but including said first battery and said mechanism for operating the same, and means including a second battery connection to said first circuit about said mechanism to stop the advance of said switch.

16. In an automatic telephone system, an incoming line, a plurality of outgoing lines, an automatic switch for interconnecting said incoming line with any of said outgoing lines, mechanism for controlling the advance of said switch, a circuit including a resistance and said mechanism for operating said mechanism, a line relay and a cut-off relay for said incoming line, said line relay functioning to close said circuit initially, and means including a second battery, a winding of said line relay and a winding of said cut-off relay connected to first circuit about said mechanism to stop said switch, the value of said first mentioned resistance being substantially equal to the combined resistance value of said line and cut-off relays.

In witness whereof, I hereunto subscribe my name this 20th day of January A. D. 1922.

WINFRED T. POWELL.