Nov. 11, 1924. 1,515,361

W. T. POWELL

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 6, 1919 4 Sheets-Sheet 1

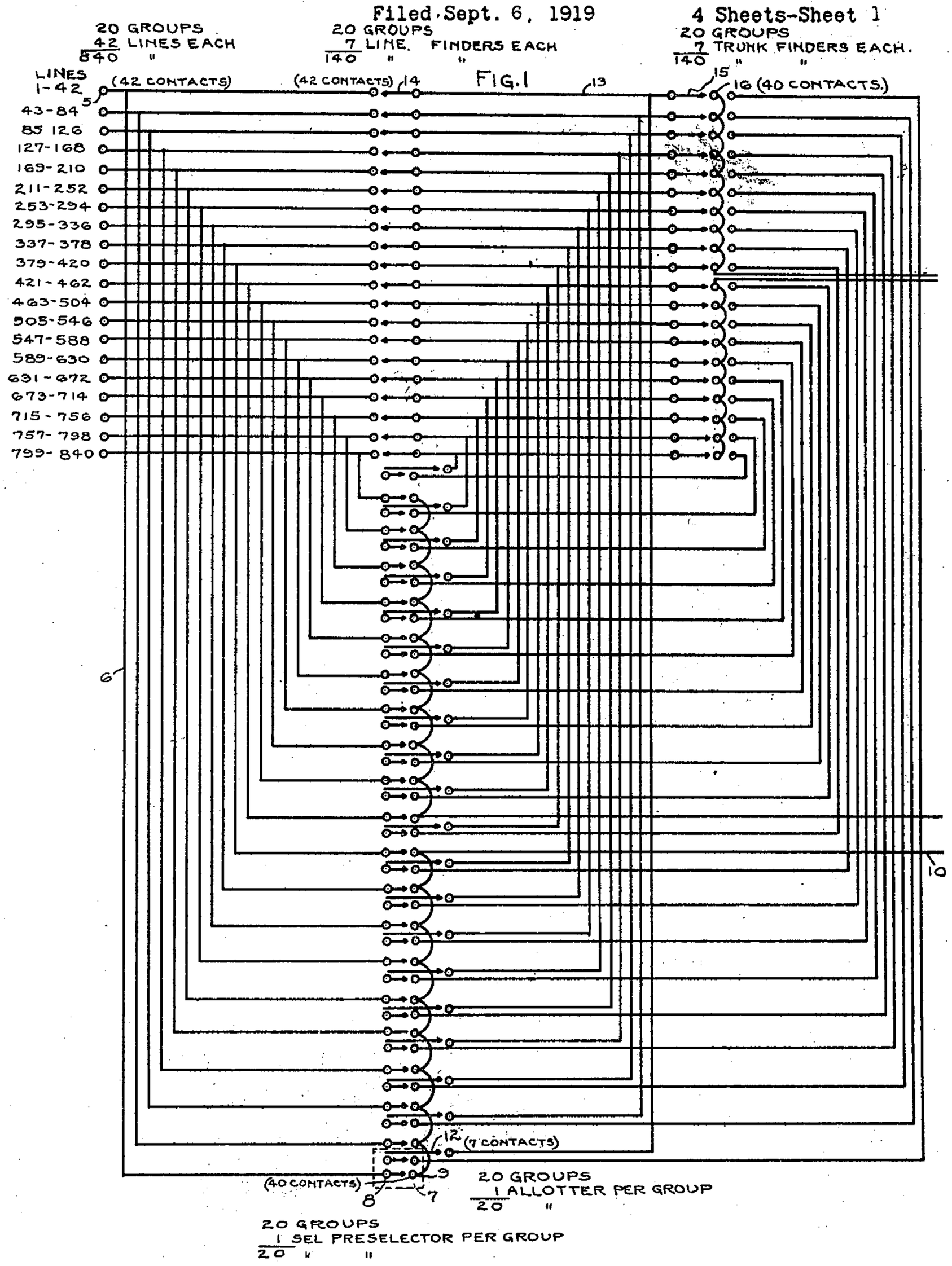

FIG. 1

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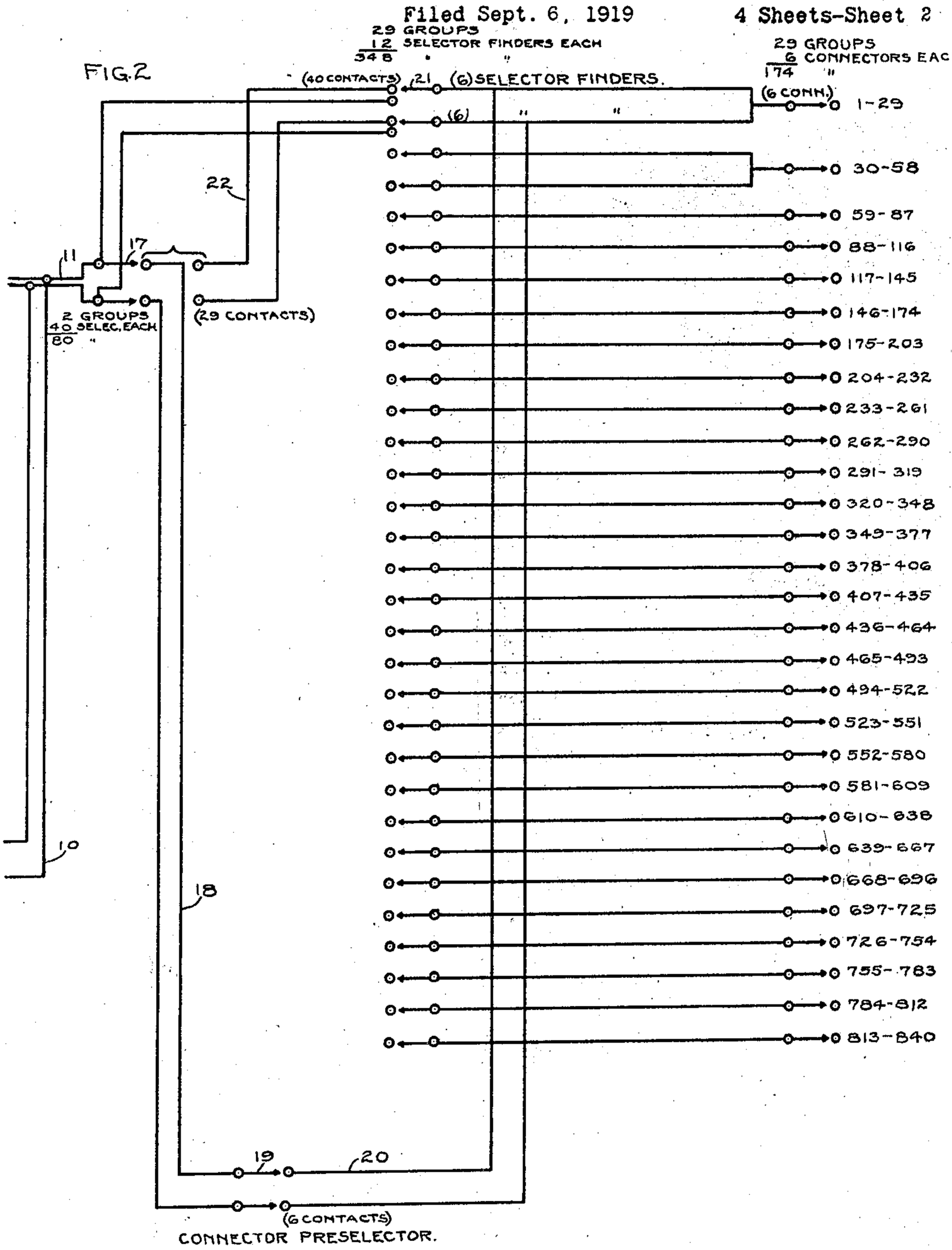
FIG. 2



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AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 6, 1919 4 Sheets-Sheet 3

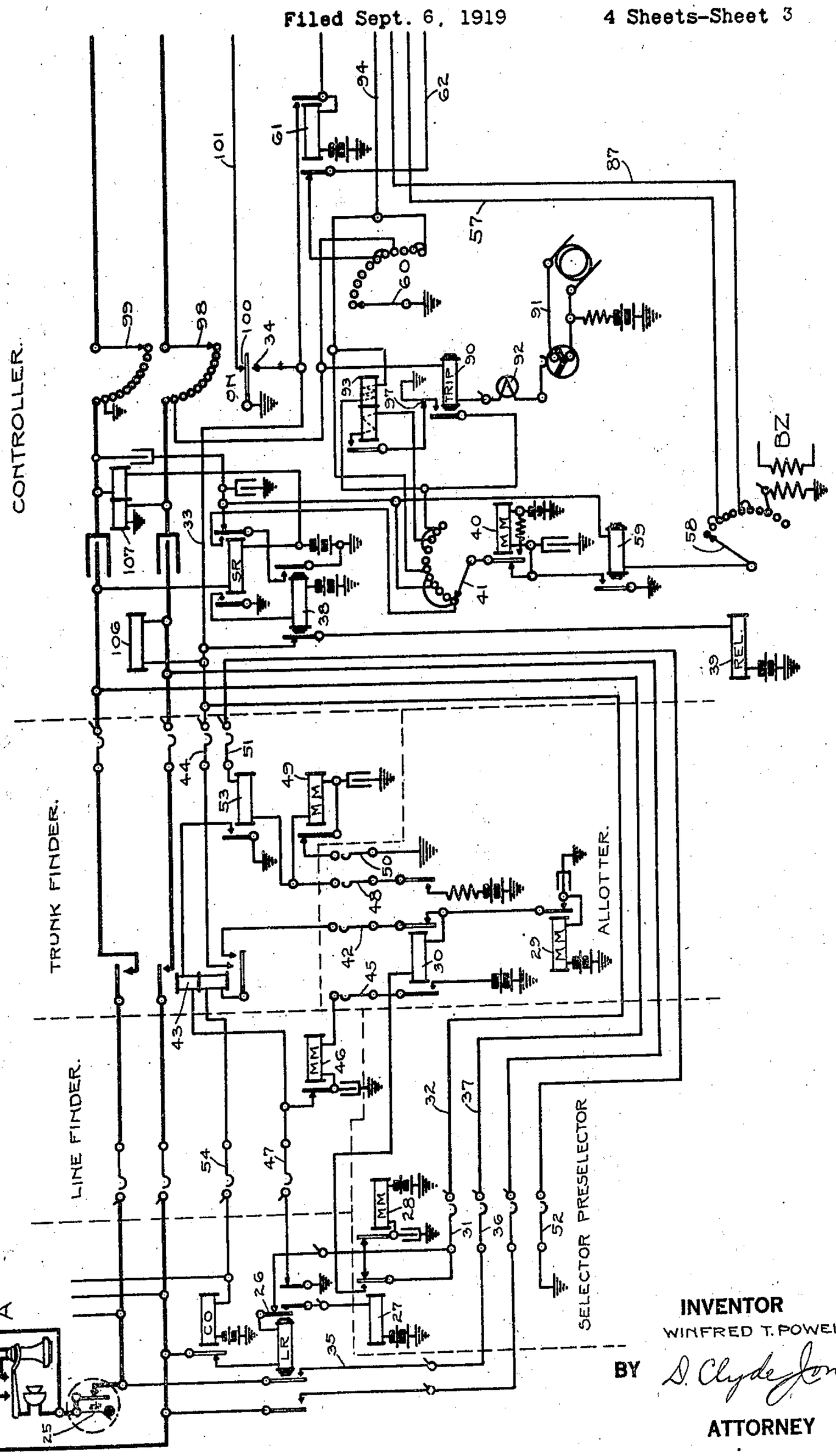

Fig. 3

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AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 6, 1919 4 Sheets-Sheet 4

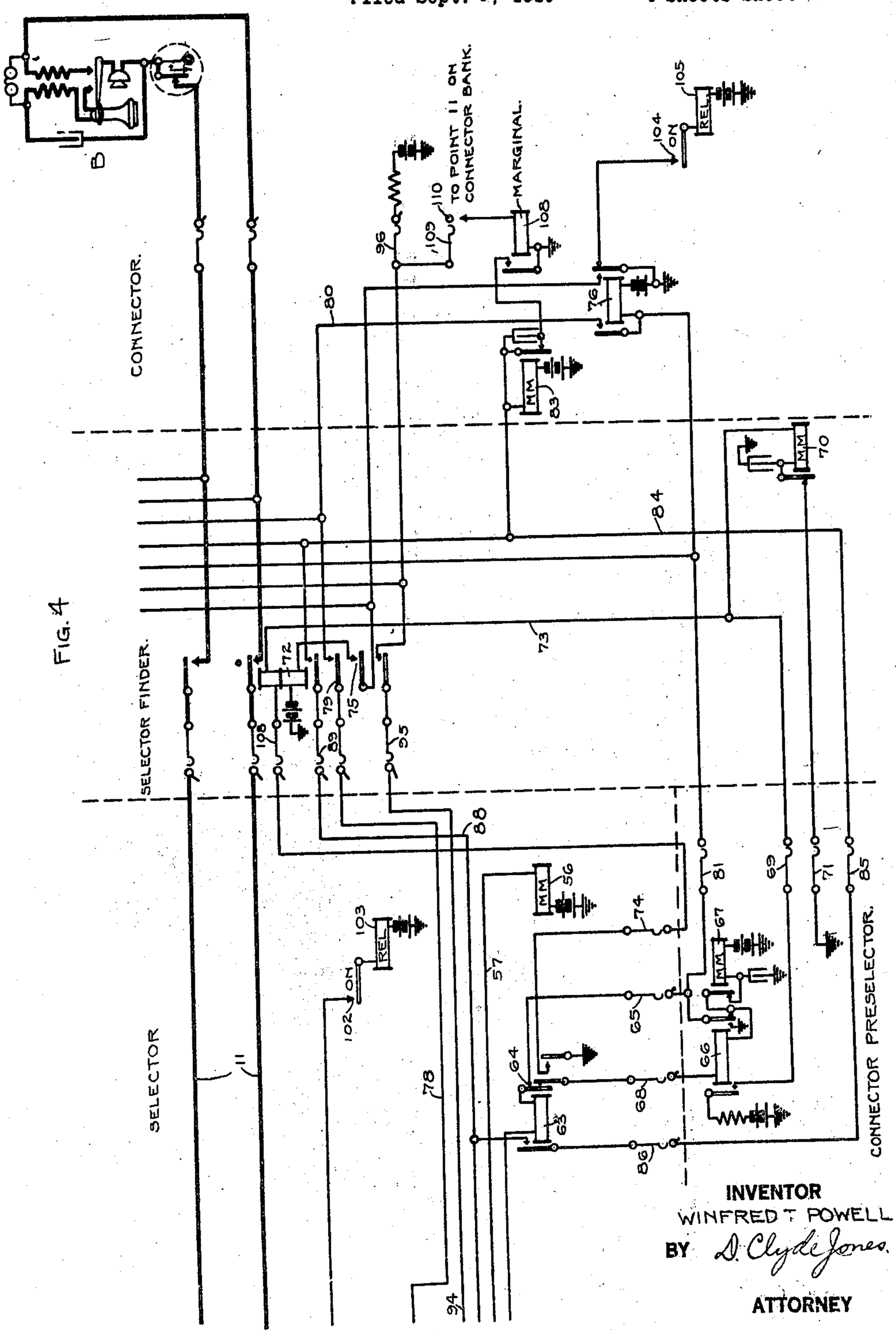

FIG. 4

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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 September 6, 1919. Serial No. 322,105.

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 establishing connections between telephone lines.

It is the purpose of the present invention to provide an automatic telephone system in which all the automatic switches are of the single motion type which may be of the same structure and in which a minimum amount of apparatus is employed. In accomplishing this result the numerical switches have no hunting movement, but instead a backward hunting or finder switch connects an idle numerical switch to a point designated by the preceding automatic switch in the chain. In order that it need not be necessary to wait for these various finder switches to complete their operation, a temporary by-path connects each numerical switch to the trunk circuit selected by a preceding numerical switch, and when this trunk is extended by means of the finder to the point designated by the selector, the temporary by-path is disestablished.

Other features not specifically named will appear from the following detailed description and appended claims.

Referring to the drawings, Figs. 1 and 2 with the Fig. 2 at the right of Fig. 1, diagrammatically represent the grouping arrangement of the telephone lines and the various switches co-operating to interconnect said lines.

Figs. 3 and 4 when arranged in the order named, diagrammatically represent the circuit details of a train of switches employed in establishing a telephone connection from one line to another.

For purposes of this disclosure a telephone system having 840 lines has been shown which lines are arranged in twenty groups having 42 lines in each. Each group of lines has provided for its individual use a selector pre-selector for pre-selecting idle selectors for use, and an allotter which selects any one of seven link circuits for interconnecting the calling line and the previously seized selector switch. Each of the seven link circuits terminates at one end in a line finder switch, and at its other end in a trunk finder switch.

For operating purposes the present system may be considered as being divided into two large groups, that is, 420 lines in each group. For each group there are provided forty selectors, so that for this system eighty selectors are provided. As soon as one of the forty selectors of one of the groups is taken for use, a connector pre-selector of which there are fifty-eight or twenty-nine for each group, extends the connection by means of a by-path to the connector switch taken for use. A selector finder switch of which there is one for each connector, completes the connection from the connector switch which has been seized for this connection to the trunk that has been taken for use.

The various switches mentioned, namely, the line finders, trunk finders, selector finders, controllers, selector and connector switches, allotters, selector pre-selectors and connector pre-selectors may be of the flat rotary type, that is, a switch in which the contacts are arranged in an arcuate contact bank and whose brushes are advanced progressively over these contacts in a step-by-step movement by pawl and ratchet mechanism under the control of the motor magnet. All of the mentioned switches, except the selectors, connector switches and controllers, have no release mechanism but remain in engagement with the contacts last used. The selector, connector and controller switches, however, are provided with a release magnet and other mechanism for restoring these switches to normal at the time when a connection is being broken down. These various switches need not all be provided with the same number of contacts, but

some of them may be of smaller capacity than the others as will be readily apparent.

The numerical switches of this system are arranged to operate on the cumulative method, that is, they are directively operated in repsonse to several series of impulses, the switches advancing a number of steps equal to the sum of the number of impulses in the various series. For example, if it is desired to advance a switch to the fifteenth contact, a series of twelve impulses is sent followed by a series of three impulses.

The present system has been designed to use an impulse transmitter to transmit twelve different series of impulses, but it will be readily understood that the invention can be readily arranged to employ the impulse transmitter now commonly in use. The impulse transmitter disclosed, is arranged to send a series of ten impulses, numbered from 1 to 0 and in addition two other series of impulses having twelve and twenty impulses respectively.

Let it be assumed that a call originates in some one of the forty-two lines of the first group herein designated 5. A by-path previously extended to all the lines of this group is completed from this calling line over conductor 6 to the selector pre-selector 7, individual to this group of lines.

This pre-selector through its brush 8 and multiple contacts 9 and conductor 10, completes the by-path from the calling line to the trunk 11 individual to some one of the group of forty selectors that has been taken for use. The allotter indicated by the brush 12 has previously operated to preselect some one of the seven link circuits individual to this group of 42 lines, and as soon as the link 13 has been selected, its line finder switch 14 hunts for the calling line, and its trunk finder switch 15 hunts for the multiple contact 16 of the trunk 11 previously selected for use. The selector switch 17 which has been seized is then directively operated by the calling party to select one of the groups of connectors in which the called line terminates. As soon as the selector completes its operation, the connector switch which has been taken for use is operated over a by-path completed over conductor 18, connector pre-selector 19 and conductor 20, and it is subsequently operated over a circuit including the selector finder 21 and conductor 22.

After this brief description of the lay-out of the system and the description of the apparatus employed, let us turn to a consideration of the method of establishing a connection from a calling telephone line the substation of which is indicated at "A" to a called line, the substation of which is designated "B." In initiating a call, the calling subscriber removes his receiver from its switchhook and adjusts the dial of his sending device in accordance with the first digit of the wanted number. On the forward movement of the dial a circuit is closed from ground, through the shunting spring 25, through the transmitter and switchhook contacts, armature and back contact of the cut-off relay CO, winding of the slow-releasing line relay LR, through its continuity spring 26 and contact, armature and back contact of relay 27, and back contact and armature of the motor magnet 28 of the selector pre-selector to grounded battery. The line relay LR is energized in this circuit but the motor magnet remains inert when in series with the line relay. The line relay LR attracts its armatures and at its outer right hand armature indicates a stopping point for the line finder switch and at its inner right hand armature and continuity spring 26 closes an operating circuit for the relay 27 in series with the line relay LR. The relay 27 on attracting its armature, opens the operating circuit of the motor magnet 28 of the selector pre-selector, but closes a break point in the energizing circuit of the relay 30. At the inner left hand armature and front contact of the line relay LR, a circuit is closed from ground, shunting spring 25, conductor 35, selector pre-selector brush 36, conductor 37, winding of the stepping relay SR to grounded battery. The stepping relay SR attracts its armatures, and at its left hand armature and front contact closes an energizing circuit for the slow-releasing relay 38. This relay attracts its armatures and opens the operating circuit of the release magnet 39, and closes a break point in the operating circuit of the motor magnet 40 of the controller, from grounded battery, winding, back contact and armature of this motor magnet, wiper 41 in its first position, right hand front contact of stepping relay SR, right hand front contact and armature of relay 38 to ground. The controller is thus advanced one step and its off normal spring ON is brought in engagement with its contact 34.

The impulses corresponding to the first digit of the wanted number may now be transmitted over the circuit just described for the stepping relay SR, and in the meantime the allotter will designate a link circuit for connecting the calling line to the selected trunk. The allotter is operated in the following manner:—As soon as the controller is moved to an off normal position, a circuit is closed for the relay 30 of the allotter from grounded battery, winding of the magnet 29, winding of the relay 30, front contact and armature of relay 27, brush 31, conductors 32 and 33, contact 34, and off normal spring to ground. Relay 30 is energized in this circuit and attracts its armatures, but the motor magnet

29 will not operate in series with the relay 30. However, if the brushes of the allotter are standing in engagement with the contacts of a link circuit that is in use, relay 30 will not be energized but the motor magnet 29 of the allotter will be operated in a circuit traceable from grounded battery, winding, back contact and armature of this magnet, inner right hand contact and armature of relay 30, allotter brush 42, lower front contact and armature of relay 43, trunk finder brush 44, conductor 33, to ground at a contact similar to 34 and off normal spring. The motor magnet 29 will continue to advance until its brush 42 fails to be connected to ground. This condition will indicate that the link with which it is in engagement is idle. The line finder and trunk finder individual to the allotted link circuit will now be advanced, the line finder to find the calling line and the trunk finder to find the trunk that has previously been taken for use in this call. The line finder is operated over a circuit extended from grounded battery, left hand front contact and armature of relay 30, allotter brush 45, winding, armature and back contact of the line finder motor magnet 46, line finder brush 47, to ground at the back contacts and armatures of line relays associated with non-calling lines. The calling line has its line relay attracted so that the energizing circuit of the motor magnet of the line finder will be interrupted as soon as the calling line is reached. The trunk finder is operated over a circuit completed from grounded battery, resistance, outer right hand front contact and armature of relay 30, allotter brush 48, winding of the motor magnet 49 of the trunk finder, armature and back contact of this magnet, and allotter brush 50 to ground. The trunk finder advances its brush step-by-step under the control of its motor magnet until its test brush 51 encounters a grounded test terminal which ground is applied through the brush 52 of the selector pre-selector and indicates that the trunk finder has reached the trunk which has been assigned for use. As soon as the test brush 51 encounters a grounded test terminal, the motor magnet 49 of the trunk finder is shunted by relay 53 and this relay 53 is energized and attracts its armature. When the line finder has completed its operations, a ground potential will be absent on line finder brush 47, and relay 53 will be actuated at the close of the operations of the trunk finder, so that switching relay 43 is now operated in a circuit from grounded battery, left hand front contact and armature of relay 30, allotter brush 45, winding of magnet 46, armature and back contact of this magnet, upper winding of relay 43, front contact and armature of relay 53 to ground. The cut-off relay CO individual to the calling line is now operated in a circuit completed from grounded battery, winding of this relay, brush 54 of the line finder, lower winding and front contact of relay 43, trunk finder brush 44, conductor 33, contact 34 and off normal spring to ground. The cut-off relay CO attracts its armature to disconnect the line relay from the calling line, and the switching relay 43 closes break points in the two sides of the link circuit taken for use, so that the impulses from the impulse transmitter which previous to this time passed over the by-path already mentioned, will now be transmitted over the upper side of the link circuit connecting the calling line and the selected trunk. On the operation of the cut-off relay, the line relay releases, which releases relay 27 and the selector pre-selector preselects a selector to be used in the next call. Relay 30 releases and closes a circuit from ground at contact 34, contact of relay 43 and brush 42 to advance the allotter, thus allotting the next link to be used. In the event that the selector pre-selector had been in engagement with a busy trunk when the call was originated, ground over conductors similar to 32 and 33 would short-circuit the line relay LR and since relay 27 would not be energized the motor magnet 28 would advance the selector pre-selector until an idle selector is found.

It will be remembered that as soon as the selector was seized for use, its controller advanced its wipers into their second position and subsequent impulses corresponding to the first digit of the wanted number were transmitted over the by-path extending from the calling line to the selected trunk, or over the allotted link circuit connecting the calling line and trunk. With the controller in its second position, the stepping relay SR vibrates its armatures in response to the first series of impulses and the motor magnet 56 of the selector is operated in a circuit closed from grounded battery, winding of this magnet conductor 57, controller wiper 58 in its second position, slow-releasing relay 59, back contact and armature of stepping relay SR, front contact and armature of relay 38 to ground. The motor magnet 56 advances the brushes of the selector one step for each impulse transmitted in this series. The motor magnet 40 of the controller is maintained energized at the front contact and armature of the slow-releasing relay 59 during the transmission of this series of impulses, but at the close of this series of impulses this motor magnet deenergizes and advances the controller wipers into their third position. In response to the next series of impulses corresponding to the second digit of the wanted number, the selector continues to advance its brushes in the same direction as in response to the first series of impulses.

In this instance as before, the motor magnet 56 of the selector is controlled at the back contact and armature of the stepping relay SR and advances its brushes one step in response to each impulse received by this last named relay. The motor magnet 40 of the controller is again maintained energized at the front contact and armature of the slow-releasing relay 59 during the transmission of the second series of impulses, and when the relay 59 deenergizes at the close of this series of impulses, the motor magnet 40 deenergizes and advances the controller wipers into their fourth position. It should be understood that the selector brushes instead of being advanced directively to select a group and then being operated automatically to select an idle line in the group, in the present instance the selector is operated on the cumulative arrangement, that is, it is advanced directively in response to several series of impulses and then a hunting switch operates to connect a succeeding numerical switch to the contacts designated by the selector switch.

When the stepping relay SR retracts its armatures in response to the first impulse of the series corresponding to the third digit of the wanted number, the motor magnet 40 is then energized in a circuit from grounded battery, winding, back contact and armature of the motor magnet 40, controller wiper 41 in its fourth position, back contact and armature of the stepping relay SR, front contact and armature of relay 38 to ground to advance these wipers into their fifth position. At the close of this impulse, the stepping relay SR attracts its armatures again and the motor magnet 40 is now energized in a circuit closed at the front contact and armature of the stepping relay SR, and almost immediately interrupts its own circuit to advance the controller wipers into their sixth position. It will thus be seen that the first impulse of the third digit is lost, and the numbering of the lines at the connector must be arranged accordingly. With the controller wipers in position six and when the selector brushes have been set, a circuit is closed from ground, controller wiper 60, back contact and armature of relay 61, conductor 62, winding of relay 63, continuity spring and contact 64, selector brush 65, armature and back contact of relay 66, armature, back contact and winding of the motor magnet 67 of the connector preselector to grounded battery. The relay 63 is energized in this circuit and attracts its armatures, thus closing a substitute locking circuit for itself from grounded battery, winding, back contact and armature of the motor magnet 67, winding of relay 66, selector brush 68, inner armature of the relay 63, continuity spring 64 over the remainder of the circuit previously traced. The relay 66 is energized in this circuit, but the motor magnet 67 is not actuated at this time. At the right hand armature of relay 66, a ground is supplied to lock out other relays like 63 and an energizing circuit is completed for relay 76, while at the left hand armature and front contact of the relay 66, a circuit is closed from grounded battery, resistance, connector pre-selector brush 69, winding of the motor magnet 70 of the selector finder, and connector pre-selector brush 71 to ground. The motor magnet 70 advances the brushes of the selector finder to extend the connector to the trunk that has previously been selected. As soon as this point is reached, the switching relay 72 is actuated in a circuit completed from grounded battery, resistance, armature and front contact of relay 66, connector pre-selector brush 69, conductor 73, upper winding of relay 72, selector finder brush 108, selector brush 74, outer front contact and armature of relay 63 to ground. Relay 72 attracts its armature and closes a locking circuit for itself from grounded battery through its lower winding, front contact and armature 75 of this relay, right hand front contact and armature of relay 76 to ground. As soon as the switching relay 72 is operated, a circuit is closed from grounded battery, through the winding of relay 61, conductor 78, selector finder brush armature 79, contact of relay 72, conductor 80, left hand front contact and armature of relay 76, connector pre-selector brush 81, right hand armature and front contact of relay 66 to ground. The relay 61 attracts its armatures and at its right hand armature closes a locking circuit for itself, and relay 76 through contact 34 and its off normal spring. At the left hand armature and back contact of relay 61, the holding circuit for the relays 63 and 76 is interrupted permitting these relays to retract their armatures.

As soon as the relay 66 retracts its right hand armature, the motor magnet 67 of the connector pre-selector is actuated to preselect the next connector to be used in its group. This circuit extends from grounded battery, winding of the motor magnet 67, its back contact and armature, back contact and armature of relay 66, connector pre-selector brush 81, left hand armature and front contact of relay 76 to ground at contact 34 and its off normal spring (Fig. 3). It will be remembered that as soon as the controller moves its wipers into position six, the relay 63 of Fig. 4 is operated to close a by-path circuit for the motor magnet 83 of the connector from grounded battery, winding of this magnet, conductor 84, connector pre-selector brush 85, selector brush 86, left hand armature and front contact of relay 63, conductor 87, controller wiper 58, relay 59, back contact and

armature of relay SR, front contact and armature of relay 38 to ground. The impulses corresponding to the third digit of the wanted number are transmitted over this circuit until the selector finder has completed its operation, whereupon the impulses are then transmitted over conductor 88, selector finder brush 89, inner-most armature and front contact of relay 72, winding of the motor magnet 83 to grounded battery.

At the close of the series of impulses corresponding to the third digit, the motor magnet 40 of the controller which has been held energized at the armature of relay 59, deenergizes and moves the controller switch wipers into position seven. In this position the fourth series of impulses is transmitted to the motor magnet 83 of the connector over the operating circuit last described. At the close of this last series of impulses, the motor magnet 40 of the controller which has been held energized as in the previous case at the armature of relay 59, deenergizes and moves the side switch wipers into their eighth position. The marginal ringing trip relay 90 is now operated in a circuit extending from grounded battery, resistance, ringing machine generally designated 91, the lamp 92, winding of the trip relay 90, controller wiper 60 in its eighth position to ground. The relay 90 attracts its armature and closes a circuit from ground through the controller wiper 41 in its eighth position, armature, back contact and winding of the motor magnet 40 of the controller to grounded battery. Under the control of this circuit the controller moves its wipers into their ninth or testing position. When the trip relay attracts its armature it closes a circuit from ground through the right hand winding of relay 93, conductor 94, selector finder brush 95, lowermost armature and front contact of relay 72, connector brush 96, through the resistance representing the cut-off relay of the called line, to grounded battery if the wanted line is idle. The relay 93 attracts its armature, and when the relay 90 retracts its armature a circuit is closed from ground, make before break contact 97, armature, front contact and left hand low resistance winding of relay 93, controller wiper 41 in its ninth position, armature, back contact and winding of the motor magnet 40 to grounded battery. Under the control of this last described circuit, the motor magnet moves the controller wipers into their tenth or ringing position.

In the event that the wanted line is busy, a reduced potential will be present on its test terminal so that when the test brush 96 of the connector engages it, the relay 93 will not be energized so that the controller will hold its wipers in their ninth position instead of moving them into the tenth or ringing position as in the case where an idle line is tested. In case the controller wipers are held in position nine, a busy tone is transmitted from the busy machine BZ through the controller wiper 58 in its ninth position, to the calling line.

It has been assumed that the called line is idle and that the controller is moved into its tenth position. In this position ringing current is transmitted from the ringing machine 91, lamp 92, marginal ringing trip relay 90, controller wiper 98 in its tenth position, through the train switches and wanted substation, back to the controller wiper 99 to ground. When the called party responds the trip relay 90 is actuated and at its armature and front contact completes a circuit for the controller motor magnet 40 to move the wipers into their eleventh or talking position.

When it is desired to disestablish the connection, the calling party replaces his receiver on its switchhook. This causes the stopping relay SR to retract its armatures and thereby interrupt the operating circuit of the slow-releasing relay 38. This last named relay then retracts its left armature to close an operating circuit for the release magnet of the controller from grounded battery, winding of this magnet, left armature and back contact of the relay 38, conductor 33, contact 34 and off normal spring to ground. The release magnet 34 restores the controller to its normal position at which time the off normal spring engages its contact 100, and closes a circuit from ground over conductor 101, contact 102 and off normal spring, winding of the release magnet 103 of the selector to grounded battery. This restores the selector to its normal position. As soon as the contact 34 disengages the off normal spring, the holding relays 61 and 76 are deenergized and relay 76 closes a circuit from ground at its right hand armature and back contact, contact 104 and its off normal spring, and winding of the release magnet 105 to grounded battery. Under the control of the release magnet 105, the connector is restored to its normal position.

Talking battery for the calling subscriber is supplied through the winding of the stepping relay SR and through the winding of the impedance coil 106. Talking battery for the called subscriber is supplied through the windings of the impedance coil 107.

It will be remembered that the first impulse of the series corresponding to the third or tens digit of the wanted number was used to advance the controller out of positions four and five. For this reason no numbers the tens digit of which is one, are assigned to any telephone lines. The system, however, is so arranged that if the impulses corresponding to the third designation of

the wanted number are 12 or 20 in number, the circuits of the connector will make up or create a new impulse to replace the impulse lost in moving the controller from position four to position six. For this purpose the marginal relay 108 is connected to the eleventh contact designated 110 on the connector bank, and when 12 or 20 impulses corresponding to the tens digit of the wanted number are transmitted, the connector brush 109 will either come to rest on or pass over connector back contact 110, so that in either case a circuit is closed for the marginal relay 108, from ground, winding of relay 108, contact 110, connector brush 109, lower-most front contact and armature of relay 72, selector finder brush 95, conductor 94, controller wiper 41 in its sixth position, armature and front contact of motor magnet 40, and resistance to grounded battery. The marginal relay 108 attracts its armature and closes a circuit from grounded battery, winding of motor magnet 83 of the connector, armature and back contact of this magnet, front contact and armature of marginal relay 108 to ground. Under the control of this circuit the connector is advanced an additional step. The relay 108 is made marginal so that when two impulses are transmitted for the tens digit followed by ten impulses for the units digit in which case the connector is moved to its eleventh contact, battery on the test brush 96 from the cut-off relay of the wanted line will not energize the relay 108 and cause the connector to take a false step. Under the last assumption battery at the controller magnet 40 will not be applied to the marginal relay 108 over controller wiper 41, for at this time the controller will be in position seven, because the impulses of the units digits of the wanted number have been transmitted.

While the system has been shown and described to accommodate 840 lines and while it has been proposed to use an impulse transmitter arranged to send series of twelve impulses, it will be understood that the number of lines may be greatly varied without departing from the present invention, since it will be clearly understood that if the number of lines is greatly diminished that the selector switch will be omitted, and if the number of lines is greatly increased an additional selector will be added. It will also be readily seen that the system may be arranged to employ an impulse transmitter arranged to send series of ten impulses without departing from the spirit of the present invention. It will also be obvious that the numerical switches may be operated to select a group of lines, and subsequently select a line from the selected group instead of selecting lines by the cumulative method.

What I claim is:

1. In a telephone system, groups of telephone lines, a group of trunks individual to each group of lines, link circuits for interconnecting calling lines and trunks, each link circuit terminating at each end in a hunting switch, a progressively operable switch for assigning link circuits for use, means for assigning an idle trunk for use, and means for extending a signaling circuit from a calling line to the assigned trunk while said hunting switches are operating.

2. In a telephone system, groups of telephone lines, a group of trunk lines individual to each group of lines, link circuits terminating at each end in a hunting switch and serving to connect a calling line with an assigned trunk, a progressively operable switch for assigning link circuits for use, and means for assigning an idle trunk for use and for extending a temporary signaling circuit from a calling line to the assigned trunk while said hunting switches are being operated.

3. In a telephone system, a plurality of groups of telephone lines, a group of trunks individual to each group of lines for extending any one of the lines of a group as a calling line, hunting switches for locating calling lines and connecting them to idle trunks, means for allotting trunks for use, a temporary signaling circuit for connecting a calling line to a trunk while the hunting switch is operating, and means effective thereafter for extending said signaling circuit to an assigned trunk.

4. In a telephone system, a plurality of groups of telephone lines, a group of trunks individual to each group of lines for extending any one of the lines of a group as a calling line, hunting switches for locating calling lines and connecting them to idle trunks, means for allotting trunks for use, a temporary signaling circuit for connecting a calling line to a trunk while its hunting switch is operating, and means effective thereafter for connecting all idle lines of a group to an assigned trunk by way of said signaling circuit.

5. In a telephone system, a plurality of telephone lines, means including automatic switches for interconnecting said lines, signaling circuits over which said switches are controlled from a distant point, means for directively operating said switches over said signaling circuit to select a desired group of succeeding switches, means thereafter operating to connect an idle switch in the selected group to the switch which selected the group, and temporary signaling circuits over which said idle switch is operated while said connection is being completed thereto.

6. In a telephone system, a plurality of telephone lines, a plurality of numerical switches for completing a connection between one telephone line and another tele-

phone line, and a signaling circuit over which said switches are controlled from a distant point, a temporary branch of said signaling circuit also extending to certain of said switches.

7. In a telephone system, an incoming line terminating in a primary numerical switch, a plurality of outgoing lines terminating in final numerical switches, means for operating said numerical switches in response to signals from a distant point, link circuits for extending said incoming line to any of said outgoing lines through a final numerical switch, means for designating a link circuit for use, a non-numerical switch individual to each link circuit for extending said link circuit to said primary numerical switch, and a temporary signaling circuit completed about said non-numerical switch during the operation thereof.

8. In a telephone system, a plurality of telephone lines, a plurality of trunk lines each terminating in an automatic switch, automatic switching means operating to connect a trunk to a calling telephone line, a progressively operable switch for assigning trunks for use, and means for completing a signaling circuit to an assigned trunk about said automatic switching means.

9. In a telephone system, a plurality of telephone lines, a plurality of trunk lines each terminating in an automatic switch, automatic switching means operating to connect a trunk to a calling line, a progressively operable switch for assigning trunks for use, and means for completing a temporary signaling circuit to an assigned trunk about said automatic switching means.

10. In a telephone system, a plurality of telephone lines, means including a chain of numerical and non-numerical switches for interconnecting any of said lines with any other line, one of said non-numerical switches being interposed between two numerical switches in the chain, and a temporary signaling circuit completed about said non-numerical switch while it is being operated.

11. In a telephone system, a plurality of telephone lines, means including a chain of numerical and non-numerical switches for interconnecting any of said lines with any other lines, one of said non-numerical switches being interposed between two numerical switches in the chain, a signaling circuit having two paths over which said second numerical switch is controlled, one path of said signaling circuit being effective while said non-numerical switch is being operated, and the second signaling path being effective after said non-numerical switch has completed its operation.

12. In a telephone system, a plurality of telephone lines, impulse transmitting devices connectable to said lines, primary and secondary numerical switches arranged to be serially connected to said incoming lines and responsive to impulses from said impulse transmitting devices, automatic switches non-responsive to said impulse transmitting devices but each operating to connect a secondary numerical switch to an actuated primary switch, and a temporary signaling circuit extending from the actuated primary switch to said secondary numerical switch completed during the operation of said automatic switch.

13. In a telephone system, incoming lines, impulse transmitting devices arranged to be connected to said incoming lines, a selector switch and a connector switch, a testing switch for interconnecting an idle connector switch and an actuated selector switch, and a temporary signaling circuit extending about said testing switch while it is being operated.

14. In a telephone system, telephone lines, impulse transmitting devices arranged to be connected thereto, impulse actuated selecting means and link circuits for extending said telephone lines, a plurality of associated independently operable switches electrically interposed betwen the various impulse actuated means for testing preceding links in succession and interconnecting them, and a temporary signaling circuit extending about each of said switches during the operation thereof.

15. In a telephone system, incoming lines, impulse transmitting devices arranged to be associated therewith, automatic switches operated by impulses from said impulse transmitting devices for interconnecting said telephone lines interposed switching devices non-responsive to impulses from said impulse transmitting devices operating to select a previously actuated automatic switch, and a temporary signaling circuit completed about said switching device during its operation.

16. In a telephone exchange system, telephone lines serving as calling and called lines, impulse transmitting devices associated therewith, link circuits each provided with an impulse actuated automatic switching device, interposed switching mechanisms non-responsive to impulses from said impulse transmitting devices for effecting a connection between a calling subscriber's line and each successive link and its automatic switching device, and a temporary signaling circuit completed to the succeeding link circuit about each automatic switching mechanism during the operation thereof.

17. In a telephone system, telephone lines serving as calling and called lines, impulse transmitting devices associated therewith, a trunk line, an impulse controlled selector associated with said trunk, a connector switch for selecting a called line, an interposed

switch adapted to test for and interconnect the impulse actuated selector to the connector switch, and a temporary signaling circuit completed from said trunk to said connector switch before said testing switch has completed its operation.

18. In an automatic telephone system, a plurality of telephone lines, means for initiating calls on said lines, means including non-numerical switches, of the backward hunting type, numerical trunking switches and final numerical switches for interconnecting said lines and means for pre-selecting said switches ahead of the calls.

19. In a telephone system, a calling line, selector switches for extending said line, controlling mechanism for controlling the operation of said selector switches, a quick acting finder switch responsive to the initiation of a call on said line for associating said mechanism therewith, means for subsequently associating said mechanism with said line, an impulse circuit established upon the initial association of said mechanism with said line, a second impulse circuit established upon the subsequent association of said mechanism with said line, means controlled by the calling subscriber for sending impulses over both of said circuits, and means responsive to such impulses for setting said controlling mechanism.

20. In a telephone system, a calling line, selector switches for extending said line, controlling mechanism for controlling the operation of said selector switches, a quick acting finder switch responsive to the initiation of a call on said line for associating said mechanism therewith, a main line finder for subsequently associating said mechanism with said line, an impulse circuit established upon the initial association of said mechanism with said line, a second impulse circuit established upon the subsequent association of said mechanism with said line, means controlled by the calling subscriber for sending impulses over said first circuit while the main line finder is hunting for the calling line and for sending impulses over said second circuit after said line is selected, and means responsive to such impulses for setting said controlling mechanism.

21. In a telephone system, a calling line, selector switches for extending said line, controlling mechanism for controlling the operation of said selector switches, a link circuit, means responsive to the initiation of a call for connecting said link circuit with said calling line and with said mechanism, a line finder switch for subsequently associating said link with said line, an impulse circuit established upon the initial association of said mechanism with said line, a second impulse circuit established upon the subsequent association of said mechanism with said line, means controlled by the calling subscriber for sending impulses over said first circuit while the main line finder is hunting for the calling line and for sending impulses over said second circuit after said line is selected, and means responsive to such impulses for setting said controlling mechanism.

22. In a telephone system, a calling line, selector switches for extending said line, controlling mechanism for controlling the operation of said selector switches, a quick acting finder switch responsive to the initiation of a call on said line for associating said mechanism therewith, a main line finder for subsequently associating said mechanism with said line, an impulse circuit established upon the initial association of said mechanism with said line, a second impulse circuit established upon the subsequent association of said mechanism with said line, means controlled by the calling subscriber for sending impulses over said first circuit while the main line finder is hunting for the calling line and for sending impulses over said second circuit after said line is selected, means responsive to such impulses for setting said mechanism, and means effective upon the establishment of said second impulse circuit for opening said first impulse circuit.

23. In a telephone system, a calling line, selector switches for extending said line, controlling mechanism for controlling the operation of said selector switches, a quick acting finder switch responsive to the initiation of a call on said line for associating said mechanism therewith, a main line finder for subsequently associating said mechanism with said line, an impulse circuit established upon the initial association of said mechanism with said line, a second impulse circuit established upon the subsequent association of said mechanism with said line, means controlled by the calling subscriber for sending impulses over said first circuit while the main line finder is hunting for the calling line and for sending impulses over said second circuit after said line is selected, means responsive to such impulses for setting said mechanism, means effective upon the establishment of said second impulse circuit for opening said first impulse circuit, and means effective upon the operation of the selector switches in accordance with the setting of said mechanism for opening said second impulse circuit.

24. In a telephone exchange system, in combination, a trunk circuit including a pair of normally open talking conductors, automatic switching apparatus accessible to one end therof, a link circuit for connection with the other end thereof, an impulse sender associated with the link circuit, and means controlled by the impulse sender for closing the

talking conductors of the trunk after the link circuit is connected therewith.

25. In a telephone exchange system, in combination, a trunk circuit including a pair of normally open talking conductors, a link circuit connected therewith, an impulse sender, means for connecting the impulse sender with the link circuit, and electromagnetic means for closing the normally open talking conductors operating in response to the initial actuation of the impulse sender.

In witness whereof, I hereunto subscribe my name this 5th day of September A. D. 1919.

WINFRED T. POWELL.