Dec. 16, 1924. 1,519,331

W. T. POWELL

AUTOMATIC TELEPHONE SYSTEM

Filed April 29, 1922 3 Sheets-Sheet 1

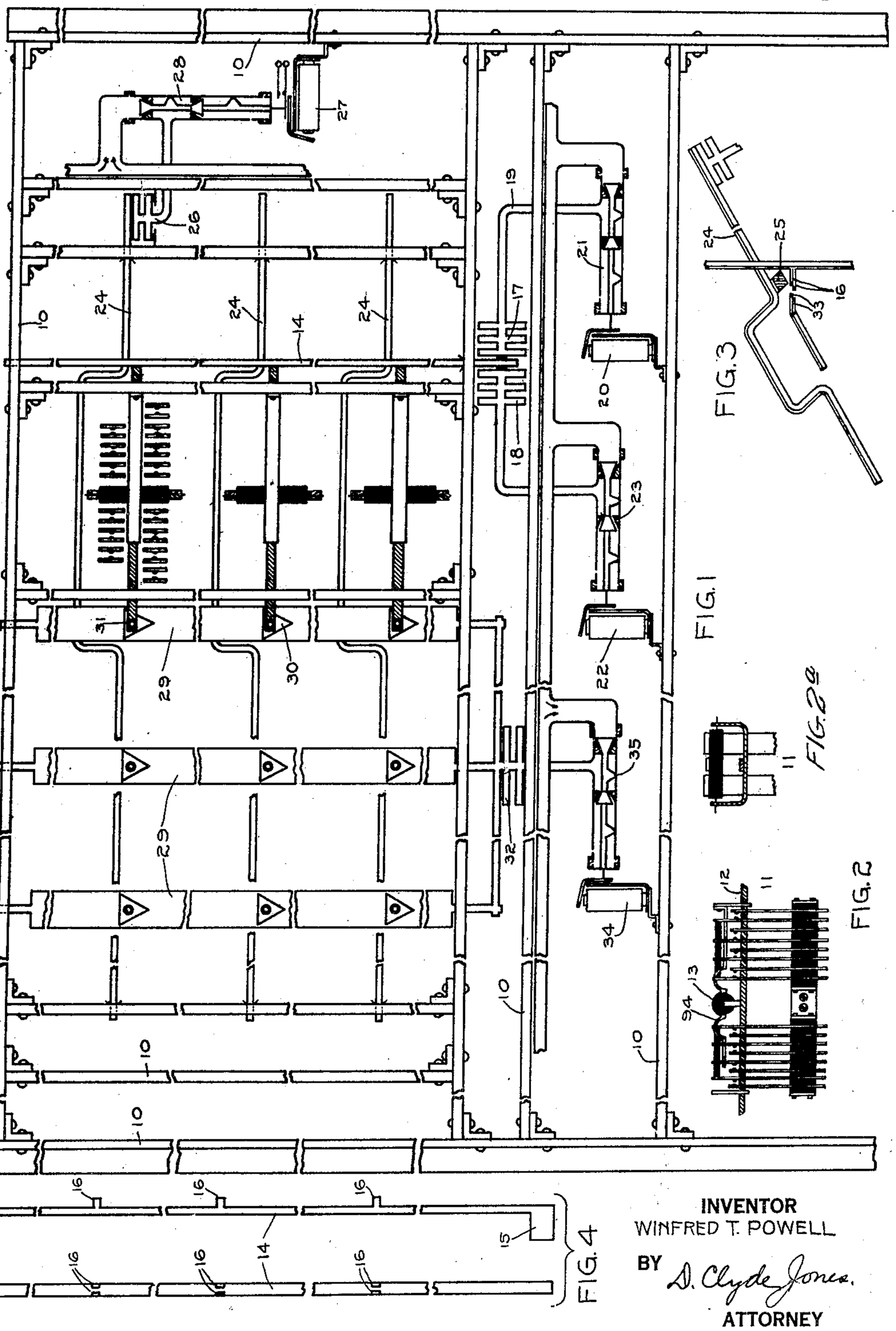

FIG. 1

FIG. 3

FIG. 2a

FIG. 2

FIG. 4

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AUTOMATIC TELEPHONE SYSTEM

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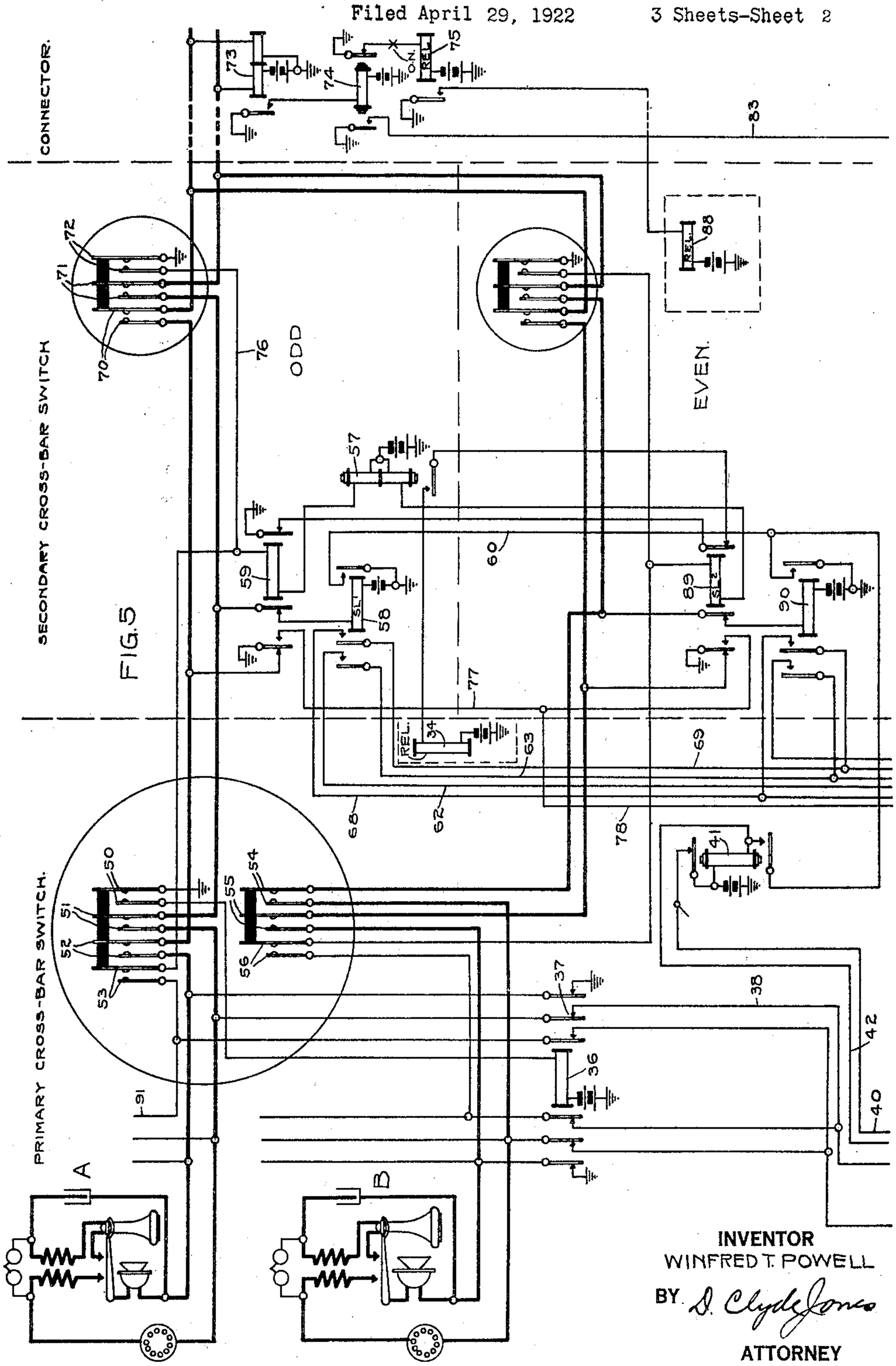

FIG.5

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Filed April 29, 1922 3 Sheets-Sheet 3

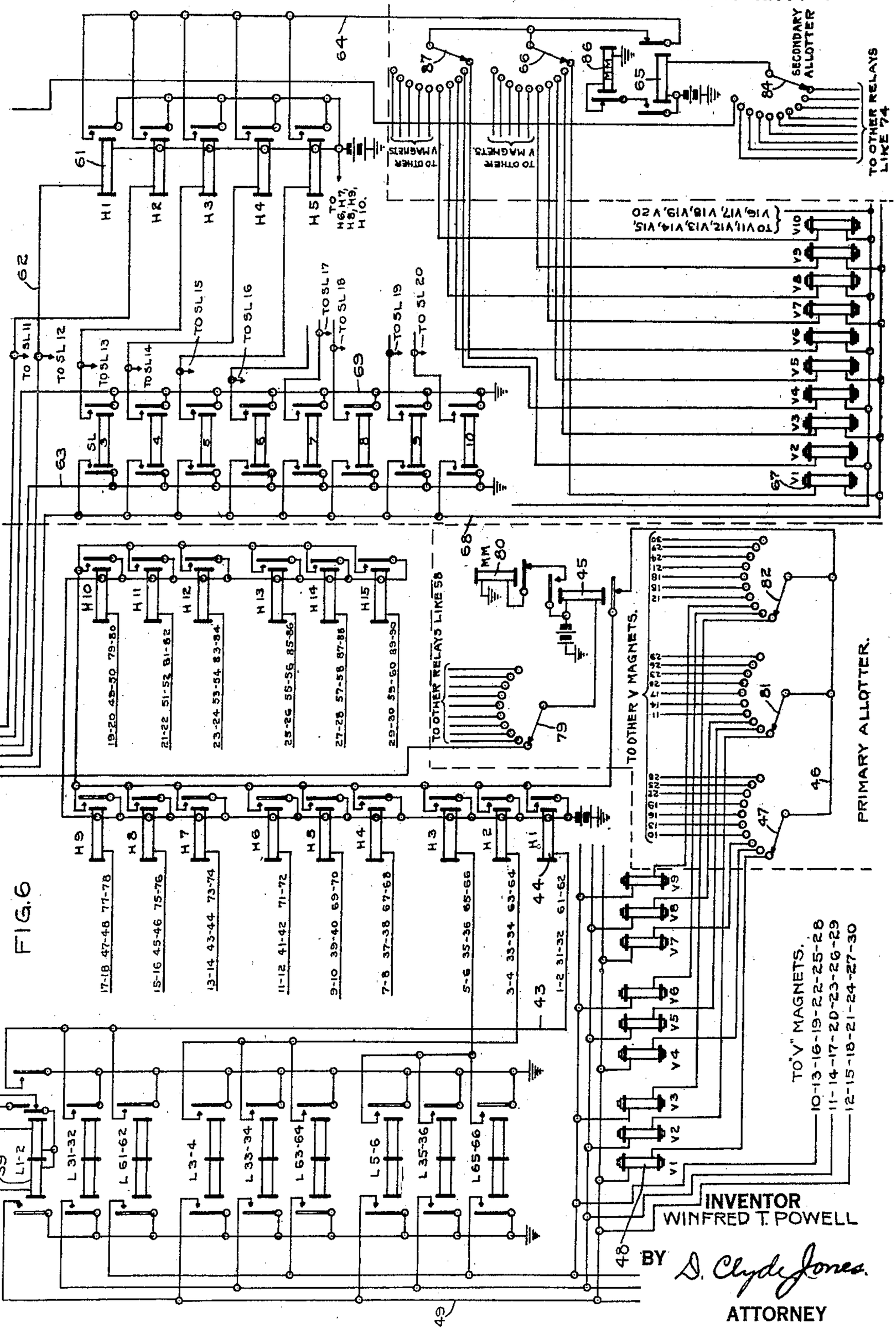

FIG. 6

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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 April 29, 1922. Serial No. 557,455.

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 some portion of a telephone connection.

The present invention has for its purpose novel means for extending calling lines to idle trunks.

The main feature of this invention resides in the mechanical structure and operating circuits by which means including a cross-bar switch function to extend a pair of telephone lines to a pair of idle trunks on the initiation of a call on one of said pair of telephone lines. Other features of this invention will appear from the detailed description and appended claims.

In the drawings Fig. 1 represents a side elevation of a cross-bar switch with many of its parts omitted and certain of its portions broken away in order that a clear understanding of the same may be had. Fig. 2 represents a side view of the spring terminals or spring combinations of lines and trunks as well as means by which these spring combinations are brought into engagement. Fig. 2^{A} is an end view of said spring combinations. Fig. 3 represents a detailed view of the cross bar switch. Fig. 4 shows two different views of a so-called vertical bar, the purpose of which will be hereinafter described.

Figs. 5 and 6 when taken together represent a portion of a telephone system, the portion of the diagram shown at the left of Fig. 5 represents the substation circuits and lines of two subscribers terminating in the terminal springs of a primary cross bar switch. In this figure, above the dotted line there is represented an odd spring combination of a secondary cross-bar switch, while below this line there is represented an even spring combination of such switch, and at the extreme right of this figure there is represented a portion of the operating circuits of a connector switch. At the left of the dotted line which divides Fig. 6 into two parts there is represented the line relays of a plurality of lines and certain of the so called vertical and horizontal magnets of the primary cross bar switch of Fig. 1 and also a primary allotter for allotting idle trunks for use. At the right of the mentioned dotted line there appear certain of the relays of a primary group of trunks as well as the horizontal and vertical magnets of a secondary cross-bar switch and a secondary allotter which functions to allot idle secondary trunks for use.

The switch structure.

A cross-bar switch is structurally shown in Figs. 1 to 4 inclusive as having a frame member 10 with many supporting brackets on which various portions of the switch structure are mounted. The subscribers' lines and the trunks terminate in sets of resilient springs generally designated 11, secured to the frame and shown in detail in Fig. 2. These sets of springs are very similar to the well known listening keys now in use, except that they are arranged to be operated automatically instead of manually. A bar 12 is arranged for horizontal motion either towards the right or towards the left and actuates the long motor springs of the various sets while a roller 13 mounted thereon is engaged by an irregularly shaped spring 94 to hold the bar and its actuated springs in a position to which it has been moved. It should be noted at this time that the bar 12 in either its right or left movement simultaneously actuates two sets of terminal springs as shown in Fig. 1 or in the right hand view of Fig. 2. The mechanism for operating the various bars 12 includes a plurality of vertical bars 14 provided with a crank arm 15 and spaced extensions or lugs 16, all mounted for rotation in the frame 10. The rotation of the bar 14 is effected by expansive air chambers 17 and 18 commonly known as sylphons, operated by a supply of compressed air applied through an air supply pipe 19. The magnet 20 operates a valve 21 to release a supply of air into air chamber 17 while a magnet 22 actuates valve 23 to allow air to pass into the expansive air chamber 18. It will of course be understood that the number of vertical bars such as 14 will depend upon the number of

lines which terminate in each switch. A plurality of horizontal bars 24 are likewise mounted for rotation in the frame 10. Each bar 24 has off-set portions to prevent its interfering with the operation of the sets of terminal springs 11 and is also provided with lugs 25 shown in detail in Fig. 3 and a crank portion not shown. The expansive air chamber 26 is mounted to engage the crank portion for rotating the horizontal bar 24 so that its lugs 25 are moved downward between the extensions 16 and 33 as shown in Fig. 3. A magnet 27 actuates a valve 28 to release air into the expansive chamber 26 to rotate bar 24. A second series of vertical bars 29 are provided with triangular openings such as 30, which function to restore bars 12 to normal position. Each opening in bar 29 receives a roller such as 31 carried on the end of bar 12 so that when the release bar 29 is elevated the roller 31 engages the sides of the opening 30 to move the bar 12 with its motor springs into neutral position as shown in Fig. 1. A set of three release bars 29 are actuated by the expansive chamber 32 but this is due to the coupling of lines and trunks in the primary cross-bar switch.

In the operation of the switch a pair of idle trunk circuits are normally allotted for use as will be described so that on the initiation of a call, a magnet such as 27 operates its valve 28 which in turn admits air into expansive air chamber 26 to rotate the horizontal bar 24. This operation brings the lugs 25 between sets of lugs 16 and pairs of arms 33 carried by the bars 12, then either magnet 20 or 22 is operated. Let it be assumed that the magnet 20 is operated to actuate its valve 21 to release air into the expansive chamber 17, which rotates the vertical bar 14 towards the left. The lug 25 communicates this motion through extensions 33 to move the bar 12 towards the left until the roller 13 engages the left hand catch of spring 94. This catch tends to hold the line and trunk terminals in engagement until the time that a release magnet such as 34 operates a valve 35 to actuate the expansive air chamber 32. This elevates the set of three release bars 29 to move the bar 12 and its motor springs to normal position.

The structure of the primary and secondary cross-bar switches is the same except that in the primary cross-bar switch the number of spring combinations 11 as well as the number of release bars are greater than those of the secondary cross-bar switch. It has been pointed out that in the primary cross bar switch the spring combinations, such as 11 comprise four sets of line and trunk terminals and the release bars are arranged in groups of three, each group being actuated by the operation of a single expansive chamber, such as 32.

In the secondary crossbar switch, the spring combinations such as 11 include the two sets of springs corresponding to what is known as an odd spring combination or an even spring combination. Also in the secondary cross-bar the release bars are arranged in groups of two, each group being operated by a single expansive chamber.

The purpose of arranging the primary release bars in groups of three while the release bars of the secondary cross-bar switches are arranged in groups of two will appear from the grouping of the lines and trunks which will now be described.

Grouping.

In this system the subscribers' telephone lines may be arranged in groups of ninety lines, which are further subdivided into three sub-groups of thirty lines each. These ninety lines have access to twenty primary trunks each trunk being accessible to each of the lines of each of the sub-groups, which explains why the primary cross-bar switch operates its release bars in groups of three.

The twenty primary trunks are, for convenience, sub-divided into an odd and even group which have access to ten secondary trunks. These trunks, therefore, appear before the two groups of primary trunks from which it will appear that it is necessary to operate the release bars in pairs.

It should be stated that each line is multiply connected to sets of springs arranged in rows extending in one direction, for example vertically, while each trunk is multiply connected to sets of terminal springs arranged in rows extending in another direction, for example horizontally. A set of multiple terminals of each line are associated with one of the sets of multiple terminals of each trunk of its group. While it has been stated that the lines are multipled vertical and the trunks are multipled horizontally, it will be understood that these connections may be reversed without departing from the present invention.

The system.

It is believed that the invention will best be understood by describing the method of extending a calling telephone line to an idle secondary trunk terminating in a numerical switch. When the subscriber at substation A removes his receiver from its switch hook a circuit is closed from ground, outermost right hand back contact and armature of cut-off relay 36, over the upper side of the calling line and through the substation circuits in series, over the lower side of the calling line, armature and back contact 37 of relay 36, conductor 38, right hand winding of relay 39, continuity spring and back contact of this relay, conductor 40, back contact and armature of slow-releasing relay 41 to grounded battery. It should here be

stated that relay 41 is common to all the lines or a group and functions to permit one pair of lines and one pair of trunks only to be interconnected at one time.

The relay 39 is energized in this circuit and closes a substitute energizing circuit for itself through its continuity spring and armature, conductor 42, winding of relay 41 to grounded battery, to actuate relay 41. As soon as the line relay 39 is operated to attract its armatures, a circuit is closed from ground, its outer armature and front contact, conductor 43, winding of horizontal magnet 44 to grounded battery. It has already been pointed out that this magnet which corresponds to magnet 27 of Fig. 1, rotates the horizontal bars 24 to position the lug 25 between extensions 16 and 33, and it now closes a circuit from grounded battery, armature and front contact of this magnet, lower armature and back contact of relay 45, conductor 46, allotter brush 47, winding of vertical magnet 48, conductor 49, left hand front contact and armature of relay 39 to ground. Magnet 48 corresponding to magnets 20 and 22 of Fig. 1, thereupon rotates vertical bar 14 to bring the sets of springs 50 to 56 inclusive into engagement and extend the calling line A to a selected primary trunk circuit. It will also be seen that the line extending from substation B is connected to an idle primary trunk circuit, but this connection is ineffective until the subscriber at B originates a call.

As soon as the calling line is extended to an idle primary trunk, secondary line relay 58 is energized in a circuit extending from grounded battery, winding of this relay, inner back contact and armature of relay 59, over the lower side of the selected trunk and calling line in series, through calling substation circuits, over the upper side of the calling line and selected trunk in series, back contact and armature of relay 59 to ground. At the outer right hand armature and front contact of relay 58 a locking circuit is closed for slow releasing relay 41, over conductor 60 which maintains the relay 41 operated until a secondary trunk has been seized, at the same time a circuit is closed from grounded battery, winding of horizontal magnet 61 of the odd secondary cross bar switch, conductor 62, outer front contact and armature of relay 58, conductor 63 to ground. The magnet 61 actuates the horizontal bar such as 24 of the secondary cross-bar switch and at the same time closes a circuit from grounded battery, its armature and front contact, conductor 64, armature and back contact of relay 65, secondary allotter brush 66, winding of vertical magnet 67, conductor 68, inner front contact and armature of relay 58, conductor 69 to ground. The vertical magnet 67 actuates the vertical bar such as 14 to close an odd spring combination including contact springs 70, 71 and 72. This extends the calling line of the selected primary trunk to the impulse relay of the selected numerical switch circuit such as is disclosed on page 57 of "Automatic Telephony" by Smith & Campbell, first edition. The impulse relay 73 is energized over the extended connection in the well known manner to close an operating circuit for the slow releasing relay 74, which in turn controls the release of the numerical switch or connector by the release magnet 75. As soon as the secondary trunk is seized contact springs 72 are closed to complete a circuit from ground, over conductor 76, winding of the relay 59, upper winding of slow releasing relay 57 to grounded battery. Relays 57 and 59 are operated at this time and relay 59 disables relay 58. Also the operation of relay 59 applies a busy potential to the terminals of the primary allotter, over a circuit traceable from ground, outer armature and front contact of relay 59, conductors 77 and 78, terminal and brush 79 of the primary allotter, winding of relay 45 to grounded battery. At the lower armature and front contact of this relay the operating circuits of all the vertical magnets of the primary cross-bar switch are opened to prevent primary trunk selection at this time while at the upper armature and front contact of this relay the circuit is closed for the motor magnet 80 of the allotter causing it to advance its brushes 47, 81, 82 and 79 until the brush 79 engages a terminal which is characterized by the absence of ground potential.

As soon as the relay 74 of the connector switch is operated it applies busy potential to the secondary allotter switch over a circuit completed from ground, armature and front contact of this relay, conductor 83, terminal and brush 84 of this allotter, winding of relay 65 to grounded battery. Relay 65 is thus energized and at its armature and back contact opens the operating circuits for all the vertical magnets of the secondary cross bar switch. At the armature and front contact of this relay, an operating circuit is closed for the motor magnet 86, which causes this magnet to advance the brushes 66, 84 and 87 of the secondary allotter until its test brush 84 engages an idle secondary trunk indicated by the absence of ground potential at its test terminal.

It is not necessary to describe the remainder of the operation of the numerical switches to extend the calling line to the called line and to signal this line since this operation may take place in the well known manner. At the close of the conversation, however, when the calling subscriber replaces his receiver on its switch hook, relay 73 again deenergizes and shortly afterwards the slow releasing relay 74 deenergizes to

complete a release circuit for the release magnet 75, which effects the release of the connector switch in the well known manner. Also at the armature and front contact of release magnet 75, a circuit is closed for operating a release magnet 88, which is individual to the secondary trunk circuit of Fig. 5 and which is effective to restore the operated sets of contacts of the secondary cross-bar switch. The release magnet 88 corresponds to magnet 34 of Fig. 1 and is effective to restore the sets of contacts 70, 71 and 72 to normal position. At this time, spring 72 reopens to permit the deenergization of relay 59 and thereby completes an operating circuit for the release magnet 34 of the primary switch, traceable from grounded battery, winding of this magnet, front contact and armature of relay 57, back contact and right hand armature of relay 89, right hand back contact and armature of relay 59 to ground. The magnet 34 elevates its set of three release bars 29 to effect the release of the sets of springs 50 to 56 inclusive.

It is to be noted that the telephone line terminating at substation B is extended to an idle secondary trunk by the operation of the primary cross bar switch. In the event that the subscriber at B desires to initiate a call at this time, the relay 90 is energized to effect the operation of the even spring combination of the secondary cross bar switch, which seizes an idle secondary trunk similar to that shown in Fig. 5.

Let it be supposed that substation A is called by some one of the connector switches where it terminates. This applies ground to its test conductor 91, over which a circuit is closed through the innermost right hand armature and back contact of relay 36, left hand winding of relay 39, its continuity spring and back contact, conductor 40, back contact and armature of relay 41 to grounded battery. Relay 39 is thus operated and is effective to cause the operation of the primary cross bar switch in the manner already indicated to extend the lines terminating at substations A and B to idle secondary trunks. The odd spring combination of the secondary cross-bar switch, however, will not be operated to seize an idle secondary trunk since the relay 59 is operated in a circuit from grounded battery, upper winding of relay 57, winding of relay 59, contacts 53, conductor 91 to ground at the connector switch as mentioned. The cut-off relay 59, by its operation prevents the actuation of the odd spring combination of the secondary cross-bar switch. The line terminating at substation B, however, is extended to the even spring combination of the secondary cross-bar switch, and if at this time the subscriber thereat initiates a call the even spring combination is operated to select an idle secondary trunk leading to a numerical switch.

What is claimed is:—

1. In a telephone system, a plurality of telephone lines arranged in pairs, a plurality of trunks arranged in pairs, contacts in which said lines and trunks terminate, means for allotting trunks in pairs and means including cooperating bars acting through intersecting planes to connect a pair of lines to an allotted pair of trunks.

2. In a telephone system, a plurality of telephone lines arranged in pairs, a plurality of primary trunks arranged in pairs, a plurality of secondary trunks, contacts in which said lines and primary trunks terminate, means for allotting primary trunks in pairs, means including cooperating bars acting through intersecting planes to connect a pair of lines to an allotted pair of primary trunks, non-numerical switch in which primary and secondary trunks terminate and means for operating said non-numerical switch.

3. In a telephone system, a plurality of telephone lines arranged in pairs, a plurality of trunks arranged in pairs, contacts in which said lines terminate, means for allotting trunks in pairs, means including cooperating bars acting through intersecting planes to connect a pair of lines to an allotted pair of trunks, a cross-bar switch in which said trunks terminate, secondary trunks terminating in said cross-bar switch, and means for operating said cross-bar switch to interconnect said secondary trunks with said primary trunks.

4. In a telephone system, a plurality of pairs of telephone lines, a plurality of pairs of trunks, sets of contacts in which said telephone lines and trunks terminate, a movable member for closing the contacts of a pair of lines and a pair of trunks to interconnect the same, and means for actuating said member on the initiation of a call on one line of said pair of telephone lines.

5. In a telephone system, a plurality of pairs of telephone lines, a plurality of pairs of trunks, sets of springs in which said telephone lines and trunks terminate, a movable member for closing the springs of certain of said pairs of lines and a pair of trunks to interconnect same, means for operating said member on the initiation of a call on one of said pairs of telephone lines, secondary trunks, secondary sets of springs in which said first mentioned sets of trunks and said secondary trunks terminate, and means for actuating certain of said secondary springs to connect a selected trunk with a secondary trunk.

6. In a telephone system, a plurality of pairs of telephone lines, a plurality of pairs of trunks, springs in which said telephone lines and trunks terminate, a longitudinally movable bar for actuating said springs to in-

terconnect a pair of lines including the calling line with a pair of trunks, means including bars cooperating through intersecting planes for actuating said movable bar, and means for actuating said cooperating bars on the initiation of a call on one of said telephone lines.

7. In a telephone system, a switch having a plurality of sets of resilient springs arranged in pairs in vertical and horizontal rows, pairs of telephone lines multiply connected to said sets of springs in a row extending in one direction, a pair of trunks multiply connected to corresponding springs of said sets in a row extending in another direction, and means operating on the initiation of a call on one of a pair of telephone lines for closing a pair of sets of springs to interconnect the pair of telephone lines including the calling line with a pair of idle trunks.

8. In a telephone system, a switch having a plurality of sets of springs arranged in pairs in vertical and horizontal rows, pairs of telephone lines multiply connected to said sets of springs in a vertical row, a pair of trunks multiply connected to corresponding springs of said sets in a horizontal row, means for allotting trunks for use, and means operating on the initiation of a call on one of a pair of telephone lines for closing a pair of sets of springs to interconnect the pair of telephone lines including a calling line with a pair of allotted trunks.

9. In a telephone system, a plurality of pairs of telephone lines, a plurality of pairs of trunks, and means operating through intersecting planes for interconnecting a pair of lines to a pair of trunks on the initiation of a call.

10. In a telephone system, a plurality of pairs of telephone lines, a plurality of pairs of trunks, means operating through intersecting planes for interconnecting a pair of lines and a pair of trunks when one of the said pairs of lines initiates a call, and means including secondary non-numerical switching means for extending said last mentioned trunks.

11. In a telephone system, a plurality of telephone lines arranged in pairs, a plurality of trunks arranged in pairs, contacts in which said lines and trunks terminate, and means including cooperating bars acting through intersecting planes to close the contacts of a pair of lines and a pair of trunks.

12. In a telephone system, a plurality of pairs of telephone lines, a single line relay for each pair of said lines, means including a circuit extending over either telephone line of a pair on the initiation of a call for actuating its line relay, a plurality of pairs of trunks, and means operating through intersecting planes for interconnecting a pair of lines and a pair of trunks, said means being controlled by said line relay.

13. In a telephone system, a plurality of pairs of telephone lines, a single line relay for each pair of said lines, means including a circuit extending over either telephone line of a pair on the initiation of a call for actuating its line relay, a cut-off relay associated with each line relay, a plurality of pairs of trunks, means operating through intersecting planes for interconnecting a pair of lines and a pair of trunks, said means being controlled by the line relay of said last-mentioned pairs of lines, and means including the cut-off relay of said pair of lines and controlled by the selection of an idle trunk for disabling its associated line relay.

14. In a telephone system, a plurality of telephone lines arranged in pairs, a plurality of trunks arranged in pairs, contacts in which said lines and trunks terminate, means including cooperating bars operating through intersecting planes to close the contacts of a pair of lines and a pair of trunks, and a release bar for operating said contacts.

15. In a telephone system, a plurality of telephone lines, a plurality of trunks, means including an allotter for simultaneously assigning two trunks for use, and means operating through intersecting planes for interconnecting certain of said lines and said allotted trunks.

16. In a telephone system, pairs of telephone lines arranged in groups, a plurality of pairs of trunks, means operating through intersecting planes for connecting a pair of lines to a pair of trunks, and means for permitting the extension of only one pair of trunks to one pair of lines of a group simultaneously.

In witness whereof, I hereunto subscribe my name this 15th day of April, A. D. 1922.

WINFRED T. POWELL.