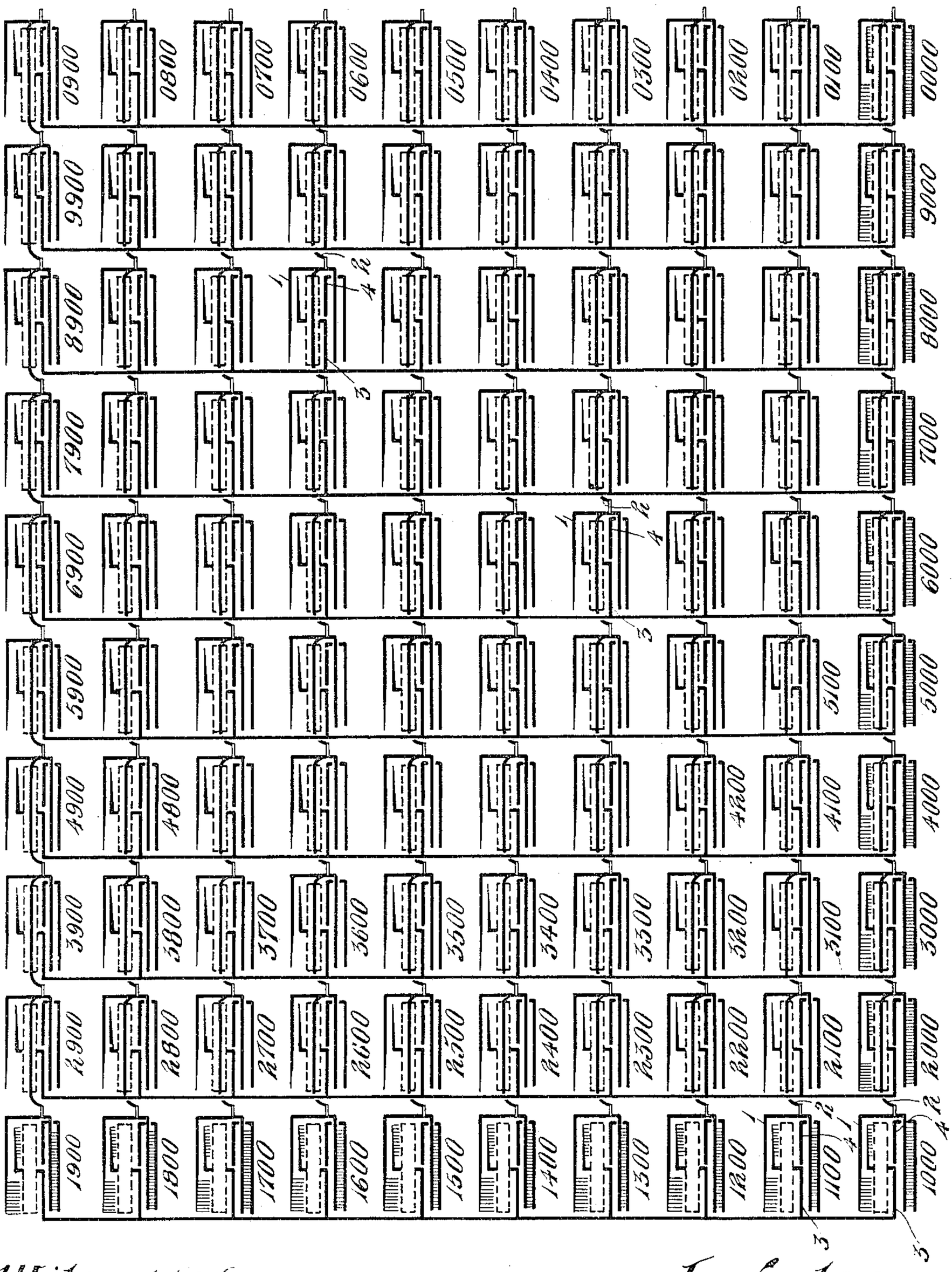
No. 831,876. PATENTED SEPT. 25, 1906.

A. E. KEITH.

SWITCHING OR TELEPHONE SYSTEM.

APPLICATION FILED MAR. 9, 1905.

6 SHEETS—SHEET 1.



Witnesses.
P. H. Bousfield
A Andersen.

Fig. 1.

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6 SHEETS—SHEET 2

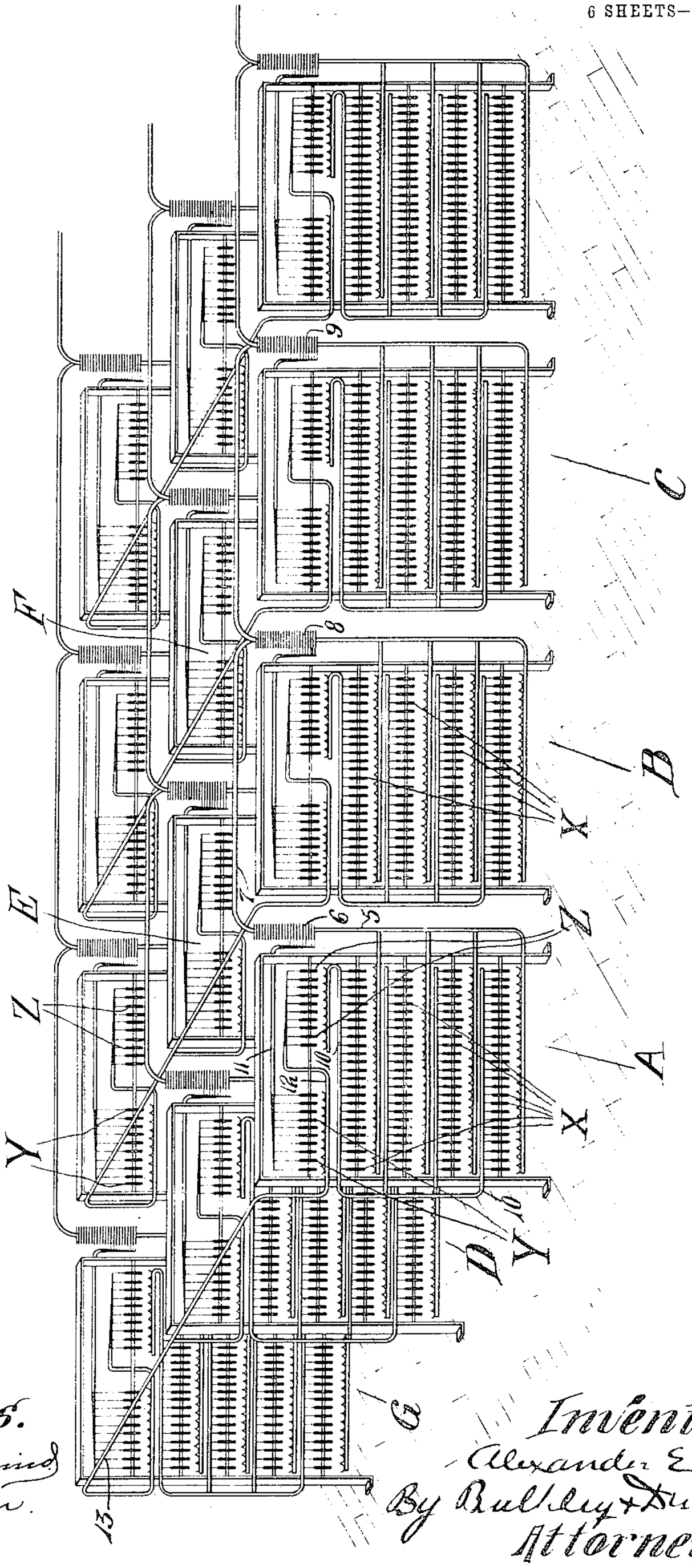

Fig. 2.

Witnesses.
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6 SHEETS—SHEET 3.

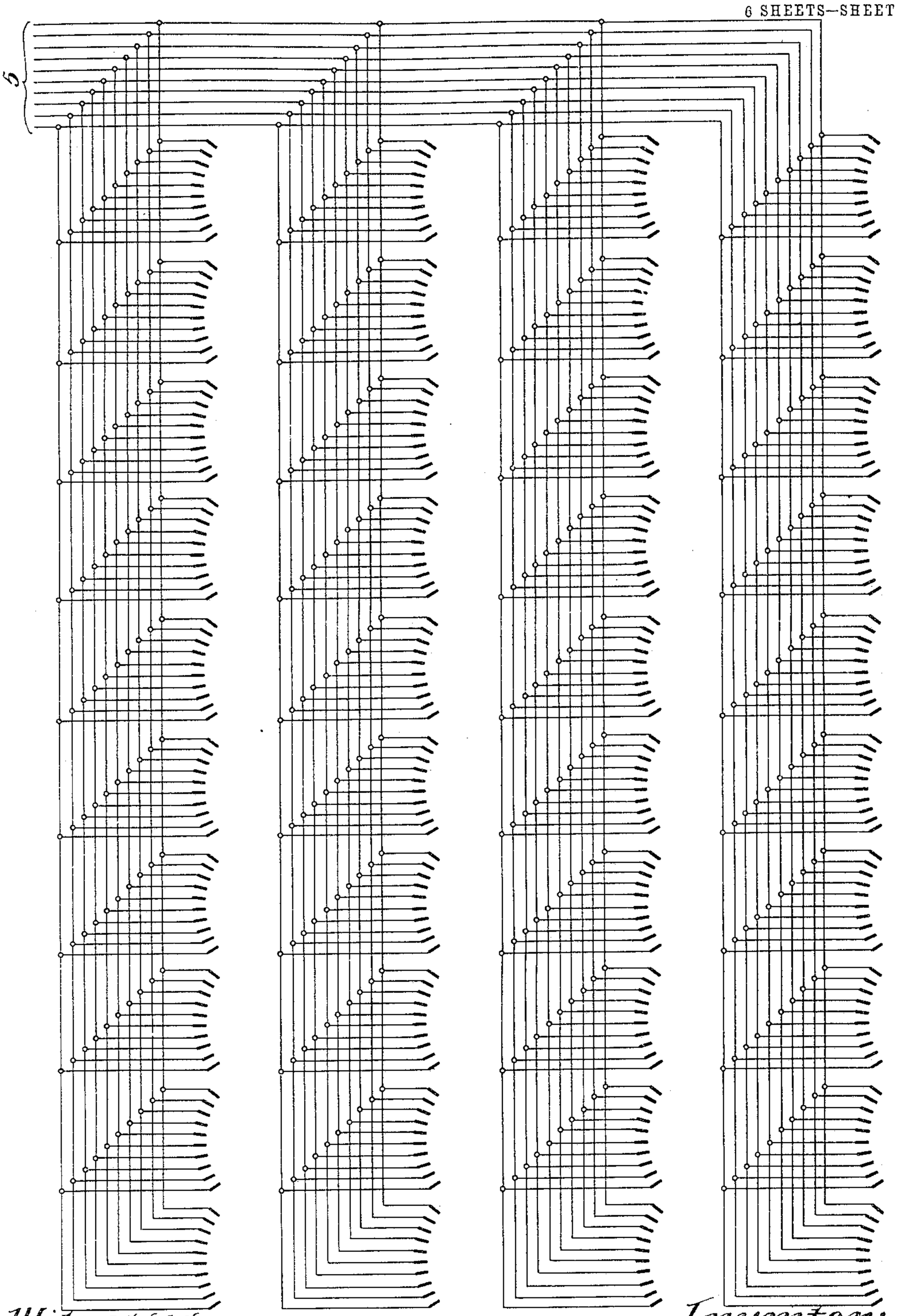

Fig. 3.

Witnesses.
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6 SHEETS—SHEET 4.

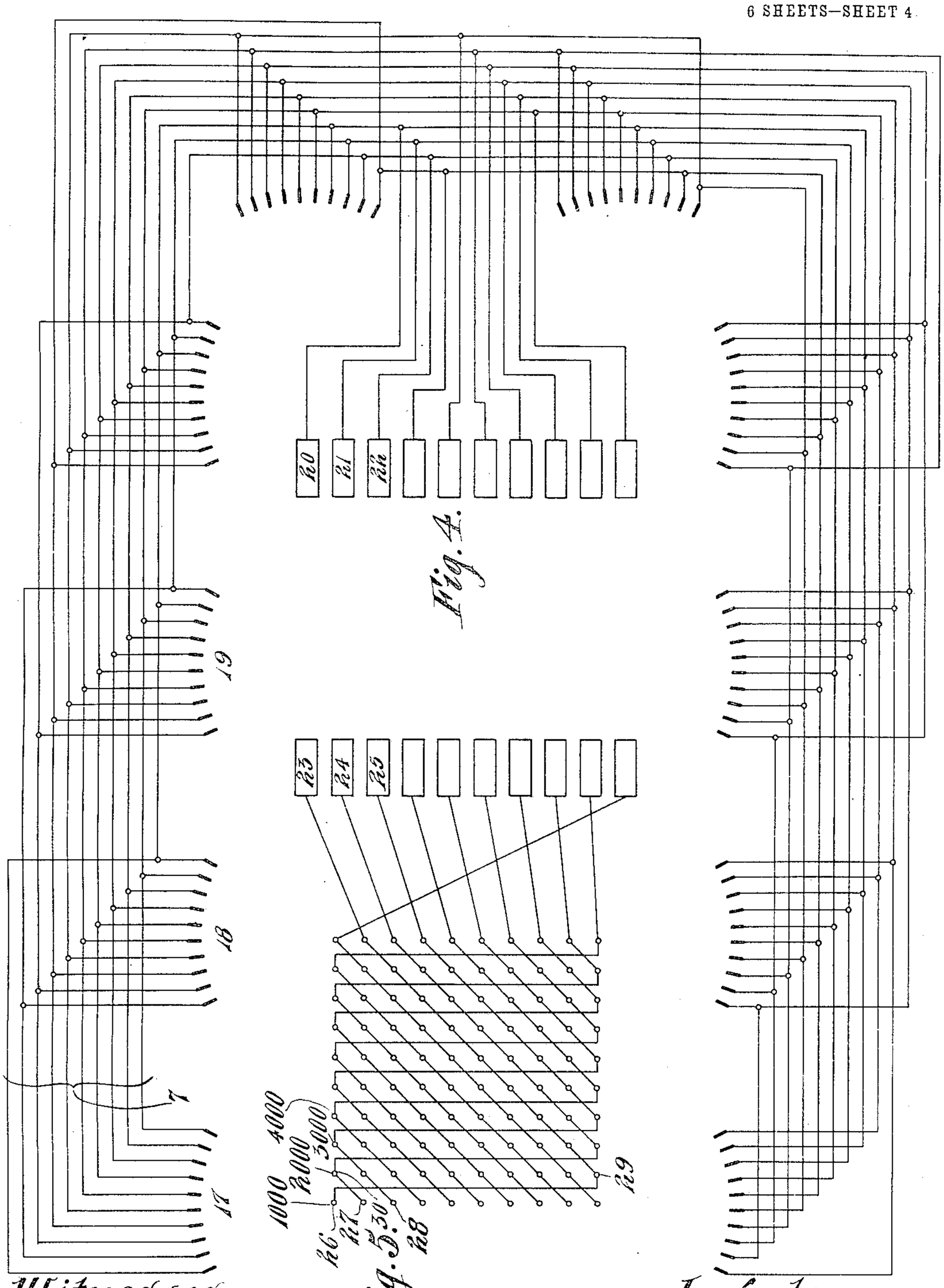

Fig. 4.

Fig. 5.

Witnesses.

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6 SHEETS—SHEET 5.

Fig. 7.

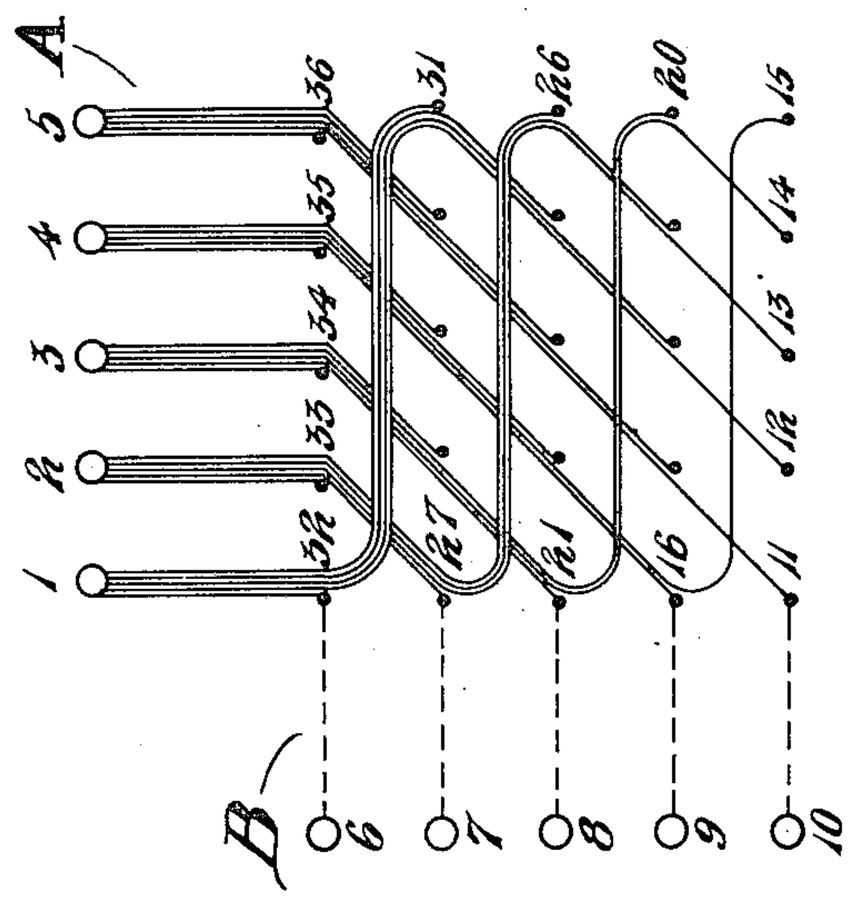
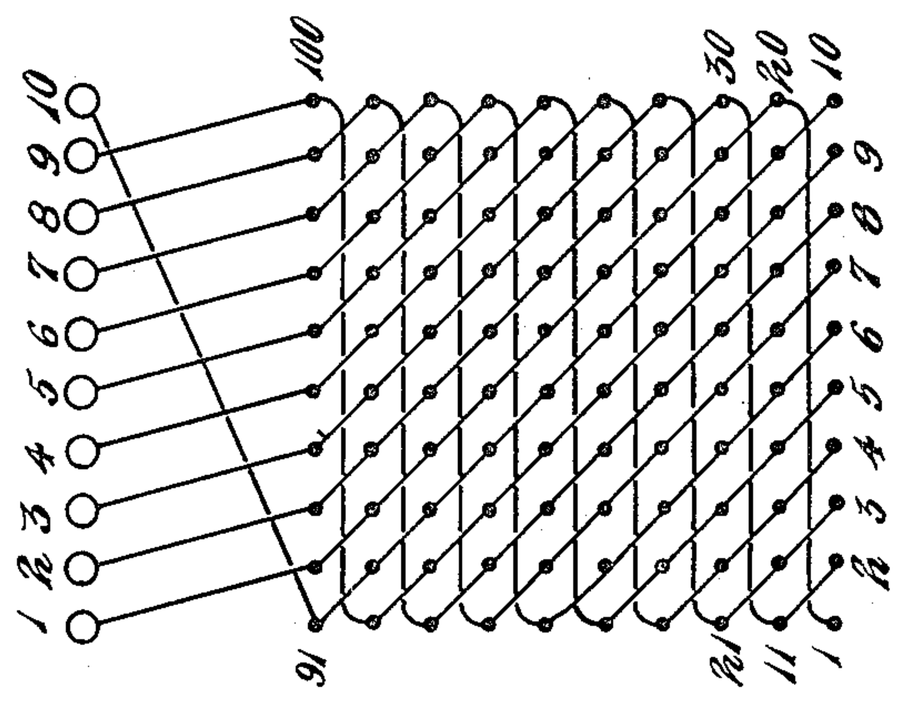


Fig. 6.



Witnesses.
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6 SHEETS—SHEET 6.

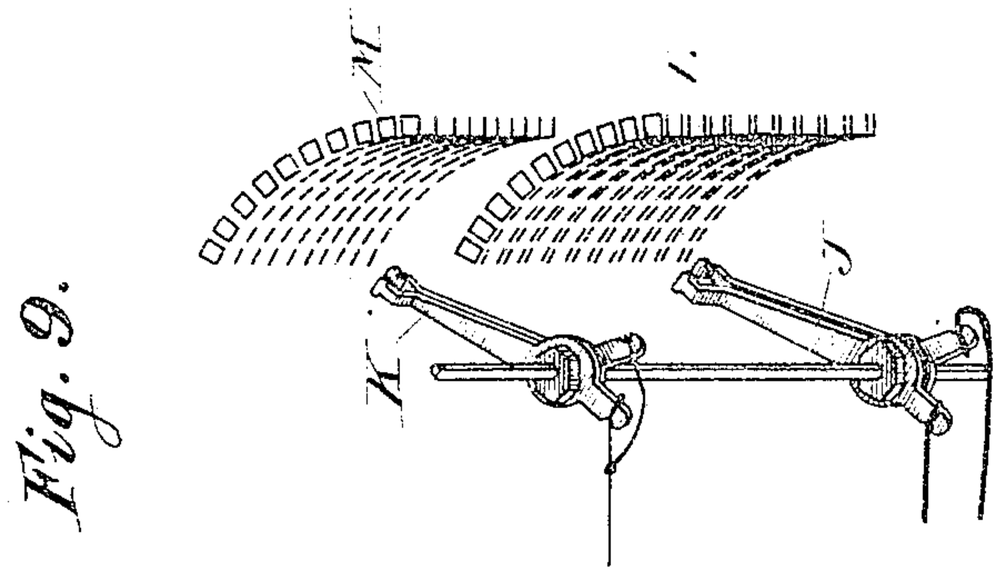

Fig. 9.

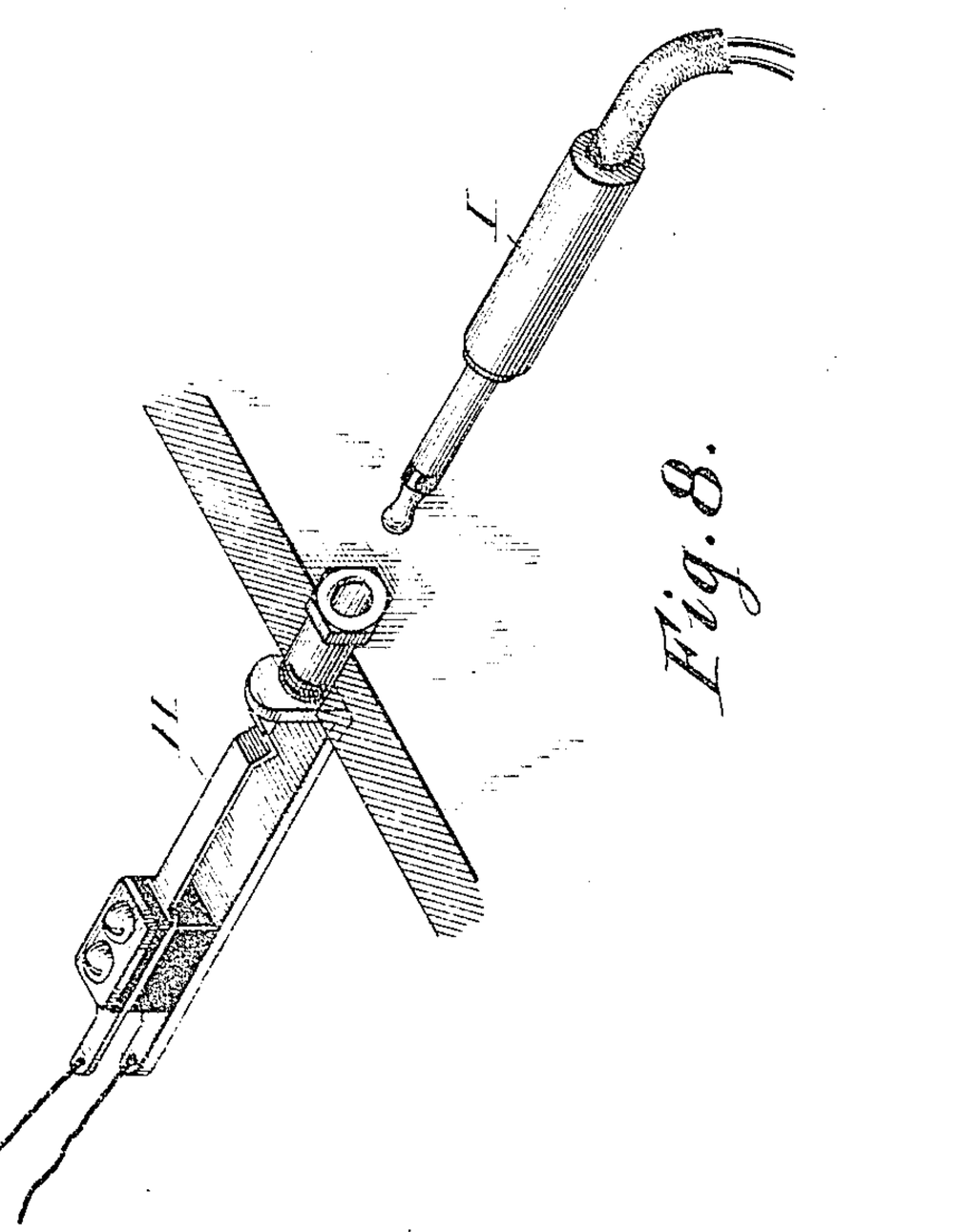

Fig. 8.

Witnesses.
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UNITED STATES PATENT OFFICE.

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SWITCHING OR TELEPHONE SYSTEM.

No. 831,876. Specification of Letters Patent. Patented Sept. 25, 1906.

Application filed March 9, 1905. Serial No. 249,189.

To all whom it may concern:

Be it known that I, ALEXANDER E. KEITH, a citizen of the United States of America, and a resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Switching or Telephone Systems, of which the following is a specification.

My invention contemplates an improved arrangement for automatic telephone-exchange wiring or cabling.

Prior to my invention in wiring automatic exchanges it has been customary, so far as I am aware, to locate "first selectors," "second selectors," and "connectors," as they are commonly called, on boards or frames by themselves, thus making the wiring very complicated and rendering it quite difficult to trace or locate calls. With my improved arrangement, however, which provides for, say, one hundred first selectors with the necessary second selectors and connectors for trunking on the same board, the wiring is very much simplified, and, furthermore, calls are much more easily traced or located by the attendant at the exchange—that is to say, if an attendant sees a second selector, for example, "off normal," so to speak, he is with my improved arrangement able to tell at once exactly from which board of first selectors the call came, and this is of course also true of the connectors.

Still another and one of the principal advantages of my improved arrangement consists in this that the original installation of any exchange may be of any desired size and that additions may be made at any time without interfering with the apparatus which is in use at the time it is desired to enlarge or extend the capacity of the exchange. Again, my improved method of wiring insures an advantageous and economical distribution of the work or "load," as it is sometimes called, among the different second selectors and connectors, which is a great advantage and material improvement, inasmuch as by so doing the wear on these switches is rendered uniform; also, as will hereinafter more fully appear, my improved method of wiring is applicable to telephone systems including both automatic and manual switchboards or to systems including only manual switchboards—that is to say, exchanges in which the connections are made by operators rather than by automatic switches.

More specifically considered and to the foregoing and other useful ends, my invention contemplates as one feature of improvement a system comprising a plurality of switching positions—such, for example, as a plurality of automatic switches or a plurality of telephone-operators' switching positions and a plurality of trunk-lines leading to said positions—together with terminals—such, for example, as the contacts of automatic switches or the contacts of the spring-jacks usually employed in manual-board systems, these terminals being connected with the other ends of said trunk-lines or other line-conductors, the said terminals being arranged in a plurality of groups, and in each case all terminals connected with a particular trunk-line occupying dissimilar positions in the different groups, so that in each case all terminals occupying similar or like positions in the different groups are connected, respectively, with as many different trunk-lines and whereby the telephone-operator, automatic switch, or whatever other provision may be made for each group of subscribers will have first "chance," so to speak, at a terminal connected with a trunk-line other than those at which any other operator or switch allotted to other groups would have first chance in endeavoring to select an automatic trunk-line—that is to say, if the operator or switch allotted to one group of terminals makes connection with the first terminal in such group the operator or switch allotted to another group may then select another or non-busy trunk-line by making connection with the first terminal, it being possible in this way for all of the operators to plug into the first jacks or terminals of their respective groups of terminals or for all of the automatic switches to make connection with the first terminals in their respective groups and still all attain connection with as many different trunk-lines, the possibility or probability of each operator or switch when called upon to select an idle trunk-line being able to make such a selection by simply selecting the first terminal in the group and without going any farther being largely and quite advantageously increased.

To these and other ends, however, my invention consists in matters hereinafter set forth and claimed.

In the accompanying drawings, Figure 1 is

a diagrammatic "floor-plan," so to speak, of an automatic telephone-exchange, embodying the principles of my invention. Fig. 2 is a perspective of a portion of said automatic telephone-exchange or of an exchange of smaller capacity. Fig. 3 is a diagram illustrating the method of multiplying together the contacts of the same or like bank-levels in the different automatic switches of a single frame or switchboard. Fig. 4 is a diagram illustrating the method of multiplying together the contacts of like or similar bank-levels of the automatic switches of a plurality of groups of switches—that is to say, of a plurality of frames or switchboards. Fig. 5 is a simplified diagram illustrating what is shown in Fig. 4—that is to say, showing ten distinct groups of terminals, but all of the same "level," as it is called, and connected with the second selectors or with the connectors, as the case may be. Fig. 6 is a diagram similar to Fig. 5, but showing my invention applied to the trunking between an automatic exchange and a manual exchange. Fig. 7 is a diagram illustrating the application of my invention to the trunking between two manual-board telephone-exchanges. Fig. 8 shows an ordinary spring-jack and operator's switch-plug for making connection with a trunk-line, as hereinafter described. Fig. 9 shows the bank-contacts, shaft, and shaft-wipers of a well-known form of automatic switch, such as any of those hereinafter referred to, it being understood that any suitable mechanism can be employed for operating the said shaft in a well-known manner.

As thus illustrated and referring to Fig. 1, it will be seen that the arrangement involves a complete ten-thousand-subscriber system—that is to say, an automatic exchange in which provision is made for service between substantially or approximately ten thousand subscribers. It will be seen that the switch-frames, or "switchboards," as they may be called, are in this diagram arranged in rows of ten from bottom to top of the figure and also in rows of ten from left to right. As indicated in Fig. 1, each of the rows extending from bottom to top represents a certain thousand in the exchange—that is to say, the first row to the left represents all subscribers' numbers beginning with "1,000," the second row all numbers beginning with "2,000," and so on to the last row, which represents all numbers in what is called the "naught thousand." The naught in these numbers has a certain significance, for wherever it occurs it refers to the tenth-thousand group, the tenth-hundred group, the tenth bank-level, or the tenth contact in a level. On the other hand, and taking the rows which run from left to right of the diagram, the bottom row represents all subscribers' numbers, the last three digits of which amount to less than one hundred, while the next row represents all subscribers' numbers the last three digits of which amount to one hundred and less than two hundred, and so on to the top row, which represents all subscribers' numbers, the last three digits of which amount to nine hundred or over. For example, the first board at the lower left-hand corner would be number "1,000"—that is to say, it would have upon it all of the first selectors of subscribers whose numbers range from "1,000" to "1,099." Again, the second board in this row would represent all the subscribers whose numbers range from "1,100" to "1,199," and so on throughout this entire row to the board in the upper left-hand corner, which latter would have upon it the first selectors of all subscribers whose numbers range from "1,900" to "1,999." In a similar manner the second or "2,000" row would contain the first selectors of all subscribers whose numbers range from "2,000" to "2,999." Preferably each of these boards carries the second selectors used by its first selectors and by the first selectors of other boards which are multipled with these first selectors in calling into the thousand row or group in which this board is located. As will hereinafter more fully appear, each board also carries the connectors, which are used by the entire exchange—that is, by any subscriber in the exchange—for calling any subscriber whose line terminates at this particular board. Referring again to the diagram, it will be seen that the row running from left to right at the bottom of the figure contains all boards representing subscribers' numbers ranging from "1,000" to "1,099," from "2,000" to "2,099, from "3,000" to "3,099," &c., to the end of the row, the second digit of any subscribers' number in this row being invariably a naught or a zero or, in the case of the board in the lower right-hand corner of this figure, all numbers from "1" to "99," for it will be understood that in an exchange of this size no subscriber's number has more than four digits, the highest number, therefore, being "9,999." It is evident, therefore, that each of these rows leading from left to right and extending horizontally when the diagram is viewed in its proper position contains the firs selectors representing the same hundred—that is to say, all of the first selectors in each of these rows represent subscribers whose numbers have the same hundred, but whose numbers are found in different vertical or thousand rows. Furthermore and in a general way, the method of running the cables between these different boards is also shown in this diagram. For example, the cable 1 extends from the "first-selector" banks to the second "selector-switches," these two kinds of switches being on the same board. Also, as shown, the cable 2, which is multiplied from this cable 1,

extends the connections of these selector-banks to the different boards in this same hundred row—that is, it multiplies together all first "selector-bank contacts" in this particular row of hundreds. The cable 3 extends from the second-selector banks to the "connector-switches," all of these switches being on the same board, and also multiplies the second-selector banks on this particular board with the second-selector banks in every other board in this particular group of thousands, or "thousand-row," as it may be called. In addition it will be seen from this diagram that the first-selector banks are multiplied together from left to right, so that the one-thousand board is multiplied with the two-thousand board, and then to the three-thousand board, and so on to the right-hand end of the row. On the other hand, however, the second-selector banks are multiplied together from bottom to top of Fig. 1—that is, from the one-thousand board to the eleven-hundred board, thence to the twelve-hundred board, &c., the same in each vertical row, as will hereinafter more fully appear. Looking at the diagram, the cable 4 extends from the connector-banks to the "normal jacks," as they are called—that is to say, to the devices by which the connector-line bank-terminals are connected through the selector-switch with their respective subscribers' lines. As illustrated, each of these cables is complete upon the board by which it is carried and to which it is allotted, and in this way the one hundred sets of "bank contacts" or "terminals," as they may be called, of the connectors are connected to the one hundred sets of normal jacks or subscribers'-line terminals of the first selectors on this particular board, there being, of course, but one set of normal jacks or terminals to each first selector. While the diagram shows a ten-thousand-subscribers' system, it is evident that the systematic, advantageous, and scientific distribution and relative arrangement of the different switches, boards, and of the cabling can be applied to an exchange of any desired size or capacity.

Referring more particularly to Fig. 2, which shows only twelve boards and which might serve as a twelve-hundred-line exchange, but having an ultimate capacity of approximately ten thousand subscribers, this figure illustrates the relative location of the first selectors, second selectors, and connectors, the first selectors X being shown on the four lower shelves of each board, the second selectors Y being shown at the left-hand end of the uppermost shelf of each board, and the connectors Z being shown at the right-hand end of the uppermost shelf of each board. As shown in this perspective view, the cabling from the first-selector banks is illustrated as extending, by way of cable 5, for example, to the terminal board 6, this particular cable being known as the "bank-cable," thence from the terminal board 6. The first level of the first-selector banks on the board A is trunked to the second selectors Y on said board by means of the cable 11, which latter is commonly known as the "first-selector trunk-cable." Also, as will be seen, the cable 7, commonly known as the "first-selector multiplying-cable," multiplies the contacts of said first level to the terminal board 8 and to the second selectors of the board B, also to the terminal board 9, and so on throughout this particular hundred-row and from each of said boards 8 9, &c., to the first-selector-bank contacts of the first level of the boards B C, &c. The same arrangement follows with respect to the second level of the first-selector bank-contacts of the board B, in which case the bank-cable leads to the terminal board 8 and from thence, by means of a selector trunk-cable similar to the selector trunk-cable 11 of board A, connection is made with the second selectors of the board B. Multiple connections are also made from the terminal board 8 and by way of the selector multiple cable 7 in both directions with the terminal boards 6 9, &c., and from the said terminal boards to the bank-contacts of the second level of the first selectors of the boards A C, &c. A similar arrangement is followed with respect to the third board C, in which case the third level is connected to the terminal board 9, from whence multiple connections are made to the second selectors of the board C by way of the selector multiple cable 7 to the terminal boards 6 8, &c., and with the bank-contacts of the third level of the first selectors of the third level in the said boards, and so on throughout the exchange. It is therefore evident that the second selectors of the first board A are allotted to the first level of the front row of boards A B, &c. The second selectors of the board B are allotted to the second level of the same boards, and the second selectors of the board C are allotted to the third level of the same boards, and so on. A similar arrangement follows with respect to the second or one-hundred row of boards in line with the boards D and likewise with respect to the third or second hundred row of boards, including the board G, and so on. At each one of these boards—as, for example, the board A—a first-selector trunk-cable 11 is installed, one end of which is suitably connected to second selectors on this board, the other end of which is connected at the terminal board 6 to contacts which are wired to bank-contacts of one level of the line-banks and the corresponding level of the private banks of all first selectors in this board. In this way the arrangement is such that if a first selector on the board A, for example, has its wipers in engagement with the first "bank-levels" of the line and private banks, respectively, of the first selector-banks,

this connection will be extended through to one of the second selectors Y of this board A; but if the same first selector has its wipers placed in engagement with the second bank-levels (line and private) of the board A, connection will then be extended through to the second selectors Y of the board B, and in a similar way the engagement of the first-selector-shaft wipers with the third bank-levels (line and private) would result in extending the connection through to the second selectors of the board C. In other words, the first selector of any board when operated by its allotted subscriber, or in any other way, picks out a second selector in the desired thousand-row. In the same manner if a first selector on the board B called in on the first bank-levels (line and private) of the first selectors it would be immediately connected with a second selector on board A; but if this same first selector called in on the third bank-levels of the first selectors the connection would then be extended to the second selectors on board C. Again, the board D would be wired in such manner that the calling in on different bank-levels of first selectors of this board would result in extending the connection to the second selectors on the board D, (the twelve-hundred board,) to board E, (the twenty-two-hundred board,) or to board F, (the thirty-two-hundred board,) depending upon which bank-level is brought into use. Also, if the second selectors on the board A were made to call in on the first bank-level of the line and private banks, respectively, of this board a connection will be extended through to the connectors on board A, assuming board A to be the eleven-hundred board, whereas if the call were made in the second bank-levels of the second selectors of this board the connection would then be extended through to a connector on the board D, assuming this latter board to be the twelve-hundred board, or, if any particular second selector called in on the third levels the connection would then extend through to a connector on board G, which latter may be considered as the thirteen-hundred board. The cable 12, which extends from the second-selector bank-terminal (not shown) to the connector-jacks on the same board with the banks, is commonly known as a second-selector "trunk-cable." The cable 13, which multiplies together the second-selector bank-terminals on the different boards, is commonly known as a "second-selector multiple cable." Also the cable 10 is ordinarily known as the "normal cable" and extends from the connector-banks to the first-selector normal jacks, and the normal cable is always complete on its particular board and does not extend to other boards. As illustrated in board A, the one-hundred sets of contacts or terminals, representing all subscribers whose numbers range from "1,100" to "1,199" of the connector-banks, are connected with the one hundred first selectors on this board, and consequently with the one-hundred subscriber's-line terminals allotted to this board and each first selector, and therefore each subscriber's line terminating at this board, being connected with a different set of connector-contacts.

In Fig. 3, which is a diagram showing the method of connecting together the contacts of any particular bank-level in the first selectors of the board A, for example, the ten sets of contacts with which each switch is provided, or ten "terminals," as they may be called, are shown arranged in subdivisions, one subdivision for each switch and each subdivision consisting of a series of terminals arranged along a definite line, preferably a curved line, as shown. In this way Fig. 3 may be said to represent the first-level terminals or contacts of all of the first-selector switches and the manner in which they are multiplied together of a board containing but forty first selectors, it being understood, however, that this arrangement would be carried out exactly as shown in a board equipped with one hundred switches—such, for example, as the board A. (Shown in Fig. 2.) In Fig. 3, however, it will be seen that all first-level terminals or contacts of the first selectors of the lower shelf are multiplied with the similar terminals or contacts of the next higher shelf, and so on, to the top first-selector shelf, and it will also be observed that in each case all terminals or contacts occupying similar or like positions in the different switches of this particular board are multiplied together—that is to say, contact 1 in the first level of one switch is multiplied with the first terminals of the first level of all other first selectors in this board, and this is true of all of the other contacts or terminals. In a smilar way all second contacts of any given level are multipiled together. All third contacts of any given level are multiplied together, and this principle or method of wiring is preferably retained throughout all of the first selectors of any particular board. The cable 5 from the terminals or contacts shown in Fig. 3, and which is known as the "bank-cable," leads to the terminal board 6. In Fig. 3 this cable 5 is shown as containing only the conductors or wires of this one bank-level, whereas in actual practice, as shown in Fig. 2, this cable 5 contains the wires or conductors leading from all of the first-selector bank-levels on this particular board. For convenience of illustration the wiring in Fig. 3 has been shown as consisting merely of a single wire leading from each terminal or set of contacts; but it will be understood that in practice each terminal thus shown diagrammatically consists, preferably, of three contacts, one for each side of the line-circuit and one for the private-bank,

and that three wires or conductors lead from each terminal or set of contacts to three bank-cable conductors included in the cable 5. Consequently with the arrangement shown the cable 5 will be composed of one hundred sets of conductors, each set consisting of three conductors and being connected with one hundred first-selector bank-terminals or sets of contacts of this particular board.

In Fig. 4, however, I have shown my improved method of connecting a given level of contacts or terminals of one board with the corresponding level of every other board in the particular hundred-row to which the same belong. For example, 17 may represent the terminals in the first or lowermost level of any first selector in the board A, it being remembered that the similar terminals or contacts of all other first selectors in this board are multiplied together and connected with these corresponding contacts or terminals of this particular switch, as shown in Fig. 3, and in the same way 18 may represent the first-level bank-contacts of a first-selector switch in the board B, the previously-described method of connecting like contacts or terminals being also true of this board, and 19 may represent the first level of a first selector in the board C, and so on to the first level in the board at the end of this particular hundred-row. It must be borne in mind, however, that this method of wiring applies either to the line or private bank-levels of either first selectors or second selectors or even to third selectors if the arrangement is to be applied to a system having a capacity of one hundred thousand subscribers—that is to say, a system in which the subscribers' numbers run as high as five digits. If these are to be considered as bank-levels of first selectors, then 17 may represent any bank-level—say the fifth, line, and private, respectively—of all the first selector on board A in Fig. 2, and 18 would represent the same bank-level of first selectors on the board B, and 19 would represent the same bank-level on board C, and so on to the end of the row. In this diagram, Fig. 4, 20, 21 ,22, &c., represent the second selectors to which these first-selector bank-contacts are connected. The method of wiring is as follows: The line and private bank-levels of the first selectors of the different boards are suitably connected to the line and release trunks of second selectors and illustrate the distribution of the work or load in such manner that the first selectors on one board call in first upon a certain second selector, while upon another board the first selectors call in first upon a different second selector, thereby advantageously and economically dividing the load or work among the different second selectors. The first selector on the board having bank-level 17, the latter having its wipers connected with the first contact will be connected through to the second selector 20, whereas the first selector on the board having the bank-level 18 in order to call this same second selector 20 must have its wipers connected with the tenth set of bank-contacts or terminals, and the first selector on the board having bank-level 19, if calling in on the ninth set of bank-contacts or terminals, will be connected with this same second selector 20. Considered in another aspect, however, while the first selector on the board having bank-level 17 calls second selector 20 by engaging the first set of jacks, first selector on the board having bank-level 18 in calling in on its first set of contacts or terminals would be connected with the second selector 21, and similarly the first selector on the board having bank-level 19 would be connected with second selector 22, and thus it is true that the first selectors on each board have the first chance to call a given second selector, while the first selectors on the different boards each have the first chance at calling a different switch. It will be understood, of course, that this method of wiring applies to all of the bank-levels between boards, whether first selectors, second selectors, or, in case of one hundred thousand systems, third selectors—that is to say, if bank-levels 17, 18, and 19 are considered as second-selector bank-levels switches 20, 21, and 22 would in such case be connectors, and the same general arrangement of connection would be carried out in the manner already explained. The wires 7 are the multiple-cable wires, either first-selector multiples or second-selector multiples, depending upon whether they multiply together first-selector banks or second-selector banks.

In Fig. 5 the method of wiring shown in Fig. 4 is shown in a simplified form. In this arrangement 23, 24, and 25 represent second selectors 20, 21, and 22 of Fig. 4, providing this diagram is to be considered in connection with a call coming from first-selector banks. The rows marked "1000," "2000," "3000," "4000," &c., represent a given bank-level of first selectors on different boards, such as the levels shown in Fig. 4. The small circles 26, 27, 28, &c., represent bank-contacts on these different boards. For example, 26 would be the first set of contacts on this bank-level on one board, such as the first contact on the level of bank-level 17, Fig. 4, 27 the second set of contacts or terminals of the same bank-level, and so on. The straight lines, as shown, represent the electrical circuits or connections from these different bank contacts or terminals through to the switches 23, 24, 25, &c. In this way it will be seen by tracing one circuit from contact 26 that in the one thousand group the first selectors calling the first contact or terminal 26 are thereby connected with the

switch 23, first selectors in the two thousand group calling the tenth contact or terminal 29 are connected with switch 23, in the three thousand group calling the ninth contact or terminal, and in the four thousand group the eighth contacts are connected with switch 23, and so on. In this same one thousand group it will be seen that a switch calling in upon the second contacts 27 would be connected with switch 24, whereas a switch in the two thousand group in calling the first contacts or terminals 30 would be connected with the switch 24, while in the three thousand group the tenth contacts or terminals would be connected with switch 24. With this arrangement it will be seen that the load or work is practically equalized or evenly distributed between the different trunking-switches. In considering this diagram in connection with second-selector banks the rows which are marked "1000," "2000," "3000," &c., would then be marked "1100," "1200," "1300," &c. Furthermore, the second-selector banks and the connector-banks of each separate board are connected together, as shown in Fig. 3—that is, the contacts are directly multiplied together, the first contacts of one bank-level being all connected together at different switches. Obviously this method of wiring is such that should an attendant be standing in front of any particular board in the exchange and see only the second selector No. 1 in operation he would know the call came from a first selector on a board in the same hundred and in the one thousand group. In like manner if he sees only the second selector No. 2 in operation he knows that the call comes from a first selector in the same hundred, but in the second thousand, or if the third second selector is in operation he knows that the call comes from the same hundred, but from the third thousand. Again, should he see only connector No. 1 in operation he would know that the call came from a second selector on the first or naught (0) hundred board of that particular thousand group, and if he should observe a second connector in operation he would know instantly that this particular call came from the same thousand group, but from the second or first hundred board. Obviously this cross-connecting of terminal contacts, as shown in Figs. 4 and 5 and for the purpose of distributing the load or work, is accomplished entirely by the multiple cables between different boards.

In Fig. 6 an arrangement is shown embodying my invention for trunking from an automatic exchange to switchboard-operators' positions in a manual exchange. In this diagram the circles represent trunking operators' positions, the work of which operators is, it will be readily understood, to receive and handle incoming calls from the automatic exchange. Ten operators' positions are shown, and the rows of black dots shown below these positions and numbered "1 to 10," "11 to 20," "21 to 30," &c., indicate the terminals of a selector bank-level used in calling the manual exchange. This terminal could of course be the end of a straight multiple of one hundred switches or one thousand switches or any other number of switches, depending upon the amount of business to be handled between the two exchanges. In a general way the arrangement will be such that each of these rows would constitute a terminal of a group of switches of approximately the same size—say, two hundred subscribers. The method of trunking from these different groups to the subscribers' positions, so as to advantageously and economically divide the work among the different operators, is illustrated by this diagram. As shown, the arrangement is such that, regardless of which of the two hundred group in the automatic exchange were the busiest, the work would be evenly divided among the operators, inasmuch as operator No. 1, for example, will be connected to the first contacts or terminals in one group, the tenth contacts or terminals in the next group numbered "11 to 20," the ninth contacts or terminals in the next group numbered "21 to 30," and the eighth in the next, the seventh in the next, and so on. Obviously, therefore, every other operator will be connected with the first contacts or terminals in one group, the second bank-contacts or terminals in another group, the third in another, and so on, so that the subscribers of the automatic exchange will, in each group, have the first chance, so to speak, at a different operator, second chance at still a different operator, and so on. This diagram does not, of course, attempt to show the number of trunks or trunk-lines that would be actually employed between the automatic switch contacts or terminals and the operators' positions of the manual exchange. It will be readily understood, however, that should the automatic groups be of the size suggested there would then probably be ten trunks or trunk-lines running into each subscriber's position, one from each of the bank contacts or terminals—that is to say, the line illustrated as connecting each operator's position with its allotted bank-contacts instead of being a single conductor would consist of a cable made up of one pair of conductors picked up at each of the ten pairs of line bank-contacts or terminals with which such operator's position is connected.

In Fig. 7, which illustrates the applicability of my invention to trunking between two manual-board telephone-exchanges the circles 1, 2, 3, 4, and 5 represent operators' positions in one manual exchange, and circles 6, 7, 8, 9, and 10 represent operators' positions in another manual exchange. The black dots

11, 12, 13, 14, 15, &c., represent the trunk-line jack belonging to operators 6, 7, 8, 9, and 10, and the lines connecting the black dots to the circles 1, 2, 3, 4, and 5 represent the trunks connecting the two exchanges and illustrate a method of trunking that will, as previously explained, evenly divide the work of the operators in both exchanges. For example, the trunk No. 11 of operator No. 10 leads to operator No. 5, No. 12 to No. 1, No. 13 to No. 2, No. 14 to No. 3, and No. 15 to No. 4, and with this arrangement the orders or calls of No. 10 are equally divided between the five operators at the other exchange. Obviously, therefore, and in the same manner the orders or calls of No. 9 are equally divided between the operators in the other exchange, or vice versa, if these trunks should be employed as two-way trunks and the black dots thus made to represent drops and jacks of any suitable character for receiving incoming trunk-calls from exchange A, as well as for carrying outgoing calls to exchange A, for in such case each operator at exchange A would have his particular trunk-lines or trunks equally divided between the operators of exchange B, as shown in the diagram.

As previously stated and for the broader purposes of my invention, a switching position may consist, therefore, of either an automatic switch or of one or more spring-jacks, &c., to be controlled and operated by a single switchboard operator. If the switching positions are manually operated and controlled, then the spring-jacks and switch-plugs therefor may be of the character shown in Fig. 8—that is to say, of any suitable known or approved character. As shown, the spring-jack H is adapted to receive the plug I, which is attached to the end of the ordinary flexible connecting-cord. If each switching position is represented by an automatic switch of any well-known character, then the bank-contacts and the shaft-wipers thereof may be of the character shown in Fig. 9, it being understood that any suitable or well-known mechanism can be employed for operating the said shaft and its wipers. As shown, each automatic switch has a pair of line-wipers J and a private wiper K, together with a bank of line-contacts L and a bank of private contacts M. For example, each first selector of the apparatus hereinbefore described may be of the general character described and illustrated in Patent No. 815,321, granted March 13, 1906, and the second selectors and also the third selectors may be of this same general type, and the connectors may be of the general type or character shown in Patent No. 815,176, granted March 13, 1906. In any event the arrangement is preferably such that the work or load, as previously explained, is evenly divided or distributed between a plurality of switching positions, such as automatic switches or operators' positions. If employed in connection with automatic apparatus, it will be seen that my invention minimizes the amount of work to be performed by the first selectors, for example—that is to say, these first selectors are not compelled to operate to the full limit of their range of adjustment as often or to such an extent as is true of the arrangement employed prior to my invention. In other words, each automatic first-selector switch or even each second-selector switch or third-selector switch, as the case may be, is enabled to perform the work imposed upon it without the necessity of operating to the full range of its switching adjustment, as is true of such switches when the contacts or terminals thereof are multiplied together in the old way. Obviously, therefore, the wear and tear on the switches is materially reduced, the wear and tear being minimized, so to speak. With respect to the receiving-switches—as, for example, the second selectors, third selectors, or connectors—it will be seen that the arrangement precludes all possibility of the burden of the work being thrown upon some one particular switch, thus distributing the work through the different switches, regardless of whether the calls are all coming from one particular group of subscribers or more or less evenly from different subscribers throughout the entire exchange. If the calls sent over the trunk-lines are received by operators at ordinary switchboards or operators' positions, my improved method of wiring then evenly divides the work of receiving calls among the different switchboard operators and evenly distributes the work among the different trunk-lines. It is evident, therefore, that by my invention I obtain a substantial saving or economy regardless of whether the system is wholly automatic, partly automatic, or partly manual or wholly manual.

From the foregoing it is evident that my improved method of wiring—that is to say, of multiplying together the contacts and effecting an economical distribution of the work—is applicable to the contacts or terminals of the line-banks and also to the private banks of the different automatic switches.

If a subscriber in the one hundred row of switchboards whose line terminates, say, at the three thousand one hundred board in this row should call the subscriber whose number is "2400," the operation is as follows: The calling subscriber first raises his first selector to the second level, and his first selector then proceeds automatically to pick out the first idle trunk-line. The automatically-selected idle trunk-line leads, of course, to a second selector on the two thousand one hundred board. Next the calling subscriber raises the second selector on this latter board to the fourth level, so as to extend the connection to the four hundred board of this particular thou-

sand group, and the second selector then proceeds automatically to pick out the first idle trunk-line running to the two thousand four hundred board. This gives the calling subscriber a connector on the board at which the line of the called subscriber terminates. He then calls the last two digits of the number, and thereby causes the connector to make connection directly with the called subscriber's line. Thus with the arrangement shown each switchboard or rack contains the first selectors of all subscribers' lines terminating at such board or rack, all of the connectors which must be employed for making connection with any of the subsccribers' lines thus terminating at this board, and all of the second selectors which must be used by any calling subscriber of this particular hundred row of boards in establishing connection with any called subscriber in this particular thousand row of boards. For example, the board "3100," (shown in Fig. 1) not only contains all of the first selectors of the one hundred subscribers' lines terminating at this board, as well as all of the connectors to be used in making connection with these lines, but also all of the second selectors to be used by any calling subscriber in the one hundred row of boards in making connection with any subscriber's line terminating at any point in the three thousand row of boards. As shown, the said first selectors are individual to the different subscribers' lines and may consequently be termed "subscribers' individual switches."

I claim as my invention—

1. A telephone system comprising a plurality of trunk-lines, a plurality of groups of terminals for said trunk-lines, there being as many terminals in each group as there are trunk-lines, and all terminals of each trunk-line being multiplied together from one group to the other, the members of each row being arranged in series along a definite line, and the terminals connected with and allotted to each trunk-line occupying dissimilar positions in the different groups, whereby all terminals occupying similar positions in the different groups are in each case all connected respectively with as many different trunk-lines.

2. A telephone system comprising a plurality of trunk-lines, a plurality of groups of terminals for said trunk-lines, there being as many groups as there are trunk-lines, and also as many terminals in each group as there are trunk-lines, all terminals which are connected with any particular trunk-line occupying dissimilar positions in the different groups, whereby all terminals occupying similar positions in the different groups are in each case connected respectively with as many different trunk-lines.

3. A telephone system comprising a plurality of groups of terminals, trunk-lines connected with said terminals and leading to a plurality of switching positions, the terminals connected with and allotted to any particular switching position occupying dissimilar positions in the different groups, whereby all terminals occupying similar positions in the different groups are in each case connected respectively with as many different switching positions.

4. A telephone system comprising a plurality of trunk-lines leading to a plurality of switching positions, terminals for the other ends of said trunk-lines, said terminals being arranged in a plurality of groups, and the members of each group having a definite arrangement, and each of said switching positions being connected with a plurality of terminals each arranged in a different group, but in each case the terminals connected with and alloted to any particular switching position occupying dissimilar positions in the different groups, whereby in each case the terminals occupying similar positions in the different groups are allotted to and connected respectively with as many different switching positions.

5. An automatic telephone system comprising a plurality of switching positions, trunk-lines leading to said switching positions, there being as many trunk-lines as there are switching positions, a plurality of groups of terminals for the other ends of said trunk-lines, there being as many groups as there are trunk-lines, and as many members in each group as there are trunk-lines, in each case the terminals allotted to and connected with any particular trunk-line occupying dissimilar positions in the different groups, and in each case the terminals occupying similar positions in the different groups being connected respectively with as many different trunk-lines.

6. An automatic telephone system comprising a plurality of trunk-lines, a plurality of terminals for said trunk-lines, said terminals being arranged in groups, and each group being divided into subdivisions, in each case all terminals connected with a particular trunk-line in the same group occupying similar positions in the different subdivisions of such group, but all terminals connected with a particular trunk-line occupying dissimilar positions in the different groups, whereby in each case all terminals occupying like positions in the different groups are connected with as many different trunk-lines as there are groups.

7. An automatic telephone system comprising a plurality of frames, said frames being arranged in rows extending at right angles to each other, the rows in one direction representing the different thousands, and the rows in the other direction representing the different hundreds, whereby all subscribers whose numbers are under two thousand will be in one row, and all those over two thousand

and under three thousand in a row parallel therewith, and whereby all subscribers the last three digits of whose numbers are over one hundred will be in a row at right angles to said parallel rows, and whereby all subscribers' numbers the last three digits of which are over one hundred and less than two hundred are in a row parallel to said last-mentioned row, each frame containing the first "selectors" of this particular group of subscribers, and also containing the "connectors" for its particular group of subscribers, and each frame also including the second "selectors"—necessary for enabling any subscriber of the thousand row in which the frame is located to make connection with any subscriber in the hundred row in which said frame is located.

8. An automatic telephone system comprising a plurality of frames, each frame containing a plurality of first "selectors," a plurality of second "selectors" less in number than said first "selectors," and a plurality of "connectors" also less in number than said first "selectors," said frames being arranged in rows at right angles to each other, together with suitable cabling whereby the second "selectors" of any frame arranged in a row extending in one direction may be employed by any of the subscribers having first "selectors" in this row for establishing connection with any of the subscribers having first "selectors" located in the row containing said second "selectors" and extending at right angles to said first-mentioned row.

9. An automatic telephone system comprising a plurality of switch-supports, each support being provided with a plurality of first "selectors," a plurality of second "selectors" less in number than said first "selectors," and a plurality of "connectors" also less in number than said first "selectors," each support thus equipped with different kinds of switches being a unit in itself and representing a distinct group of subscribers.

10. An automatic telephone system comprising a plurality of supporting structures, each structure carrying a plurality of first "selectors," and also a plurality of "connectors," each structure thus equipped with automatic switches being a unit in itself and representing a distinct hundred group of subscribers, each connector having a multiple terminal of each telephone-line terminating at the structure on which it is mounted.

11. An automatic telephone system comprising a plurality of switch-frames, a suitable number of first "selectors" mounted on each frame, a suitable number of second "selectors" mounted on each frame and less in number than the said first "selectors" thereof, a plurality of "connectors" mounted on each frame and corresponding in number to the number of second "selectors" thereon, said frames being arranged in rows at right angles to each other, first "selector" multiple cables extending along the rows in one direction, a normal cable for each switch-frame, each normal cable connecting the banks of its "connectors" with the banks of its first "selectors," and second "selector" multiple cables extending at right angles to the first "selector" multiple cables, each frame thus equipped with suitable switches being a unit in itself and representing a distinct group of subscribers.

12. An automatic telephone system comprising a plurality of switches, each switch having a series of terminals, a plurality of trunk-lines corresponding in number to the number of terminals in any particular series, and means for connecting each trunk-line with at least one terminal in each series, the terminals connected with any particular trunk-line occupying dissimilar positions in the different switches, and in each case the terminals occupying similar positions in the different switches being connected with as many different trunk-lines.

13. An automatic telephone system comprising a plurality of switches, a plurality of trunk-lines, each switch containing a series of terminals, means for connecting each trunk-line with at least one terminal in each series, in each case all of the terminals connected with any particular trunk-line occupying dissimilar positions in the different switches, and in each case all of the terminals occupying similar positions in the different switches being connected respectively with as many different trunk-lines, whereby the different switches may all assume first position and thereby each connect with a different trunk-line, or may each assume second position or third position and so on to the final position, with the same result.

14. An automatic telephone system comprising a plurality of switches, a plurality of trunk-lines, each switch having a series of terminals, and each switch being capable of assuming as many connective positions as there are terminals in this particular series, means for connecting each trunk-line with at least one terminal in each switch, the connections being such that two or more or any number of said switches may assume the first, second or third or other position, all at the same time, and thereby connect with as many different trunk-lines as there are switches in operation.

15. An automatic telephone system comprising a plurality of trunk-lines, a plurality of switches having terminals connected with said trunk-lines, each trunk-line being connected with at least one terminal in each switch, and with the terminals of the different switches so arranged that each switch has first chance at a different trunk-line, second chance at a trunk-line other than those with which the other switches would connect by

assuming second position, and so on throughout the range of adjustment of each switch.

16. An automatic telephone system comprising a plurality of switchboards, each board being provided with a plurality of subscribers' individual trunk-selecting switch mechanisms or switches, and with a plurality of connectors, each individual switch adapted to perform a trunking operation in accordance with the first digit of the called number, the connectors being less in number than the said individual switches, but each connector having a multiple terminal of each of the different subscribers' lines terminating at said individual switches, and each board thus equipped with different kinds of switching-machines being a unit in itself and representing a particular hundred group of subscribers.

17. An automatic telephone system comprising a plurality of switchboards, each board being provided with a plurality of first selectors and also with a plurality of second selectors, each selector, either first or second, consisting of an automatic trunk-selecting switch mechanism, and each board thus equipped with different classes of switching-machines being a unit in itself, said switchboards arranged in parallel rows extending in one direction, as well as in parallel rows extending in a direction at right angles to the first direction, and each first selector having trunk connection with all second selectors of the two right-angle rows in which its board is included.

Signed by me at Chicago, Cook county, Illinois, this 6th day of March, 1905.

ALEXANDER E. KEITH.

Witnesses:
W. LEE CAMPBELL,
R. C. GIFFORD.