(No Model.)

4 Sheets—Sheet 1.

T. N. VAIL & J. A. SEELY.

TELEPHONE CENTRAL STATION APPARATUS.

No. 385,976. Patented July 10, 1888.

Fig. 1.

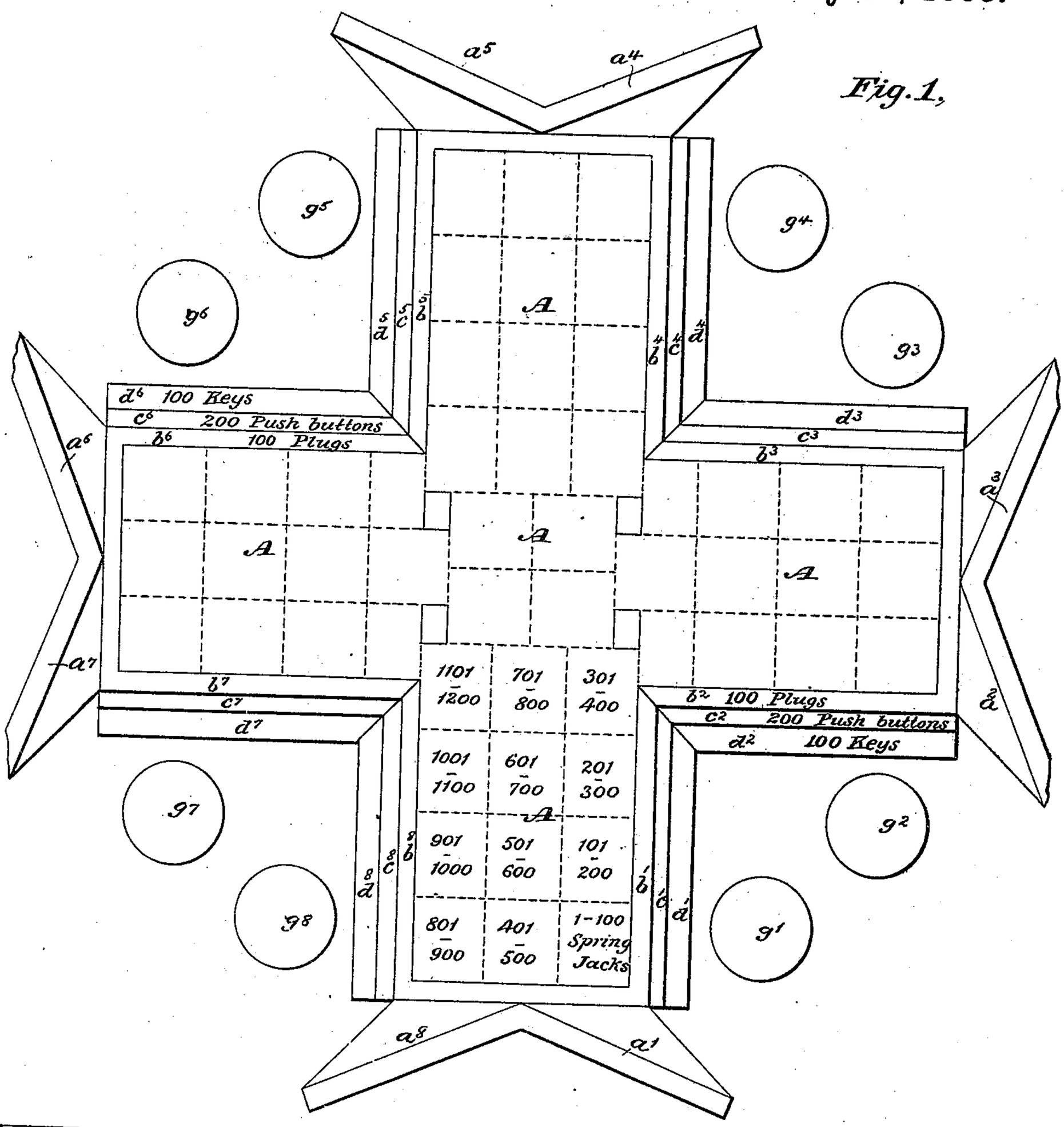
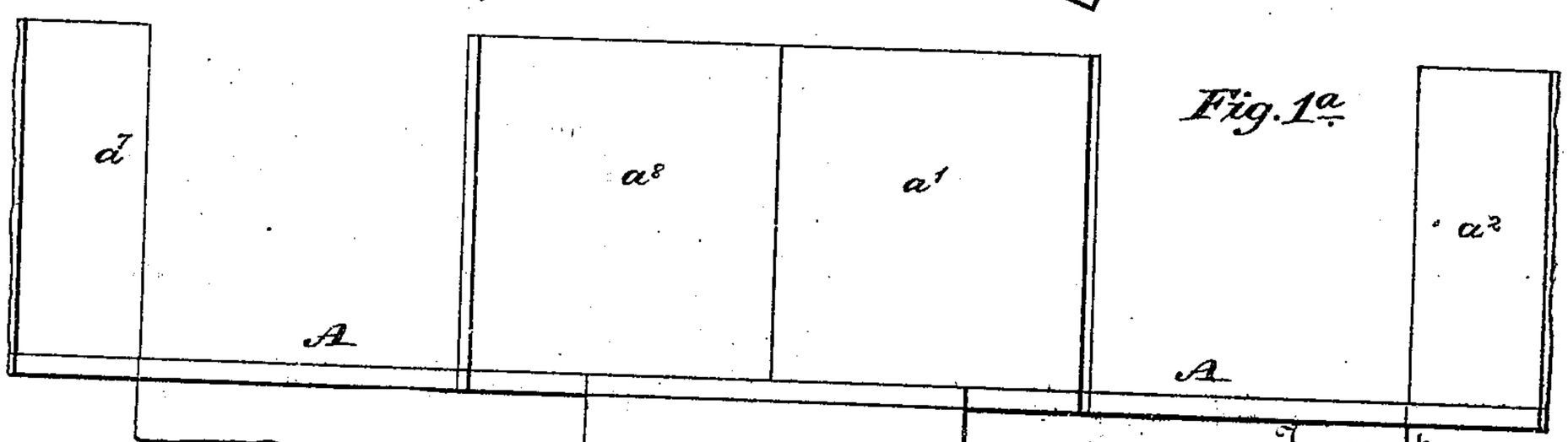


Fig. 1a.



Witnesses
Geo. W. Breck.
Carrie E. Ashley

Inventors.
Theo N. Vail
John A. Seely.
By their Attorneys
Wm B. Vanizo.

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4 Sheets—Sheet 2.

T. N. VAIL & J. A. SEELY.

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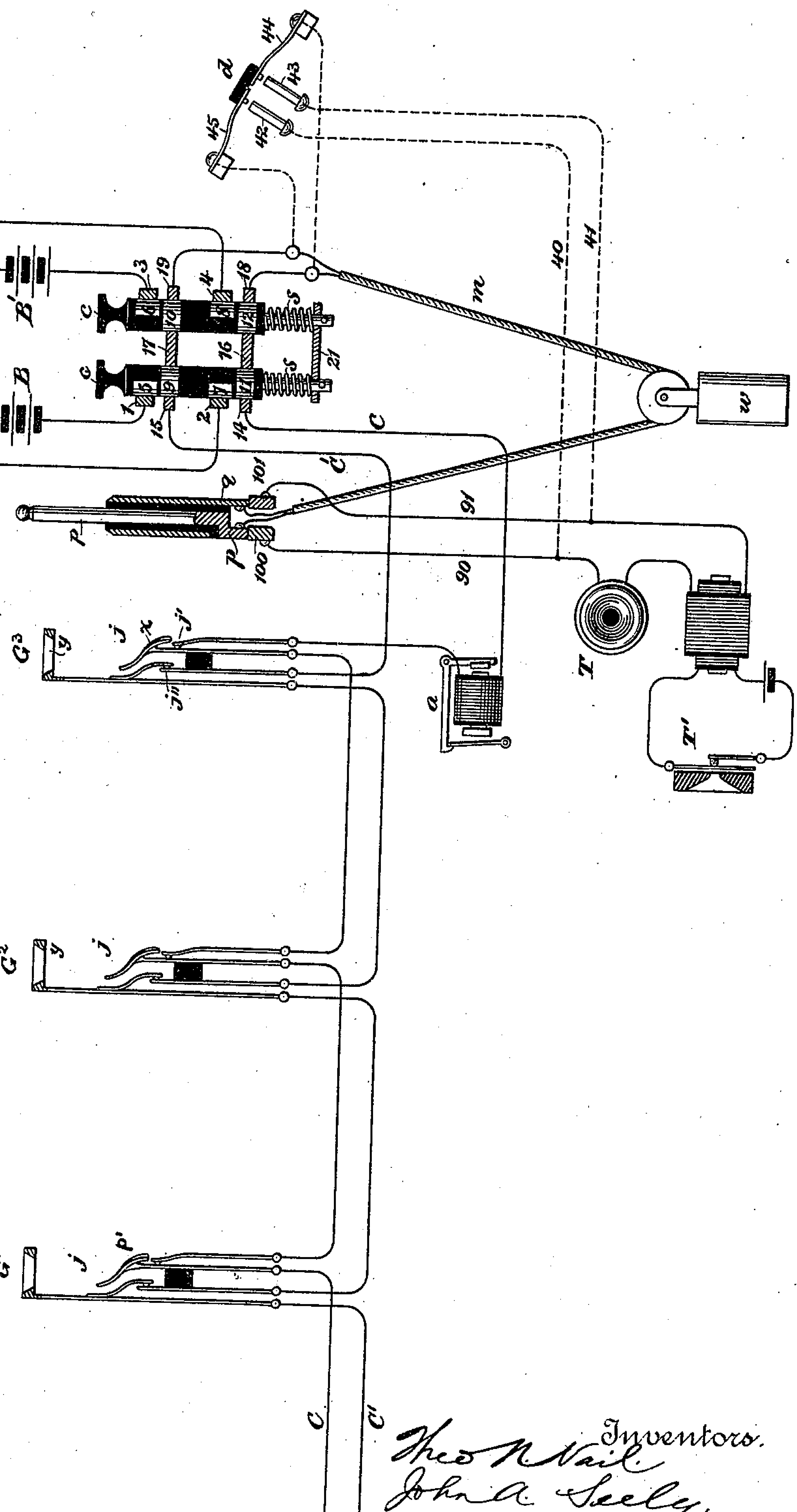
Fig. 2.



Witnesses,
Geo. W. Breck.
Carrie E. Ashley.

Inventors.
Theo. N. Vail.
John A. Seely.
By their Attorney Wm. B. Vansize

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T. N. VAIL & J. A. SEELY.

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Fig. 3.

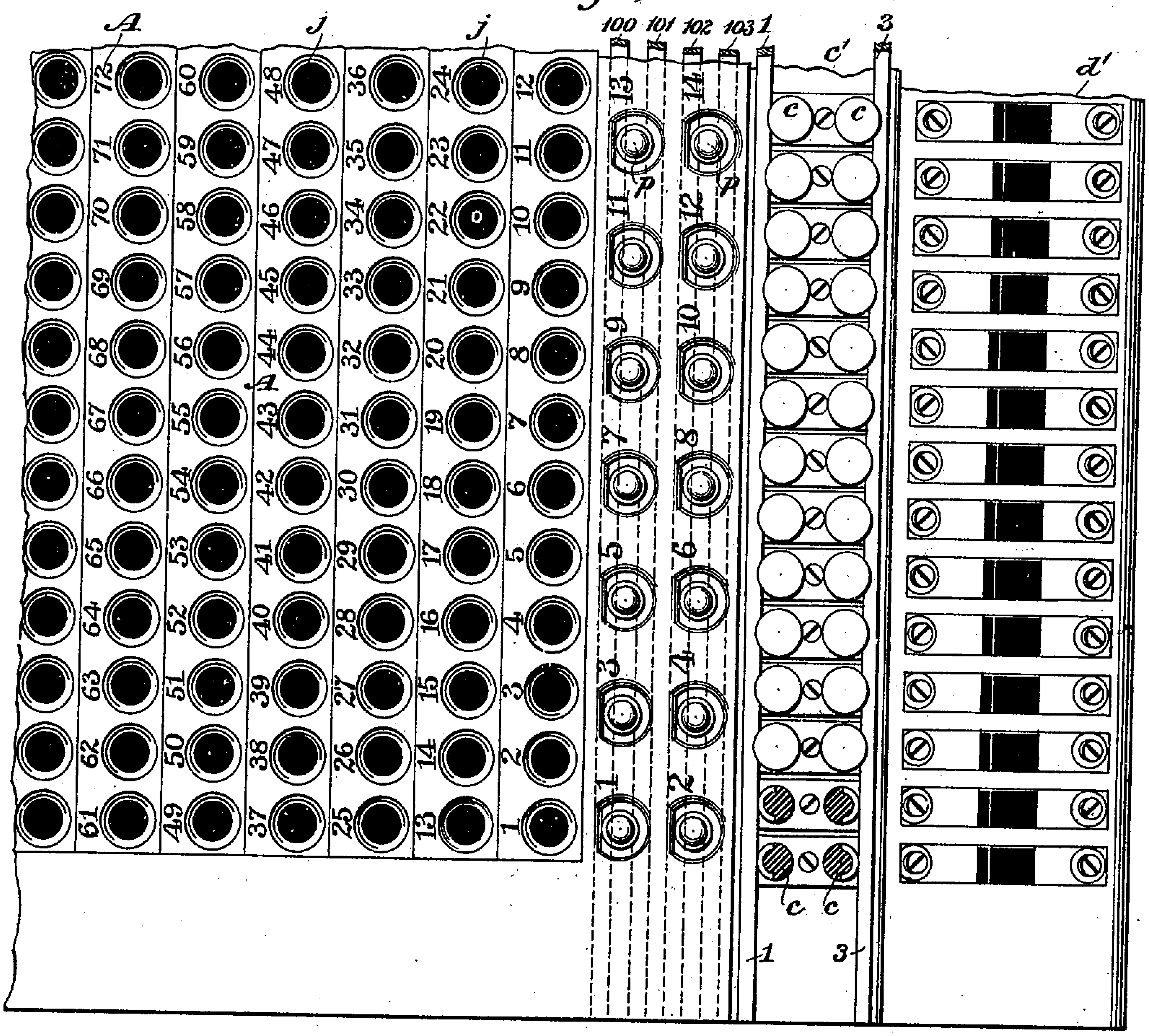
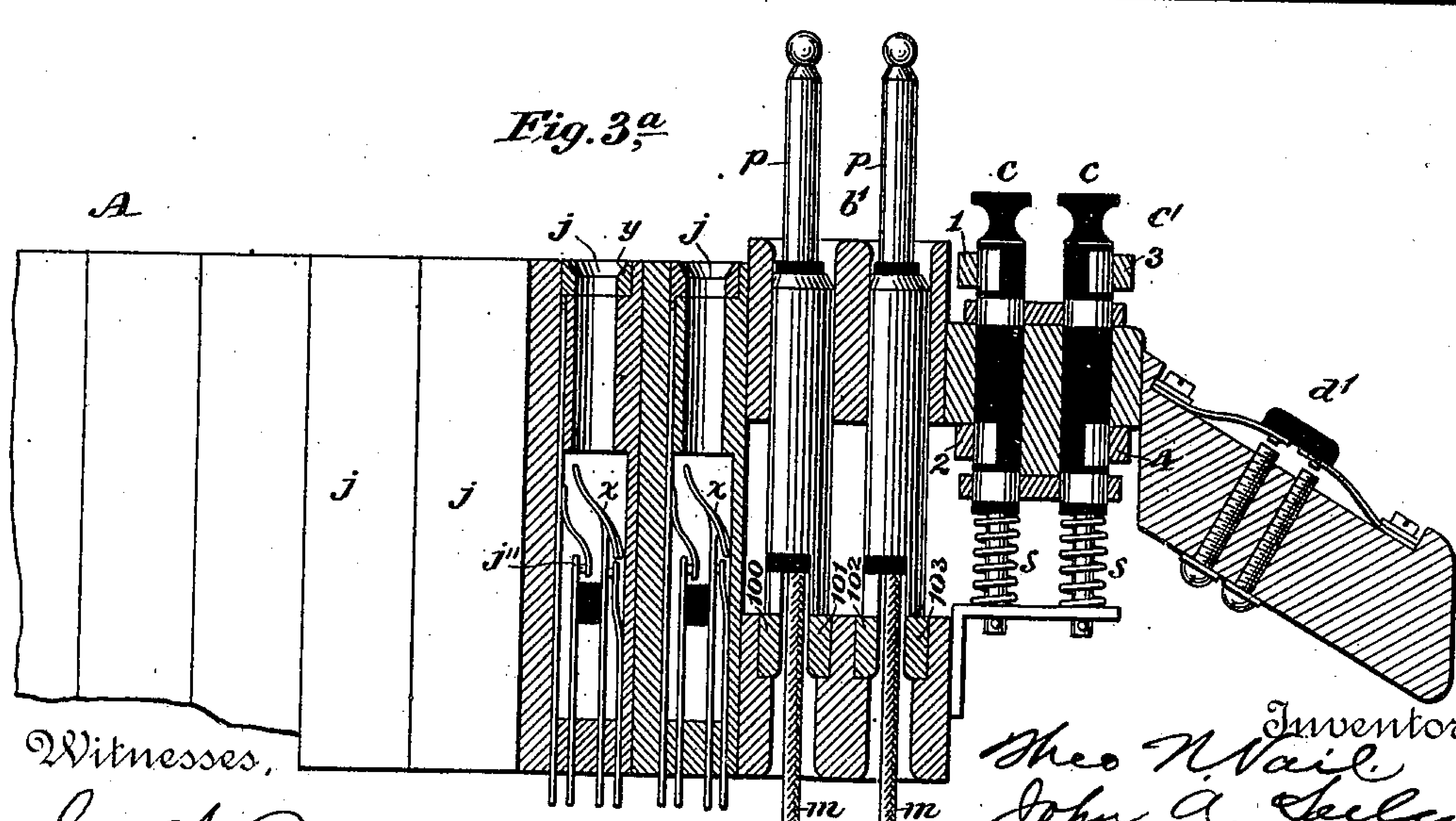


Fig. 3a.



Witnesses,
Geo. W. Breck.
Carrie E. Ashley.

Inventors,
Theo. N. Vail.
John A. Seely.
By their Attorney Wm. B. Vansize

(No Model.)

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T. N. VAIL & J. A. SEELY.

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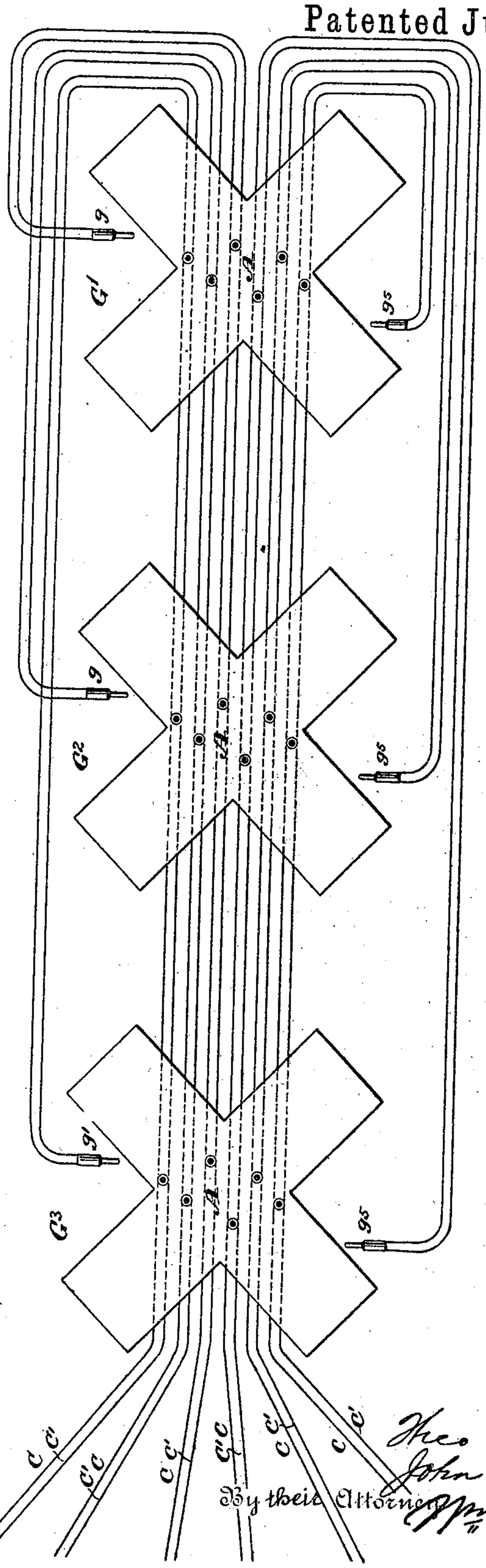

Fig. 4.

Witnesses.
Geo. W. Breck.
Carrie E. Ashley.

Inventors.
Theo. N. Vail.
John A. Seely.
By their Attorney
Wm B. Vansize

UNITED STATES PATENT OFFICE.

THEODORE N. VAIL, OF BOSTON, MASSACHUSETTS, AND JOHN A. SEELY, OF NEW YORK, N. Y.

TELEPHONE CENTRAL-STATION APPARATUS.

SPECIFICATION forming part of Letters Patent No. 385,976, dated July 10, 1888.

Application filed February 25, 1888. Serial No. 265,298. (No model.)

To all whom it may concern:

Be it known that we, THEODORE N. VAIL and JOHN A. SEELY, citizens of the United States, and residents, respectively, of Boston, county of Suffolk, State of Massachusetts, and of the city, county, and State of New York, have jointly invented certain new and useful Improvements in Telephone Central-Station Apparatus, of which the following is a specification.

Our invention is an improvement in the arrangement of telephone apparatus, whereby intercommunication between distant points is facilitated, while the space occupied and the expense of erecting and maintaining such apparatus are reduced.

This improved apparatus is adapted for use in the multiple-board arrangement for central stations, which is the most efficient system now known. Its distinguishing characteristics are a series of duplicate boards, upon each and every one of which the aggregate number of sub-station lines have electrical connection. This aggregate number of lines or circuits is divided into a number of groups, each group being substantially equal to the number of circuits which experience has demonstrated that an operator can satisfactorily attend to. The aggregate number of circuits divided by the number of circuits in a group gives the number of separate boards constituting the multiple-board system, and upon each and every one of which each and every wire has a spring-jack connection. Each circuit of each group is furnished with a device for indicating or receiving calls, and a suitable means for indicating the condition of every line is also a necessary auxiliary or incident to every board and every circuit.

Experience has demonstrated that one central-station operator can under ordinary circumstances care for about one hundred circuits. Such number, then, should constitute the maximum in one group. If an exchange has an aggregate number of five thousand subscribers, there will be fifty groups of one hundred each. There will be fifty boards and five thousand spring-jacks on every board, or two hundred and fifty thousand spring-jacks in all. We have then in the supposed multiple-board central station five thousand subscribers' circuits, fifty boards, and fifty operators. Each board has five thousand spring-jacks accessible to but one operator, one group of one hundred circuits with their indicating devices, a telephone set, with testing, calling, and looping-in devices. This was the state of the art at or about the date of our invention.

Our invention embraces the following improvements:

First. One switch or circuit-changer being located in each of the aggregate number of circuits, we assemble or locate such aggregate number of switches or circuit-changers at one point, as upon a board—that is, locate them upon a frame or table or in any equivalent manner, provided always that they be assembled within a space accessible to or within reach of an operator without substantial change in his or her position of support. We then take two or more groups or subdivisions of this aggregate number of circuits, each of which is provided with a special switch or circuit-closer designed to co-operate with any switch of the aggregate number. These groups are separated from each other, but are located in proximity to the aggregate number of switches. An operator is assigned to each group, and from a position of support determined by the location of the group the said operator has access to the aggregate number of circuits, as has also the operator assigned to the second group and the third group, and so on. Each operator has charge of one group and is supplied with the necessary telephone set, testing, calling, looping-in devices, and clearing-out annunciators. The spring-jack is the switch or circuit-closer used in the aggregate number of circuits, though we do not limit ourselves to that specific form. The same is true of the jack-plug used as a switching device for the circuits of each group. Thus in the supposed exchange of five thousand circuits we place five thousand spring-jacks upon each board, which board is so formed and arranged as to be accessible to a number of groups or to a number of operators, each operator being supplied with necessary apparatus, and the aggregate number of circuits is accessible to two or more, instead of being accessible to only one group or one operator, as has been the case in the best-known arrangements. A very convenient arrangement is to

place a board horizontally. We prefer a board having the outline of a Greek cross. This presents eight available positions for operators, each having before her the necessary indicating devices and other apparatus constituting a group, and to each one and all of which the aggregate number of spring-jacks upon the surface of the board is accessible without any substantial movement or change in the position of support of the operator. Changes in the outline of the board or table may, and probably will, suggest themselves as coming within the principle of our invention, which consists in so arranging a board or a multiple-board system that the number of boards shall be only equal in number to the quotient of the aggregate number of circuits divided by the product of the number of circuits in a group into the number of operators—not less than two—to which the aggregate number of jacks upon any one board is accessible; or, in other words, divide the aggregate number of circuits by the product of the number of circuits in a group into the number of groups at a table or board. In the supposed exchange of five thousand subscribers, instead of employing fifty boards, we should have at each multiple board eight operators and one hundred circuits for each group. Dividing five thousand by eight hundred, we find that seven boards would fill all requirements. Each board having five thousand jacks, we should have a total of thirty-five thousand jacks in use in our improved system, as compared with two hundred and fifty thousand jacks in the best arrangement heretofore known, and only seven boards, occupying a limited space, as compared with fifty boards occupying six or seven times the floor-space. In our improved system there is also a great gain in the matter of testing for lines in use, for every operator when receiving a call can, by simple inspection, immediately determine whether or not one-seventh of the aggregate number of lines are connected upon demand received over such line, while in the present multiple-board system, assuming the same number of circuits, one-fiftieth only can be determined by inspection, and the remainder must be subjected to special test to determine the fact.

Second. We avoid the necessity for the use of special indicating devices to receive calls or requests from sub-stations, and we only use an annunciator for clearing-out purposes, such clearing out annunciators being located upon a frame fixed at a convenient angle to the position of the operator. Our improvement consists in connecting every sub-station line of a group in multiple arc with an operator's head telephone and in terminating every sub-station line of a group in a flexible connecting-cord normally resting by force of a gravity or equivalent take-up upon strips, conductors, or connections, forming the terminals of said operator's telephone. By this means no preliminary signal is necessary, the sub-station merely removing his telephone and speaking into the transmitter his own number or designation and the number or designation of the sub station required. The details and arrangement of such a sub station, with certain novel and improved features, we have described in another application, to which reference may be had.

Third. We have also invented improved apparatus for calling in either direction upon metallic circuit sub station lines after they are united, in apparatus for looping in an operator's telephone set after two sub-station circuits are united, and in the arrangement or location of the clearing-out annunciators and the signaling and indicating devices, all of which can be more satisfactorily described by reference to the drawings. Means for "testing" or determining whether or not any circuit of the aggregate number not included in a group found on any particular table is in use must be supplied.

The accompanying drawings show our invention applied to metallic-circuit sub-station lines.

Figure 1 shows the arrangement of the preferred form of board on which the aggregate number of circuits each have a connection, the subdivisions or groups, and the position of support of the operator assigned to each group. Fig. 1ª is a detail view of the arrangement of the annunciators. Fig. 2 shows the details of a circuit having a connection upon each of three boards, such circuit being assigned to a group at the last board. Figs. 3 and 3ª are plan and sectional views, respectively, of the apparatus forming part of one group and of the connections forming a part of the aggregate number of circuits immediately adjoining said group. Fig. 4 illustrates the multiple-board feature having our improvements applied thereto.

In Fig. 1 there is a horizontally-fixed table or support having the outline of a Greek cross. The entire number of circuits entering the exchange have spring-jack connections upon the face of this board, one hundred jacks being placed within each square. (Indicated by dotted lines and by the figures marked on one wing of the board.) We have denominated these the "aggregate number" of circuits A. There are thus afforded eight positions of support for eight operators, g' to g^8, from each of which an operator, without moving from such position of support, can reach any connection or jack of the aggregate number. Each operator, as in the multiple-board system, has a subdivision of the aggregate number under special charge, such group being located in a position accessible to but one operator. We prefer to assign about one hundred circuits to each group and to terminate the circuits of a group in flexible cords having a gravity take-up, w, as shown in Fig. 2.

We have shown and will describe our improvements as applied to circuits having a "metallic return" or "metallic circuits," as they are called, and we will now describe the

connection of such a circuit and the apparatus assigned to each group.

The circuit C C′ enters the first board, G′, passes through a spring-jack, *j*, forming one of the aggregate number on that board, then through a similar jack on the second board, G², then to the third board, G³, and terminates, let us suppose, in group g^2 on that board in a flexible cord, *m*, having a double contact-plug, *p q*, the two insulated contacts at its base resting upon continuous strips or contacts 100 and 101, as shown in Figs. 3 and 3ª, where four such rows are shown connected in pairs. These strips or pairs of strips form the group terminals of the opposite ends of one hundred circuits, and also the terminals, respectively, of a local circuit, 90 91, containing a head-telephone, T, and a transmitter, T′, which are continuously in position for use by the operator assigned to that particular group. It is to be observed, therefore, that the operator's head telephone and all the sub-station circuits of the group are connected in parallel circuit, and any order or request telephonically transmitted by a sub-station will be heard by the operator assigned to the group, who raises the plug *p q* and places it in the jack of the called-for circuit, which jack constitutes one of the aggregate number on the same board, G³. Each operator has push-buttons for ringing in either direction and keys for looping a telephone into a circuit after it has been removed from its normal position. These are shown in Figs. 2 and 3.

c indicates two separate push-buttons, a similar pair being assigned to each circuit of a group. They consist of cylinders of insulating material, each having two bands of conducting material, 7 and 9, 8 and 10. 15, 17, and 19 are three sections of conducting material, as are also 14 16 18. These sections form a continuous conductor, including the bands 9, 11, 10, and 12, when the buttons are in a normal position. 1 and 2, 3 and 4 are bars of conducting material, each forming the terminals of a generator of electricity. 5 and 7, 6 and 8 are contacts for uniting the line and generator when the buttons or either of them is depressed. S S are springs for returning the buttons *c c* to their normal position. The metal strip 21 furnishes a suitable bearing for the lower end of these buttons. There is also a looping-in apparatus for each circuit. This is designed for use when the plug is lifted from its normal contact and it is necessary or desirable to listen to operations on the connected circuits. We provide electrical connections 40 41 from the telephone set T to two fixed contacts, 42 43, and the sub-station circuit is electrically connected to two movable contacts, 44 45, as shown, so that by depressing button *d* a telephone set is connected to the circuit independently of the normal position of the apparatus and without disturbing the two circuits connected together for conversation.

The two rows of plugs forming the terminals of one group are located in rows before the operator of each group, as *b′ b⁸*. There are also two rows of push-buttons, as *c′ c⁸*, and rows of looping-in keys, as *d′ d⁸*. The clearing-out annunciators are located upon frames *a′* to *a⁸* at an angle with the position of the group apparatus and immediately adjoining it. These annunciators, however, are only intended to be used for "ringing off."

The capacity of the board, as illustrated, is an aggregate number of five thousand jacks and eight groups, the aggregate number being accessible to any one of the eight operators without substantial change in the position of support—that is, no spring-jack is out of reach of any operator. If an exchange have a greater number than that assumed and the aggregate number of jacks cannot be more compactly arranged, other arrangements may be resorted to to obtain more space within reach of a fixed position. To afford more space for the groups and accompanying operators, the tables are duplicated as in the multiple-board system, which we have illustrated in Fig. 4. There is here shown a series of circuits, each and all of which have a connection forming one of the aggregate number A on each and every board G′ G² G³. These circuits are divided into groups terminating at one of the eight groups assigned to each board, as *g′* or *g⁵*, the number of boards required being equal to the aggregate number of circuits (five thousand) divided by the product of the number of circuits in a group (one hundred) into the number of groups at a table (eight)—that is, five thousand divided by eight hundred is equal to seven—the smallest whole number which will accommodate all the circuits and groups.

We will now describe the operation of receiving a call and connecting two sub-stations, referring to Figs. 1 and 2. We have a connection with every circuit before us in the aggregate number A. Our operator has the head telephone in position. This telephone is normally connected with one hundred circuits, forming group g^2, let us suppose. A call is heard, "200 on 900," the first being the number of the calling station, the second that of the station called for. The operator immediately raises plug *p q* of the circuit 200, and if circuit 900 is idle places said plug in spring-jack 900. This breaks circuit 900 at points *j′ j″* in its jack, and the points *p* and *q* of the two contact-plugs connect with points *x* and *y*, respectively. (See Fig. 2, G³.) The two metallic circuits now form one continuous metallic circuit containing a clearing-out annunciator at the central station only, being free from the central-station telephone because all behind the jack *j* of circuit 900 is cut off and the plug of circuit 200 is lifted from its telephone-contact. The central station now depresses the rear push-button to signal the called-for sub-station, circuit passing from circuit 900 to plug *p q*, thence *via* elements 18, 12, 8, 4, B′, 3, 6, and 19. The called-for station responds and the conversation is carried on, as is well understood.

Should the central-station operator desire to listen, key *d* is depressed, connecting 42 with 45 and 43 with 44, circuit being from the transmitting-station to plug *p q*, thence *via* cord *m* to point 45, 42, 40, T, T', 41, 43, and 44 to cord *m*. When conversation is concluded, the calling-station sends an impulse from a generator to line, dropping the annunciator, and the parts are restored to their normal position by the operator.

We have shown a spring-jack having a dust-guard, *p'*, and a jack-plug, *p q*, having two or more contacts in a position to register with two or more fixed contacts, and means whereby the said plug when retracted by the gravity take-up will always assume the same position; but these features of improvement we have described and claimed in another application, filed March 1, 1888, Serial No. 265,783.

We do not herein claim the multiple arc arrangement of line-wires with a telephone in a local circuit at the central station, as that forms the subject-matter of an application filed by us in the United States Patent Office April 20, 1888, Serial No. 271,296.

What we claim, and desire to secure by Letters Patent, is—

1. The combination of an aggregate number or series of electrical circuits connecting a central station with a series of sub-stations, a telephone-instrument at each sub station, at the central station a series of spring-jacks or circuit-changers—one for each circuit—located in close proximity on one board, two or more groups or subdivisions of said circuits separated from each other, located at said board, each having a second switch or circuit-changer co-operating with the switches or circuit-changers of the first-named series and located in close proximity thereto, whereby any circuit of the first-named series and any circuit of either subdivision may be connected together.

2. The combination of an aggregate number or series of electrical circuits connecting a central station with a series of sub-stations, telephonic instruments at each sub-station, at the central station a series of switches or circuit-changers, one for each circuit, two or more separated groups or subdivisions of said circuits, each having a switch or circuit changer co-operating with the switches or circuit-changers of the first-named series, but located on the same board in proximity thereto, whereby any circuit of the first-named series and any circuit of either subdivision may be connected together, and a receiving-telephone common to the circuits of each group or subdivision to receive calls or communications therefrom.

3. The combination of an aggregate number or series of electrical circuits connecting a central station with a series of sub-stations, a telephonic instrument at each sub-station, at the central station a series of spring-jacks or circuit-changers, one for each circuit, fixed in close proximity, two or more groups or subdivisions of said circuits separated from each other, but at the same board, each circuit of a group terminating in a flexible conducting-cord, and a jack-plug co-operating with the spring jacks of the first-named series and normally resting in close proximity thereto, whereby any circuit of the first-named series may be connected with any circuit of either group or subdivision.

4. At a telephone station, a switch-board having the form or outline of a Greek cross, an aggregate number of electrical circuits, each circuit uniting a central station and one sub-station, a series of electrical connections—one for each circuit—located on said switch-board, means for connecting circuits in pairs, eight subdivisions or groups of said circuits, eight electro-magnetic receiving-instruments, one for each group, each instrument being common to all circuits of its group, and eight positions of support for eight operators, one for each group, said positions being so located that one group and the aggregate number of circuits are accessible to an operator therefrom.

5. The combination of two or more switch-boards each having the form or outline of a Greek cross, duplicate electrical connections with an aggregate number of circuits on said boards, means at each board for electrically connecting circuits together, eight different subdivisions or groups of said circuits at each board, and separate indicating devices for each group, the whole being so arranged that eight operators may be assigned to each board, one operator to a group, each operator being in a position of support accessible to one group and to one and the same series of connections with the aggregate number of circuits.

6. The combination of an aggregate number or series of electrical circuits connecting a central station with a series of sub stations, a telephonic instrument at each sub-station, at the central station a series of duplicate switches or circuit-changers in each circuit of the aggregate number, one switch for each circuit, being located upon each of a series of boards or frames in close proximity, two or more groups or subdivisions of said circuits located upon each board or frame, each circuit of each group having a second switch or circuit-changer, said groups being separated from each other, but located in close proximity to the switches connected with the aggregate number of circuits, the number of boards or supports being equal to the aggregate number of circuits divided by the product of the number of groups at a board into the number of circuits in a group.

7. The combination of an aggregate number of series of electrical circuits connecting a central station with a series of sub-stations, a telephonic instrument at each sub-station, at the central station a series of spring-jacks or circuit-changers, one for each circuit, fixed in close proximity, two or more groups or subdivisions of said circuits separated from each other, but at the same board, each circuit of a

group terminating in a flexible conducting-cord, and a jack-plug to co-operate with the spring-jacks of the first-named series and normally resting in close proximity thereto, a receiving telephone common to each circuit of a group, and a ringing-off annunciator in each such circuit.

8. At a telephone-station, the combination of a metallic circuit consisting of two substantially parallel wires or conductors united at or near their terminals, a switch or circuit-changer located in said circuit intermediate said terminals, two pairs of fixed contacts and one pair of movable contacts equally divided between and normally forming part of the circuit of both wires, a third pair of fixed contacts and a second pair of movable contacts, a generator of electricity having its opposite poles connected to one pair of said contacts, and a base of insulating material upon which the two pairs of movable contacts are located, all said contacts being so located with respect to each other that a predetermined change in position of said insulating-base removes a fragment of the circuit and substitutes said generator therefor.

9. At a telephone-station, the combination of a metallic circuit consisting of two substantially parallel wires or conductors united at or near their terminals, two switches or circuit-changers located in said circuit intermediate said terminals, each switch consisting of two pairs of fixed contacts, one pair of movable contacts equally divided between and normally forming part of the circuit of both wires, a third pair of fixed contacts and a second pair of movable contacts, a generator of electricity having its opposite poles connected to one pair of contacts of each switch, and a base of insulating material for each switch, upon which the two pairs of movable contacts are located, the contacts composing the two switches occupying reversed positions, respectively, and the contacts of each switch being so located with respect to each other that a predetermined change in position of one of said insulating-bases divides the line and substitutes the generator for one half a section thereof, while a similar change in position of the second insulating-base divides the line and substitutes the generator for the other half or section.

THEO. N. VAIL.
JOHN A. SEELY.

Witnesses:
WM. H. BAKER,
WM. B. VANSIZE.