

(No Model.)

3 Sheets—Sheet 1

T. N. VAIL.

ELECTRIC MULTIPLE SWITCH BOARD SYSTEM.

No. 299,039.

Patented May 20, 1884.

Fig. 1.

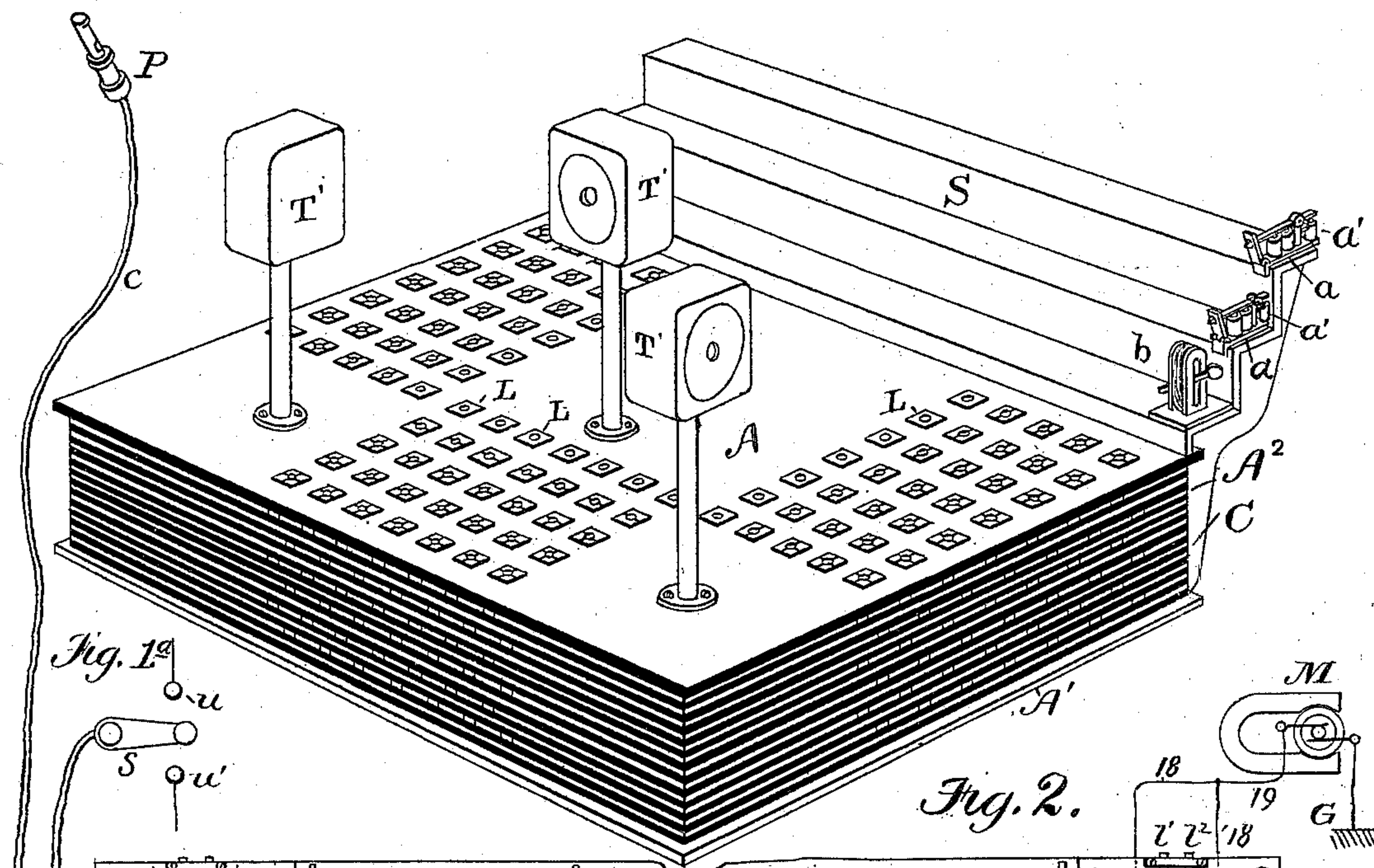


Fig. 2.

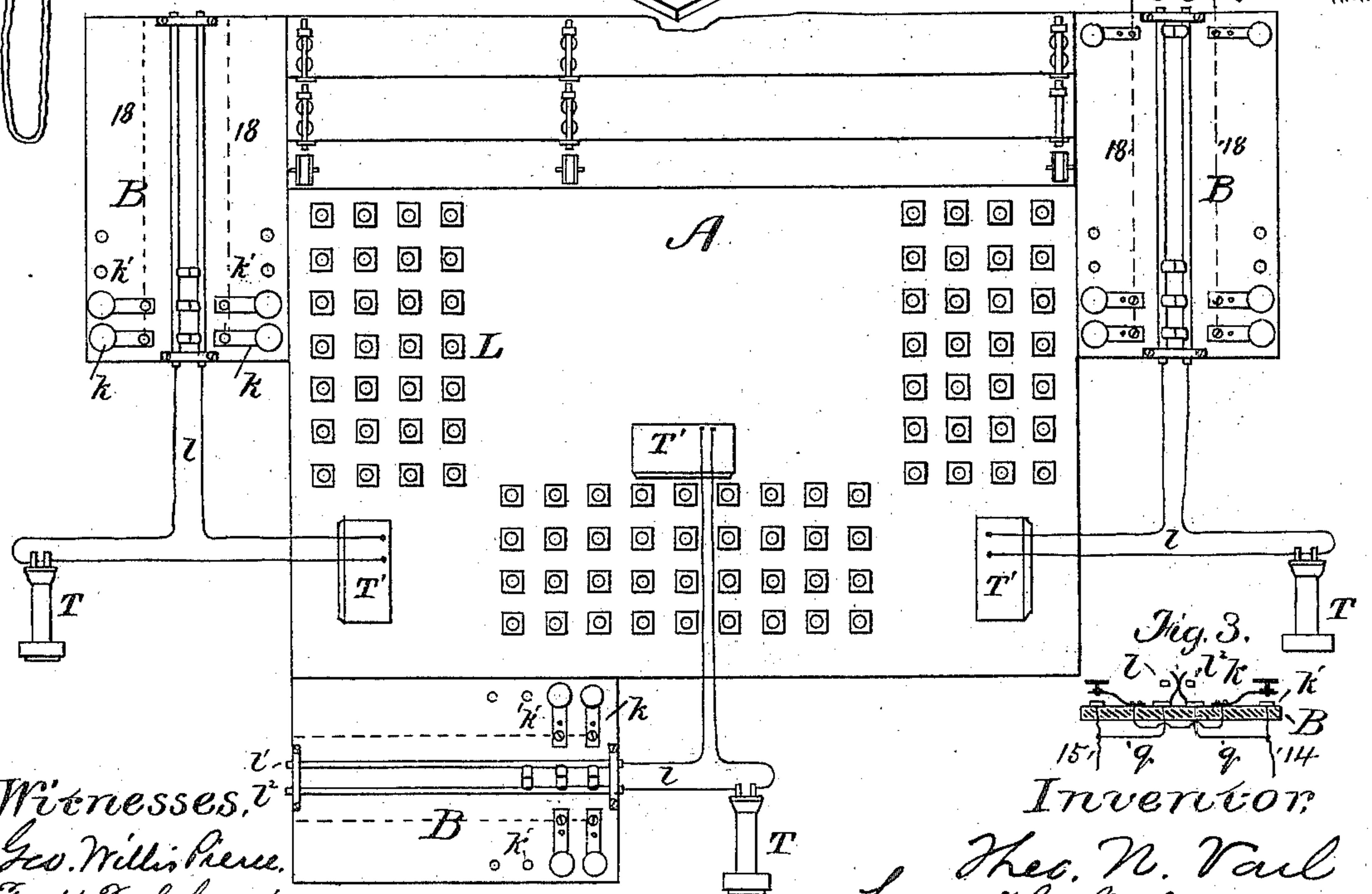


Fig. 3.

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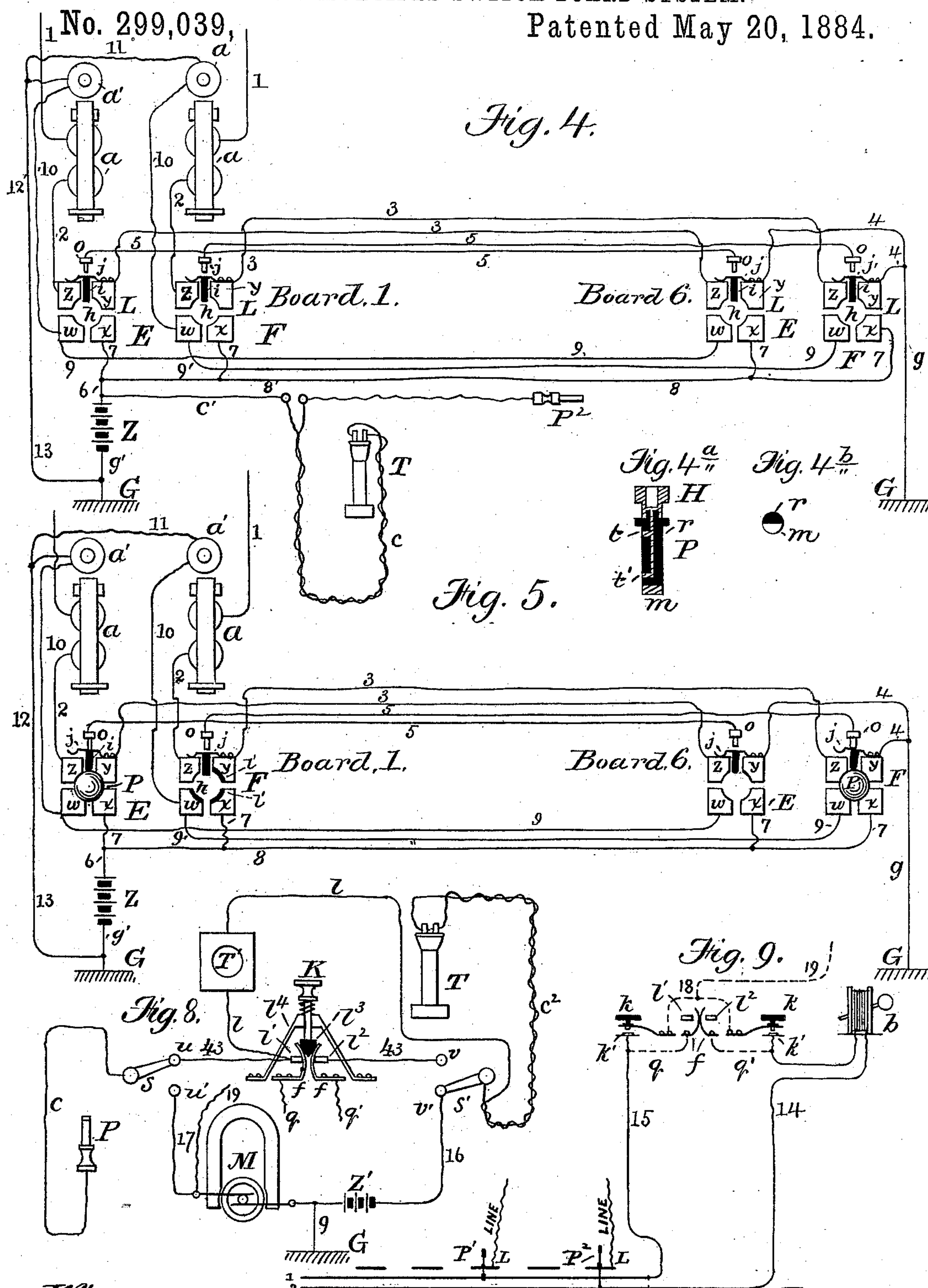
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3 Sheets—Sheet 2.

ELECTRIC MULTIPLE SWITCH BOARD SYSTEM.

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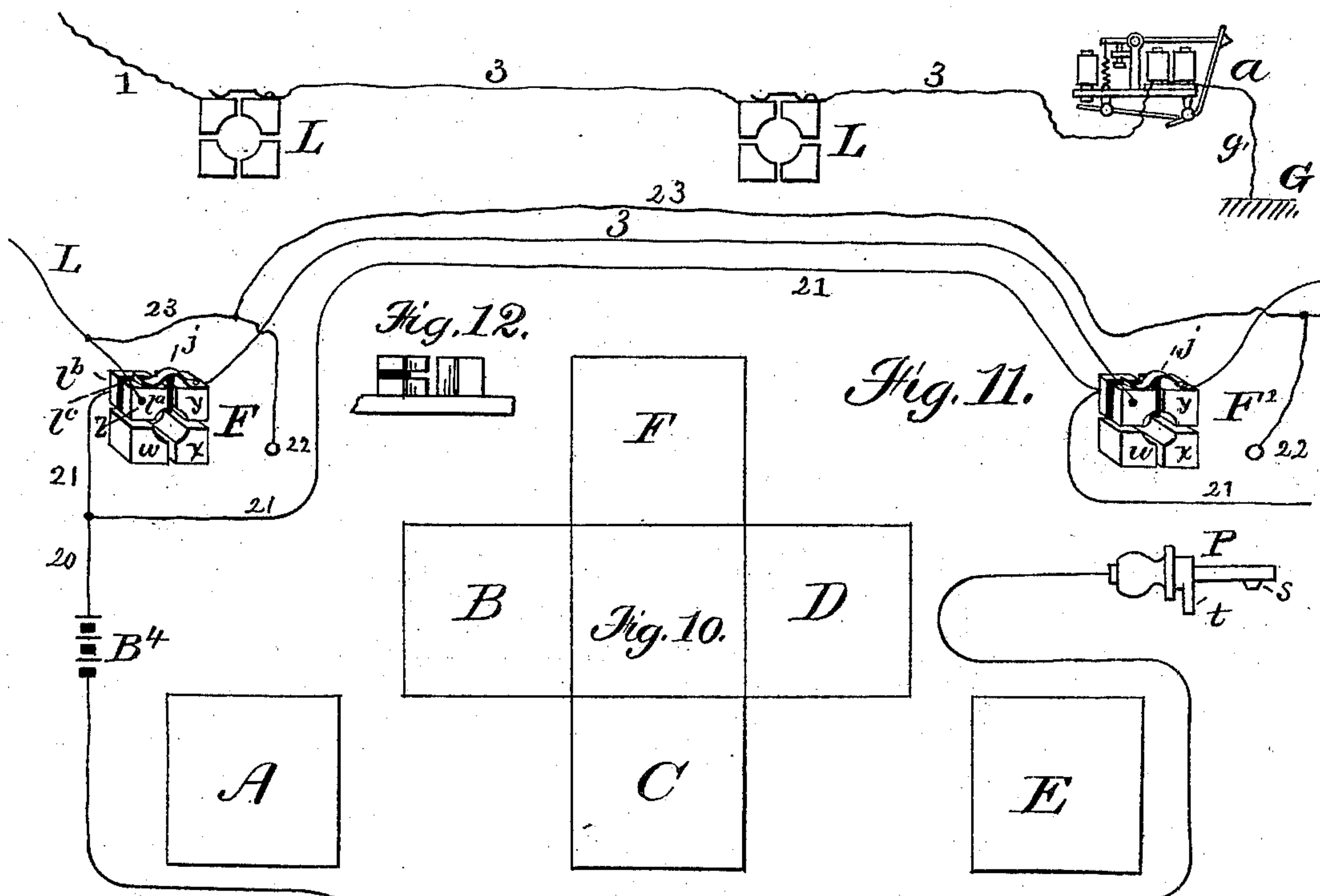
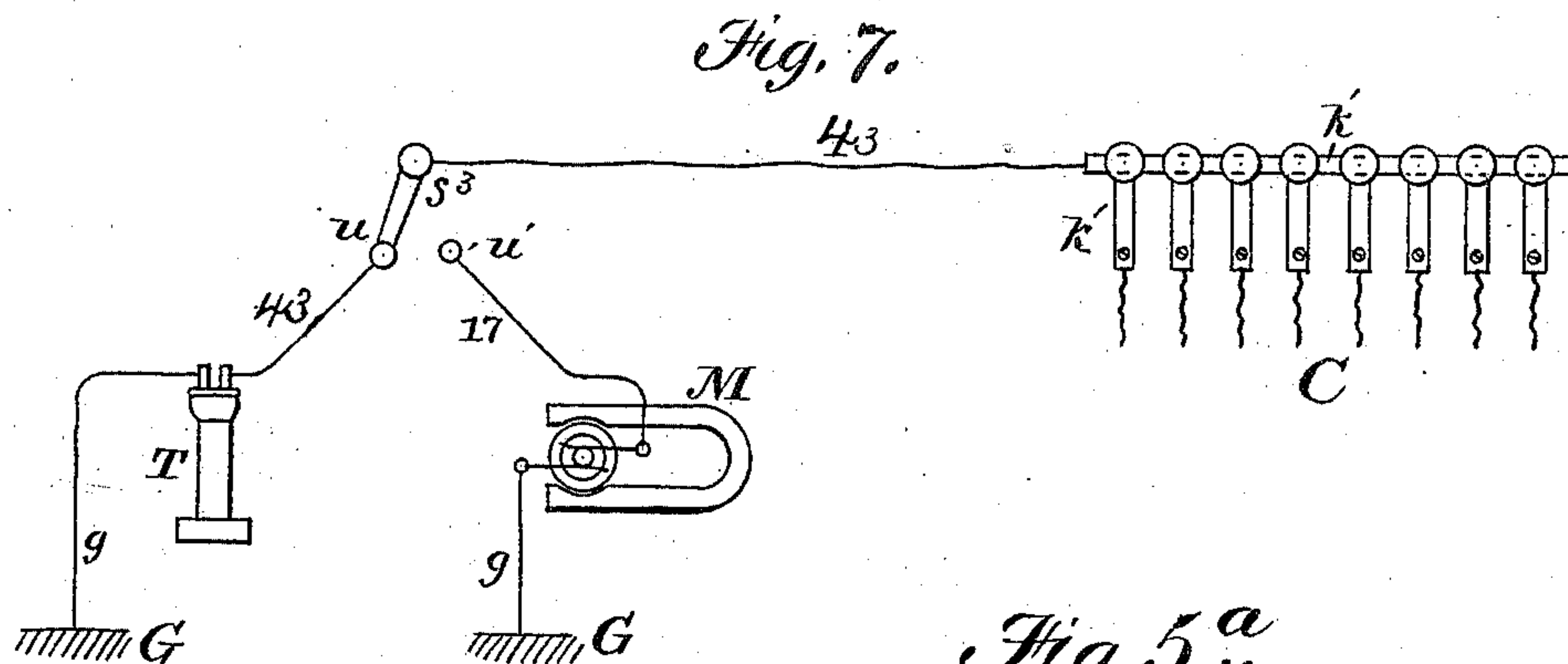
Witnesses,
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(No Model.)

3 Sheets—Sheet 3.

T. N. VAIL.
ELECTRIC MULTIPLE SWITCH BOARD SYSTEM.
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Witnesses,
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UNITED STATES PATENT OFFICE.

THEODORE N. VAIL, OF BOSTON, MASSACHUSETTS.

ELECTRIC MULTIPLE-SWITCH-BOARD SYSTEM.

SPECIFICATION forming part of Letters Patent No. 299,039, dated May 20, 1884.

Application filed January 30, 1884. (No model.)

To all whom it may concern:

Be it known that I, THEO. N. VAIL, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain Improvements in Electric Multiple-Switch-Board Systems, of which the following is a specification.

My invention relates to an organization of electric circuits and apparatus for direct intercommunication by means of speaking-telephones, which is known as a "telephone-exchange" or "central-office" system, the central station being connected by means of telegraph or telephone lines extending in different directions, with a number of separate sub-stations situated at various points within the territory which the central station is designed to serve. The organization and arrangement of the wires, switches, and instruments in the central office enable the operator or attendant who is there constantly on duty to place two sub-stations in direct electric communication with one another at a moment's notice when called to do so by a subscriber at any of the sub-stations. This is done by means of suitable switching or connecting devices.

In Letters Patent issued to me March 14, 1882, No. 255,056, I have described a switch-board in which the connectors between any two circuits consist of metal plates interleaved with non-conducting plates, the whole being surmounted with a small metal plate to represent the line-circuit.

In other applications for Letters Patent, filed of even date herewith, I have described an improvement on the above switch-board, in which the connecting-plates are superseded by strips or wires, an annunciator of peculiar construction and capable of being electrically reset from a distance, together with circuit arrangements for operating the same. Therefore, although these instrumentalities are described in this specification and are employed in connection with the system shown and claimed herein, I do not specifically claim them.

My present invention provides more particularly for the application of switch-boards of the class referred to in a system of multiple switch-boards. In such a system all the wires entering the office run to each of a series of switch-boards. One operator is capable of taking charge of a definite number of circuits, with complete devices for signaling and receiving

calls, while at the same time every other subscriber's line, has a branch or loop line running to the board of the same operator, to the end of that each operator may connect the circuits in his especial care to any other circuit entering the station without leaving his board and without communication with any other operator. For example, if one thousand circuits enter the central station, there may be five separate switch-boards, each of which is in charge of a separate attendant. At each of these separate boards are the terminal signaling facilities of two hundred wires, and also branches or loops from the eight hundred other wires entering the office. Such a system, because all the wires entering the office are represented at each board, is called the "multiple-board system." Like other telephone-exchange systems, it requires signaling apparatus to denote to the operator a subscriber's call, apparatus for sending outgoing signals, and switch devices for connecting any two lines together. In addition to this, the multiple system requires some suitable means of ascertaining at each board whether or not the line is in use at any other. By the use of my present invention all of the foregoing ends are conveniently and easily accomplished.

In the drawings which accompany and form a part of this specification, Figure 1 is a representation in perspective of the switch-board used in my invention. Fig. 1^a is a detail showing the operator's cord and connecting-plug. Fig. 2 is a diagrammatical plan view of the switch-board with the supervising-telephones and apparatus for sending outgoing signals. Fig. 3 is a sectional elevation of the signaling apparatus shown in Fig. 2. Fig. 4 is a diagram showing the connections of two circuits at each of two boards. Figs. 4^a and 4^b are detail view of one kind of connecting-plug which may be employed, together with a portion of the conducting cord and stub, indicating the detachability of the plug. Fig. 5 is a diagram of two circuits represented at two boards, each of which is already connected with some other subscriber's line. Fig. 5^a is a diagram showing the position of the line-annunciator when two connecting-plates and a "ring-off" indicator are used. Fig. 6, Sheet 3, is a skeleton diagram representing two circuits connected together by a switch, together with the branch exten-

sions by which the said connection may be supervised. Fig. 7 is a diagram of the signaling apparatus and circuits adapted for use with the arrangement shown in Fig. 6. Fig. 8 is a diagram of the signaling and telephone circuits adapted for use with any exemplification of my system. Fig. 9 is a diagram showing the signaling apparatus and ring-off signal in elevation, and as adapted for use when two connecting-strips are used; and Fig. 10 is a drawing showing how several switch-boards complete may be arranged in a central office with reference to one another. Fig. 11 is a diagram showing a modified form of plug-socket and try-circuit, and Fig. 12 is a vertical section of said plug-socket.

In Figs. 1 and 2, A represents a switch-board of the type described in my prior patent, which I have hereinbefore cited, and in the separate application filed herewith. It consists of a series of conducting plates, strips, or bars, C, piled upon a non-conducting base, A', and alternated with non-conducting plates A². The uppermost plate is also non-conducting, and is surmounted by a series of small line-plates, L, each of which represents and is united with a line-wire. In the system which I now describe these line-plates are divided into four segmental pieces, each of which is totally severed from the others, only one thus being the line-plate proper. I also have in Fig. 1 shown the operators' transmitters T' as being supported on standards at two of the corners and at the center of the board, although I do not restrict myself to that arrangement, since it may be frequently necessary to increase the number of line-plates and to cover the entire surface of the switch-board with them. The transmitters may then either be placed upon the auxiliary operating-boards B or suspended from any suitable point above the board.

The connecting-plug P is attached to a cord, c, extending from the switch s, which is capable of being turned upon either of the studs u or u', one of the said studs being connected with the telephones, and the other with a source of electricity, for the purpose of sending outgoing signals. (See Fig. 8.) This plug, when inserted in the holes through any one of the line-plates, is adapted to make contact between the said plate and any predetermined connecting strip or bar C.

Attached to the switch-board A are a series of shelves, S, whereon the line-annunciators a and the disconnecting or ring-off coils or annunciators b are arranged. I have shown these shelves disposed at one side of the board; but they are not necessarily so placed, but may be constructed round the center of the board, or even at any distance from the board, provided they are within range of vision of the operators. By removing them from the fourth side of the board I am enabled to use four operators—one on each side. In Fig. 1 I have shown but one annunciator a and ring-off annunciator b upon the shelves; but of course

in practice the shelves will be filled, as one annunciator is required for each line, and one ring-off indicator b for each pair of connecting-strips C.

The annunciators a, as fully described in a separate application for Letters Patent, which, as already stated, I have filed of even date herewith, are, in addition to the ordinary helices which are adapted to be included in the line-circuit, provided with an auxiliary electromagnet, a', arranged in the circuit of a local battery, the wires of which run to two of the segments of the line-plate. The circuit is at these plates normally open, and is adapted to be closed by the first contact of the connecting-plug which connects for a moment the two segments. The auxiliary magnet, by means of its armature and a lever actuated thereby, is adapted to lift the drop-signal of the annunciator a when fallen, and thus to replace it, ready for another call.

As described in my former patent of March 14, 1882, the switch-board connecting-plugs are of different lengths. If two connecting-strips C are used in each connection, so as to make a loop including a clearing-out indicator, the plugs must be provided in pairs, one of the plugs being of a length adapted to connect with one strip of the pair, and the other plug being adapted to make contact with the other strip. If, however, but one strip be used, as in Fig. 6, the contact-piece of both plugs of the pair must be at a similar point in each—that is, the plugs must be electrically of the same length.

Figs. 2, 8, and 9 show the connections of the signaling and telephone apparatus.

The connecting-strips C, when used in pairs, are each united with wires extending upward to the auxiliary or signaling board B. One of these wires, 15, may be terminated on the surface of the said board by a stud or anvil, k', with a permanently-attached branch wire, q, leading to one of the spring-jaws f. The complementary wire 14 likewise leads to a similar stud, k', and the opposing spring-jaw f, through the ring-off indicator-coil b, thus completing the loop. Any two lines connected together on this plan will, then arriving first at the line-plates, be connected by means of their plugs with the two connecting-strips C, and then through the loop formed by the wires 15 and 14, the spring-jaws f, and the indicating-coil b. A series of keys or spring circuit-closers, k—one for each stud k' on both sides—are united by the wires 18, the said wires all being in turn branched from the main wire 19 of an electrical generator, M, which is preferably, as shown, a magneto-generator, but which may be, if desired, a battery. The current from the said generator may be directed to the lines through the connecting-strips C when the keys are depressed. Two metal bars, l' l'', are fixed along the middle of the board—one on each side of the spring-jaws f—and these form the two open terminals of a telephone-loop, l, which in-

cludes the telephone T and the transmitter T'. Although in Fig. 2 the lines indicating said loop are drawn full, it must be understood that circumstances frequently arise when it becomes desirable to use the telephones in the operation of a single circuit; and it is obvious that in such circumstances the loop arrangement is not the most desirable. The representation shown in Fig. 2 must therefore be regarded merely as illustrating the principle whereby the telephones may be looped between two lines by forcing the two spring-jaws *f* apart and against the bars *l'* *l''*, when it is clear that the telephones are thus introduced between the two connected lines. The above contingencies are provided for by the instrumentalities and circuits shown in Fig. 8, which shows the actual construction of the loop *l* in detail. The wires *g* and *g'* lead from the connecting-strips C, and each are attached to the spring-jaws *f*. These jaws, though normally closed and in contact with one another, may be pressed apart and forced into contact with the bars *l'* and *l''* by the pressure on the knob K, which at its lower end is furnished with a non-conducting wedge, *l'''*. Each pair of spring-jaws representing a couple of line-plates is similarly furnished with a knob, K, so that the entire number are ranged along the bars *l'* *l''* in the frame or standard *l''*. A wire, *l*, leads from the bar *l'* to the transmitter T', and from thence through the cord *c*² and receiving-telephone T to the button-switch *s'*, and by means of the said switch, when turned on to the stud *v*, back to the bar *l''*, completing the loop. The calling keys and button shown in Fig. 9 are, for the sake of clearness, omitted in Fig. 8, being represented only by the wire 19, which is shown as leading out from the generator M.

The arrangements for calling or speaking over a single line by means of the ground-circuit are as follows: The plug P is adapted, of course, for insertion in the holes *h*, and is capable of being severed from the cord *c*, to which, in the drawings, it is attached. This cord leads to the button-switch *s*, which may be turned to either of the studs *u* or *u'*. When turned to *u'*, it connects the plug electrically by the wire 17 with the generator M, and to earth by wire *g*. When turned onto *u*, the circuit is by wire 43 to plate *l'*, then by wire *l* to transmitter, by cord *c* to the telephone T, back to the switch *s'*, then to stud *v'*, wire 16, and through battery Z' and wire *g* to ground, thus affording a ground-circuit for the telephones. The plug I prefer is of the electrical construction indicated in Figs. 4^a and 4^b—that is, although the shank *r* is of non-conducting material, a metallic plate, *m*, insulated from all other conductors, crosses the end of the plug, which, in practice, is more of a taper form than that shown in the drawings. The handle of the plug is also of metal, and is perforated longitudinally, so as to be capable of ready attachment to or detachment from the cords *c* when the plug is inserted. A projecting

conducting-piece, *t*, makes the contact with the line-plate, and a second and lower projection, *t'*, makes contact with the connecting-plate C.

The path of the several circuits is delineated in Figs. 4 and 5. Two line-wires are shown as entering the office and as passing through two switch-boards. Entering at 1, the line-wire passes at once to the annunciator *a*, thence by wire 2 to segment *z* of the line-plate E, through spring *j* to segment *y*, then by wire 3 to segment *z* of the line-plate E at the second board, thence by spring *j*, segment *y*, and wires 4 and *g* to ground.

Both of the line-wires shown are designated by the same letters, and follow a similar course, except that one of the wires runs to the plates E and the other to the plates F. It will be of course understood that these wires may successively pass through any number of switch-boards. It must be understood, also, that, although I have shown but two lines, as many lines as may be required may be similarly connected.

Attached to each spring *j* is a short non-conducting pin, *i*, which projects through the aperture between the two segments *z* and *y*, and extends for a short distance into the hole *h*. This is adapted to be impinged against by entrance of the plug into the hole, and acts to force and maintain the spring *j* away from the plate *z* when a plug is inserted, thus severing the line from its ground-connection.

A wire, 6, is led from the battery Z and branches, by the main wire 8 and the lateral wires 7, to the segments *x* of all of the line-plates.

All of the segments *w* belonging to the line-plates of each main line are connected together by a wire, 9, and then by a wire, 10, to one side of the auxiliary or resetting magnet *a'* of the annunciator, the several return-wires 11 of the said annunciators being all united together to lead to the other pole of the battery Z by wires 12 and 13. The object of this arrangement is the automatic replacement of the annunciator-signal by the act of inserting the plug, the plate *m* of the plug being adapted to unite for a moment the two segments *w* and *x*, and thus to close the circuit of the battery Z and actuate the resetting-magnet *a'*. A limit-pin is placed behind each of the line-plate springs *j*, and all of the limit-pins of the same main line are connected together by wires 5, for a purpose which will hereinafter appear.

The telephone T, cord *c*, and wire *c'* are here shown as being directly attached to the battery-wire, although practically switches and other apparatus are interposed, so as to connect the cord *c* in any way that may be desired.

When two connection-strips C are employed in conjunction with a loop including a ring-off indicator, as shown in Figs. 8 and 9, it is obvious that the signaling-annunciators *a* need not be left in the compound circuit composed of two lines connected together through

the switch-board, since their only use there is to subserve the purpose of a ring-off signaling device themselves. Therefore in such a case I place the call-annunciator *a* between the last line-plate *L* and the ground-wire, as shown in Fig. 5^a. Thus whenever two lines are connected together the annunciators of both are cut out of circuit and the total resistance of the circuit made much less than it would otherwise be. The arrangements I show in Figs. 6 and 7, on the contrary, provide for cases where but one of the connection-strips *C* are used to unite the lines, when of course the regular call-annunciators *a* must be in the position they are shown in Figs. 4 and 5, so as to serve for disconnecting-signals.

In Fig. 6 two lines, *r* and *r'*, are represented as being connected together. The line *r* comes to its line-plate *L*, and is there connected by the plug *P* with the connection-strip 5 at the point *p*. The other line, *r'*, is likewise united by the plug *P* to the same connection-strip at the point *p*, and thus the lines can work with one another. Each connection-strip is, however, permanently united with a key, *k*, by means of the wire *q*, and all of the keys arranged as in Fig. 7 may be depressed onto the plate *k'*, which, by wire 43 and switch *s*³, can be brought into connection either with the telephone *T* and ground or with the wire 17, generator *M*, and ground by turning the switch to *u* or *u'*, as may be desired. Either of the two lines or both at once may thus be connected with or signaled over.

I may arrange any number of switch-boards in any desirable way, and I find the arrangement shown in Fig. 10 very satisfactory in practice, as the operators have sufficient space to move and perform their manipulations, while at the same time they are within easy speaking distance of one another.

I will now describe the operation of my system.

A sub-station sends a call-signal, and the annunciator *a* drops its shutter or signal. The operator, to ascertain what is wanted, takes the plug *P*, which is previously attached to the cord *c*, and inserts it in the line-plate hole *h* of the calling subscriber. This pushes off the ground-springs *j* by the pin *i*, and puts the operator's telephones into circuit, the route of said circuit being from the line to segment *Z* of the line-plate to point *t* of the plug, and then through the handle *H* of the plug, and through the cord *c*, switch *s* to stud *u*, wire 43, wire *l*, transmitter *T'*, telephone *T*, cord *c*², switch *s*¹, and wire 16 to ground-wire *g* and earth. Finding what is wanted, the operator may now release his cord from the plug, leave the plug inserted, and proceed to call up the required sub-station on another line. This will be done by first attaching the cord *c* to the second plug of the same pair. Then turning the switch *s* to the other stud, *u'*, the operator may be either tap with the metal handle of the plug on the line-plate of the subscriber wanted, at the same time lifting the

ground-spring; or he may insert the plug completely in the hole of said line-plate, when the current from the generator will pass through the cord *c* and plug *P*; and if the plan of Fig. 6 is employed will flow both to the line wanted and to the line which called, ringing the bell of both and notifying one that he is wanted and the other that the line he desired is connected. Before completely entering the plugs, it will be necessary, if the annunciators are connected outside of the line-plates, as shown in Figs. 4 and 5, to rest the metal plate *m* of each plug across the hiatus between the two segments *w* and *x* of the line-plate, so as to close the local circuit of the battery *Z*, and thereupon reset the annunciator. This local circuit will thus be completed from one pole of the battery by wires 6 and 8 and branch wire 7 to segment *x*; then by the small plate *m* of the plug to segment *w*, and then by wires 10 or 9 and 10 to one side of the resetting-helix, from which it returns by wires 12 and 13 to the other side of the battery. After the plug is inserted there is no further contact between the segments *w* and *x*, because that part of the plug which rests upon their internal surface is of a non-conducting character; or the said internal surface of the three segments *x* and *y* may be lined with a suitable non-conducting lining, as shown. After calling the required subscriber, the switch *s* may be turned onto the stud *u* to connect the telephones, and the called subscriber may be told who desires correspondence with him. The cord *c* may now be detached from the second plug, and the subscribers may converse. Should a second call for any reason be necessary, the key *k* of the strip *C* on which the two lines are connected may be depressed, first turning the switch *s*³ to the generator side *u'*; and if it is desired to listen for a moment to the conversation, the same operation may be performed with the switch turned to the stud *u*, which introduces the telephone. This will connect a ground branch through the telephones to the united lines and enable the operator to supervise conversation while the communication between the two lines is unimpaired. Upon the conclusion of the conversation either subscriber may send a disconnecting-signal and drop the annunciators. If the connection-plates *C* are connected on the loop plan, the same procedure may be carried out until the plugs are both inserted in the hole and the cord detached therefrom, except that it will be necessary to unite the segments *w* and *x* by the handles of the plug to close the local circuit, inasmuch as the annunciator is on the ground side of the line plates, and are not used as disconnecting-signals; or, as soon as the call is received, both plugs, if desired, may be inserted, and the remaining manipulations made by the apparatus of the auxiliary board *B*. The operation of this apparatus, as represented partly in Fig. 8 and partly in Fig. 9, is as follows: Let it be supposed that one of

the lines is connected with No. 1 of the connecting-strips C and the other with No. 2. To send an additional call-signal to both lines at once, either of the keys k may be depressed onto the studs k' , these keys being connected by wire 19 with the generator to send the calling-current *via* 19, key k , stud k' , wire 15, connecting-strip No. 1, and plug P' to line-plate L and one of the lines, and by wire 19, key k , stud k' , wire q , spring-jaws f , wire q' , needle-indicator b , wire 14, and connecting-strip No. 2 to the other line.

If it is desired to send signals to but one of the lines, the spring-jaws may be separated for but a short distance (not sufficient to bring them against the telephone-bars l') by pressure upon the knob K, and the key k depressed as before. The signal will now go to the first line when the key on the left side is depressed, and to the second line when the key on the right side is depressed. If the operator desires to talk to both subscribers at once, or to listen to hear if the conversation is over, it is only necessary to press the knob K. This presses the jaws f against the loop-bars l' , and introduces the telephones into the circuit *via* wire q from the connecting-strip No. 1, jaw f , bar l' , wire l , transmitter T', wire l , cord c^2 , telephone T, switch s' , stud v , wire 13, bar l' , jaw f , and wire q' back to the second connecting-strip and line. Upon the conclusion of a conversation, one of the subscribers may ring a disconnecting-signal, which will deflect the needle and exhibit the signal of the indicator b .

My system contemplates the combined operation of a number of multiple switch-boards, and in Figs. 4 and 5 two of these are represented, each but two lines.

It is evident that occasions will frequently occur when the subscriber's line wanted may already be connected to a line at some other board, and that some means must be provided whereby any operator receiving a call for a certain line may ascertain whether that line is or is not in use by some other board. Each line is, it is true, represented upon his own board; but it is also represented at every other board, so that some device for the accomplishment of this is absolutely essential. I effect this by the limit-pin o and the wires 5, running between the boards, and by the interposition of the battery Z' in the ground-circuit of the telephones. (See Fig. 8.) If, for example, the line entering the line-plate E calls for the subscriber on the line entering the plate F, it is necessary first to ascertain if F is already in use at some other board. Referring to Fig. 4, the operator only has to place his telephone T to his ear and touch with the metal part of his plug the limit-pin o of the line-plate F. If F is not in use, there will be no click in the telephone, because there is no circuit completed. The incomplete circuit can be traced as far as it goes from ground G, wire g' , battery Z, wire c' , cord c , telephone T, plug P^2 , pin o , wire 5, to limit-pin o at the

distant boards, at all of which it is open. It is thus proved that the line F is not in use. *Per contra*, if the line wanted is in use, a click will be heard in the telephone when the trial is made, because the try-circuit is completed as follows: Fig. 5, limit-pin o of the line-plate F at board No. 1, wire 5, to limit-pin o at board 6, and as the plug P is there inserted to make a connection with some other line, the spring j is forced against the pin o there, completing the try-circuit to earth at G. The operator, hearing the consequent click, knows the required line to be in use, and so informs the person who called for it.

The modified arrangement which I show in Figs. 11 and 12 is adapted for use in connection with a form of plug-socket and plug in which the segment z , forming the line-plate, is constituted of two quadrantal plates, 1^a and 1^b , arranged one above the other, and separated by an intervening non-conducting plate, 1^c . It is thus provided with a recess between the two plates 1^a and 1^b , the non-conducting plate not being so large as the others, as shown in Fig. 12. The plug P, adapted for insertion into this socket, is formed as shown, with a projecting pin, t , adapted, when the plug is inserted in the hole and slightly turned round, to fit into the recess between the two plates, the lower projection simultaneously making contact with one of the connecting-strips. I avail myself of this construction to establish another form of try-circuit, which in some cases may be preferred.

F represents the line-socket at one switch-board, while F' represents the second socket of the same line at another switch-board.

B^4 is a local battery; V, a vibrating bell or any suitable electro-magnetic signaling device. The battery-circuit leads from one pole *via* wire 20 and branch wires 21 to the lower line-segment 1^b of all the lines. From the other battery-pole a wire, 24, leads to one screw of the vibratory bell V, and from the other bell-terminal another wire or cord leads to the plug P. From the main line L a wire, 23, leads to a series of studs, 22, one of which is placed at each line-plate. When the plug is inserted in the socket, and its pin t is turned so that it rests in the recess between the upper and lower segment, said pin t makes contact with and unites the two segment-plates 1^a and 1^b . If, now, at any other board it is desired to ascertain whether the line L is in use, the operator takes his plug P and touches the stud 22 of the line L with it, thus closing the local circuit from the battery B^4 *via* wire 24, bell V, wire 25, plug P, stud 22, wire 23, plate 1^a , plug-pin t , plate 1^b , wire 21, and wire 20 to the battery, and causing the bell to ring; but if the line should not be in use at another board, the two plates 1^a and 1^b will of course be out of contact with one another, the circuit will be open, and the bell will not ring.

It will be understood that the shank of the plug P must either be of non-conducting material, or else the other three segments must

be lined with some suitable non-conductor, so that when inserted in the hole contact will be made only with the line-segment. I have shown many circuits and wires in the drawings, and if these were in practice intermixed with the apparatus, it is obvious that much confusion would result. It is, however, well understood by those skilled in the art of electrical engineering, that these wires can readily be arranged in the switch-board symmetrically, and that my representation is diagrammatical. It is also apparent that many other manipulations in addition to those I have indicated may be performed in my system, and that the two plans of arranging the connecting-strips C may be combined with one switch-board often to advantage.

One great advantage over other systems which is attainable by my arrangement is the much greater number of subscribers' lines which can be terminated and served on one board, for in a system employing upright boards operators can only be arranged at the face of the board, whereas by the employment of my plan they can be stationed upon four sides of the board, if necessary.

I am not aware that heretofore any practical means have been devised for the combination, with a switch-board of the character specified, of suitable organizations of manipulating apparatus, whereby such board may be adapted for use in a multiple system, and this fact has militated against the introduction of boards of this class into extensive use.

I have so far described the connecting-plugs as being all adapted for attachment to and detachment from the cord *c*, which I use both to test for line in use, and also to call and converse with single lines. I may, however, without departing from the spirit of my invention, provide plugs which are not so adapted, and which have solid handles, and in that case I fit the cord *c* with a permanently-attached metal plug, which is alike adapted to bridge the hiatus between the segments *w* and *x*, for the purpose of closing the local circuit to reset the annunciator, and also to send call-signals and to connect the telephones to line by manual contact with the handle of the detached plug, when said detached plug is inserted in any of the plug-sockets.

I claim as of my own invention—

1. In a multiple-switch system for a telephone central station, the series of horizontal switch-boards, each furnished, as described, with annunciators for a definite number of lines, and with line-plates equaling in number and connected with every line entering the station, the auxiliary manipulating-boards provided with apparatus for sending outgoing signals and for telephonic communication, and means, as indicated, whereby an operator at one board may ascertain whether any line is in use at any other board, substantially as described.

2. In a multiple-switch-board telephone-exchange system, the combination of a horizontal switch-board composed of alternate layers

of conducting connecting-strips and non-conducting insulating-plates, the whole surmounted by line-plates, with annunciators for receiving incoming signals, means for sending outgoing call-signals, and other means, substantially as indicated, for connecting the central-station telephones with one or more lines, as specified, and for the purposes set forth.

3. The combination, with a horizontal multiple switch-board constructed as herein described, of a series of annunciators to give incoming signals—one for each line—and means for automatically resetting the said annunciators, whereby they are adapted to subserve the purpose of a disconnecting-signal.

4. The combination, in a multiple-switch-board system, of the divided line-plates, spring-contacts for normally connecting two of the segments of said line-plates, circuit-connections uniting the spring-contact of the line-plate at each board with the main part of the line-plate at the next, a limit-pin for each spring-contact, and a wire connecting all the limit-pins of the same line together, with the telephone, its cord and plug, and a battery in a normally-open earth-circuit, whereby each line may be tested before use, substantially as specified.

5. In combination with the connecting-strips of a horizontally-disposed switch-board of the character hereinbefore described; the said strips being arranged in pairs, a generator of electricity, keys for directing the current of said generator to the said strips, and a normally-closed loop-circuit including a spring-circuit changer and a disconnecting-indicator extending from one strip of the pair to the other, for the purposes set forth.

6. In a multiple-switch-board exchange system, the switch-boards consisting of interleaved conducting-strips, and insulating-plates surmounted by line-plates, combined with the flexible cord and the detachable connecting-plug, the latter being adapted, when inserted, to unite one segment of the line-plate with one of the connection-strips, and with means, substantially as described, whereby call-signals or telephone-signals may be transmitted to the line through the said cord and plug, for the purposes described.

7. The combination, substantially as hereinbefore described, with a series of telephone-line circuits, of switching devices for connecting any two of said circuits in pairs through a loop including a disconnecting-indicator, and means for introducing the central-station telephones into said loop, whereby the central office may supervise conversation passing between any two lines.

8. The combination, substantially as hereinbefore described, of a series of line-plates, each representing a telephonic main line, with connecting-strips, constituting the normally-open ends of a loop, including a disconnecting-indicator, devices for introducing telephones into the said loop, plug-connectors for uniting any two line-plates with any pair of

the said connecting-strips, means, as indicated, for sending call-signals through the loop simultaneously to line through both line-plates, and other means whereby the said loop may be severed and call-signals sent to either line independently, for the purposes specified.

9. The combination, in a telephone-exchange system, with the operators' telephones, and an electrical generator, of the spring-jaws *f* and knob *K*, the branch wires 43, the switches *s* and *s'*, the ground-wire *g*, key *k*, and the conducting cord and plug, all arranged as described, whereby the same calling and conversing apparatus may be used for working upon a single grounded circuit, and also for operating two circuits when connected together, dispensing with the central-station ground, as described.

10. The combination, in a switch-board comprising alternating layers of connecting-strips and non-conducting plates, of the compound line-plate consisting of a number of quadrantal or segmental divisions perforated in the center, with a connecting-plug adapted to fit in the said perforation, and to rest mechanically upon all of the said segments or quadrants, and to make electrical contact with one of said strips, and means, substantially as indicated, for insulating the said plug from all of the said segments, except the one actually connected with the line-wire, for the purposes specified.

11. The combination, in an electric switch-board consisting of line-plates surmounting a structure of interleaved conducting-strips and insulating-plates, of the said conducting connecting-strips, with branch circuits leading to a key system, whereby any of the said strips may be connected with a telephone or with an electric generator, as described.

12. The combination, in a multiple-board telephone-exchange system, of two or more

horizontal switch-boards of the character described, means, as indicated, for receiving incoming and for sending outgoing call-signals, other means for ascertaining at one switch-board whether the line is in use at another, and an automatic device whereby a line-annunciator located at any one of the switch-boards may be reset from any one of the other switch-boards.

13. The combination, in a telephone-exchange system, with two or more horizontal multiple switch-boards provided each with plug-sockets representing every line entering the exchange, of lines extending from each plug-socket on each board to the plug-socket of the same number on the next board, and contact-springs permanently connected with such lines, and normally maintaining the continuity of the main line through all the switch-boards, together with normally-discontinuous lines—one for each main line—provided with a limit screw or pin at each board immediately in the rear of each contact-spring, and adapted to limit the outward play of the same, and plug-connectors adapted, when inserted, to press aside the contact-spring, thus severing the main line from its normal termination through the switch-boards to earth, and simultaneously forcing the said contact-spring against the limit-pin of the normally-discontinuous line, connecting the same to earth, substantially as hereinbefore described, and for the purposes set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 17th day of January, 1884.

THEO. N. VAIL.

Witnesses:

THOS. D. LOCKWOOD,
GEO. WILLIS PIERCE.