

(No Model.)

T. N. VAIL.
ELECTRIC SWITCH BOARD

No. 296,253.

Patented Apr. 1, 1884.

Fig. 1.

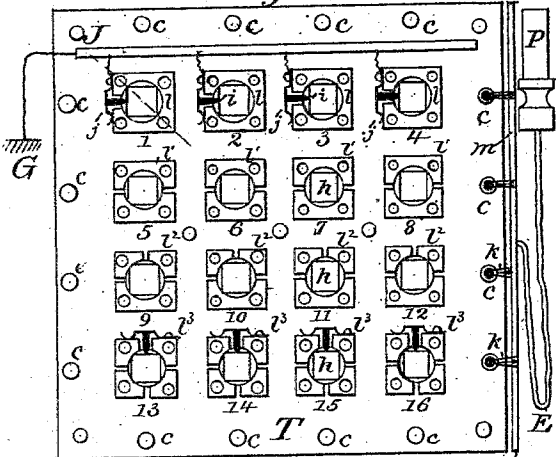


Fig. 3.

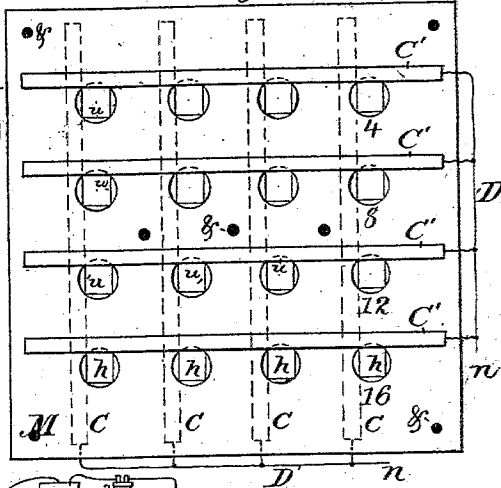


Fig. 2.

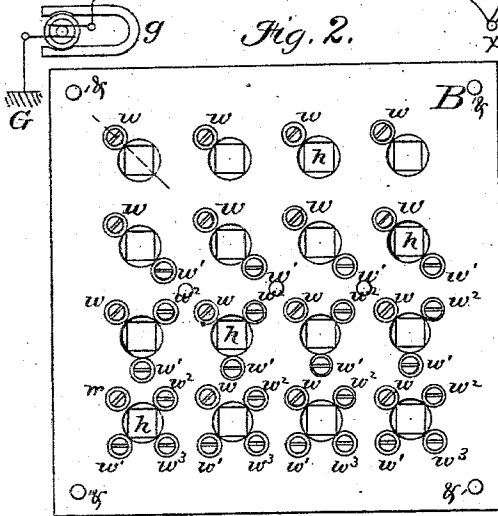


Fig. 4.

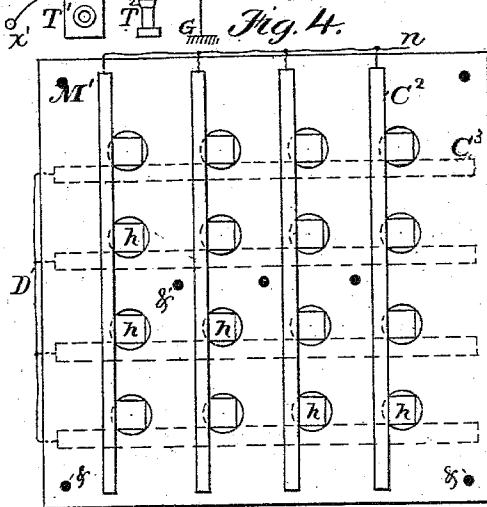


Fig. 5.



Fig. 6.

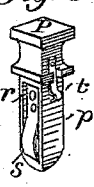


Fig. 7.

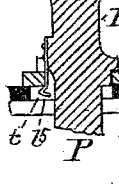


Fig. 8.

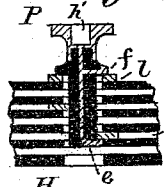


Fig. 11.

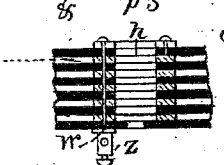


Fig. 12.

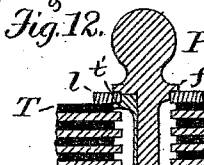


Fig. 10.

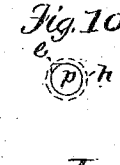
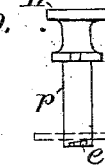


Fig. 9.



Witnesses.

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UNITED STATES PATENT OFFICE.

THEODORE N. VAIL, OF BOSTON, MASSACHUSETTS.

ELECTRIC SWITCH-BOARD.

SPECIFICATION forming part of Letters Patent No. 296,253, dated April 1, 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 Switch-Boards, of which the following is a specification.

My invention consists in certain improvements in the construction of electrical switch-boards of the class wherein the intermediate conductors, whereby any two line-circuits may be connected together, consist of plates or strips of metal insulated from one another by alternating sheets of any suitable non-conducting substance, while the several line-circuits entering the switch-board each ordinarily terminate at and are represented by much smaller plates—one for each circuit—these latter being secured to the surface of the uppermost or front non-conducting plate, thus surmounting the whole. The connections in switch-boards of this class are made by the insertion of plugs made in pairs of different lengths, each separate pair of plugs being of the precise length required to make contact with one of the connection-plates only; or, in the event of a pair of connection-plates being used when two lines are united, one of the plugs is adapted to make contact with one of the pair, the other similarly making contact with the remaining plate. All of the plugs, when inserted, are, however, adapted to make contact with the surmounting or line plate.

I have, prior to my present invention, obtained Letters Patent of the United States No. 255,056, and bearing date March 14, 1882, describing such a board, and constituting an improvement upon the patent of Francis Blake, No. 249,574, November 16, 1881, by which the switch-board of said Francis Blake is adapted for use in exchanges of a much more extensive character than was originally the case.

The improvement described in my former patent consisted in the use of very thin connecting and insulating plates made operative by causing a portion only of each plate to project into the plug-hole, the plug being provided also with a corresponding projection arranged to meet the same and make contact therewith. By such an arrangement I have been enabled to multiply the connecting-plates greatly without impairing the efficiency of the apparatus.

Reference may be made to my former patent hereinbefore cited, as my present invention is an improvement thereon.

In my present invention I dispense with the connection-plates of the former patent and substitute therefor conducting strips, bars, or wires, the several strips or wires of one layer being all connected together at the side of the switch-board, or in other convenient place and way, so that they constitute for electrical purposes a practical equivalent of a complete plate. The object of this improvement and modification is to provide a more economical construction by using a much smaller amount of metal; to facilitate construction by using light strips or wires; to make a more efficient apparatus by causing the edge of each connecting-strip to cross over the edge of the series of holes in its plane, thus forming a chord to one of the arcs produced by the circumference of said hole.

In pursuance of the foregoing objects my invention, concisely stated, consists in a switching apparatus composed of a series of sheets of non-conducting material superposed one upon another, the mass being perforated with as many holes as there are subscribers' lines. Interleaved with the said insulating-sheets are alternating series of conducting strips, bars, or wires, the consecutive layers being transversely disposed with reference to the layer immediately adjacent upon either side. The several strips are so fixed that each one extends across an arc of the holes it crosses, thus forming a chord to the said arc. Each hole, in virtue of the numerous chords it thus contains, is practically square. The several connecting-plugs are made in pairs to reach through the mass and to connect the line-plate with any desired one or two of the connection-strips; and, finally, all of the connection-strips upon the same horizontal plane are connected together, so as to constitute an individual electrical conductor separate from all others and complete in itself. The several connecting-conductors thus formed may, by suitable wires or other continuations, be brought to the surface of the board and combined with manipulating devices, such as the central-station telephones and signaling apparatus.

In the drawings which illustrate my invention and form a part of this specification, Fig-

ure 1 represents a plan view of the top of the improved switch-board, showing the line-plates of varied character, as may be required in different systems. Fig. 2 is a view of the bottom of the switch-board. Figs. 3 and 4 are horizontal sections, showing the construction. Fig. 5 is a vertical section taken across two of the plug-holes, and showing the said plugs inserted. Figs. 6 and 9 are forms of connecting-plugs adapted for use in conjunction with my switch-board, and Fig. 10 is a cross-section of the latter form. Fig. 7 shows the upper end of an inserted plug, representing the contact-making and locking device. Fig. 8 shows a detail section of a plug-hole fitted with the form of plug shown in Fig. 9. Fig. 11 shows the methods I adopt to connect the line-wires with their respective plates. Fig. 12 is another detail hole-section, showing the insertion of still a third form of plug. Fig. 13 is still another plug-socket section, and Fig. 14 shows the form of plug adapted for insertion therein.

It is to be understood that the greater or less size of the apparatus does not enter into my invention, and I have purposely magnified some of the views in the drawings in order to facilitate explanation. I provide as many insulating-plates C as may be necessary for the proposed capacity of the switch-board, and perforate them, as shown, with holes equal in number to the number of circuits which the board is intended to serve.

In the drawings, B represents the lowest non-conducting plate, on which the component parts of the switch-board are, as it were, built up. Upon it a number of thin metallic strips, bars, or wires, C, are laid, as indicated in dotted lines in Fig. 3, and are so placed as to lap slightly over the edge of each hole in the row which it crosses. Thus the right-hand strip C crosses the board, slightly overlapping the left-hand edge of the holes 4, 8, 12, and 16, constituting at each hole a chord of the arc thus formed. The other strips of the same layer similarly overlap a small portion of the other holes, and when all of the strips of the layer are in place they are metallically united by a wire or foil connector, D, and the leading-out wire n is attached to the united series, which thus forms an electrical equivalent to the complete sheet or plate described in my former patent. Over the metal strips so arranged I now lay a second non-conducting plate, M, the holes of which correspond exactly and in every way to the holes of the base-plate B, and upon the plate M a second series of conducting crossing strips, C', are laid, each of which, as in the former series, is made to overlap the edge of an arc of the hole through the plates, as shown in full lines in Fig. 3. This second layer or series, C', I prefer to arrange at right angles to those immediately below, so as to present a point for contact with the connecting-plug separated from the strip below, not only by the thickness of the intermediate plate, but also by a quarter

of a turn round the circle of the plug-hole. The strips C' are, in like manner to the preceding, united by the wire D, and from them a wire, n , is led out. A third non-conducting plate, M', is now laid upon the strips C, and is in turn provided with the conducting-strips C'', crossing the holes at right angles to the strips C', but parallel to and divided by two insulating thicknesses from the first set of conductors, C. The several strips C'' are, as before, united together and to the wire n , which leads out. A fourth non-conducting sheet is now laid on the pile, and over it the metal strips C'', which are shown in dotted lines in Fig. 4, and the method of construction is carried on until the required number of alternating non-conducting plates and conducting strips or wires are incorporated. It is evident that either wires or flat metal strips will serve this purpose, as in either case the object is to provide a metal surface or line which shall cut across the edge of the hole and slightly overhang the same. In some cases, where the contact with the conducting-point of the plug is made by impingement, I prefer the strips or bars; but in other cases, where contact is made by the hooking of the projecting point of the plug under the crossing conductor, the wires may profitably be adopted. In any case, whether strips or wires are used, the part u in each hole where the strip or wire chords the arc is the point of contact with the connecting-plug. After the required number of layers are set up, the whole, as in my prior patent, is covered by a non-conducting plate, T, and this over each hole is surmounted by a line-plate, l , which, by wires W, passing through the mass and connecting with the binding-screws z , is united to the line. Looking down through the perforated line-plates into each hole h , the edges of the several connecting-strips may be seen, assuming, as they cross the arcs of the hole at right angles to one another, the form of a square. The entire mass of the switch-board, when built up, may be held firmly together by a series of bolts, which pass through from top to bottom at the four corners, and between as many of the plug-sockets as may be found necessary. In switch-boards of this class it is frequently necessary, for convenient manipulation of the board, to split the line-plate l into two, three, or four segments, and I have instanced this construction in Fig. 1, where the first four line-plates, l , are in one piece, the second four, l' , are split in half, the third four into three pieces, and the remainder into four pieces. The connecting-wires from each segment are laid down through the substance of the board, (holes being previously drilled for their reception,) and united with the binding-screws w , w' , w'' , and w''' at the base of the board.

There are several forms of plug adapted for use with my board, and in Figs. 5, 6, 7, 8, 9, 10, and 13 I show some of these. The plug shown in Figs. 5, 6, and 7 has a spring-connection at both extremities, the upper one

serving the double purpose of holding the plug in place, and of making contact with the line-plate. The plug P is square in form, and has a curved contact-spring, *s*, adapted, upon insertion, to make contact, as shown in Fig. 5, in the hole *h*, with the overhanging part of one of the crossing strips C which it reaches, and with no other. The spring *s* is of course prevented from contacting with strips below, since it is not sufficiently long so to do, while it cannot make an undesired contact above the required strip on account of the recess *r*, in which it is embedded at all points, except the point of contact. From the shoulder down, the plug P is formed of non-conducting material, and may thus be permitted to strike against the different conducting crossing wires which it passes in its progress to its seat in the hole *h*, and when the plug is in place the edges of the said wires or strips aid in supporting it. Immediately below the line-plate *l* is a recess, *l'*, between the said line-plate and the highest connecting-strip, the highest non-conducting plate, T, being cut away to make such recess, and the small contact and locking spring *t* is adapted, as clearly shown in Fig. 7, to fit therein and to make contact with the line-plate. The handle of the plug I also prefer to form of metal, and its under surface, resting upon the upper surface of the line-plate, also aids in maintaining a good electrical connection. The vertical section in Fig. 5 shows the general arrangement of the parts.

Figs. 8, 9, and 10 show another form of connecting-plug. The handle H of this plug P is preferably of metal, and has a hole, *h'*, extending into its substance. By means of this hole the plug is adapted to be attached to the end of a conducting-cord, as in Fig. 1. In this way the plug which is to be next used may always be fitted to the telephone-cord, and when the plug is inserted the cord may be withdrawn from it and attached to the next plug. The main body *p* of the plug is non-conducting, but a projecting stud, *f*, and also a projecting cam, *e*, are conducting, and are electrically united by a wire which may run through the substance of the plug or be let into its surface. The metal handle is also in electrical contact with the stud *f* and cam *e*, the former being adapted to make contact with the line-plate, and the latter with the connecting-strip C'. To insert properly the plug shown in Fig. 6 it is only necessary to drop the plug squarely into the hole. It will, with a slight pressure, assume its proper seat at once. The plug last described is round, and must, on the contrary, be slid in and then slightly turned, so that the cam *e* may bring its thickest part to bear firmly upon the under side of the crossing wire C'.

Fig. 12 shows still another form. In this modification the main body *p* of the plug will always be of the same length irrespective of the point at which the lower contacting projection or cam, *e*, is placed.

In Figs. 13 and 14, I show still another modification of plug-socket and plug. In this form

the line-plate *l* has a recess in its internal edge, and is preferably formed of two metal quadrants, *l'* and *l''*, placed one over the other, and insulated from one another by an intervening non-conducting plate, *l'''*. The plug has a handle, P, which, together with the shank *p*, may be of suitable non-conducting material. A contact-spring, *s*, is attached to the lower end of the plug at a point corresponding to the connecting-strip which the plug is arranged for, and a projecting pin, *t*, is formed at the upper end and is adapted to fit into the aperture between the two line-plate quadrants *l'* and *l''*. The pin *t* and spring *s* are united through the substance of the plug by a wire, *s'*, and thus the line-plate may be connected electrically with the desired connecting-strip. By this construction I am enabled to arrange the line-plates in such a manner that the plug may be inserted in the hole, but form no connection between the line-plate and connecting-strip until turned into position, for the plug, when first inserted, will be so disposed that the spring *s* will descend in the angle formed by the intersecting connection-strips, while the pin *t* will fall through the slit formed by the separation of the line quadrant or segment from the adjoining quadrant. It is of course evident that the spring *s* must be so placed on the plug as to fall into the angle, while the pin *t* must correspondingly be placed at the same time so as to fall into the slit between the line-segments. This construction can only be used when the line-plate is bisected or quartered, as in the three lower rows of sockets in Fig. 1; but when it is desired to make connection the plug is not only dropped into the hole, but it is also turned round so that the spring *s* is brought into contact with the connecting-strip, and the pin *t* is simultaneously inserted in the recess between the two plates *l'* and *l''*, with both of which it makes contact. The entire plug may be of metal, and the extreme end *b* may be tapered and adapted to socket into the hole through the base-plate B, which may be a little thicker than the other plates. If this conformation be adopted, it is preferable to make the holes through the base-plate smaller than in any of the intermediate plates, as shown in Fig. 11. The shank *p* of the plug may be much smaller than the hole, so as to fit when inserted only in the base-plate and the line-plate. The shoulder *f* of the plug rests upon the line-plate *l*, and when the plug is inserted it is turned slightly, so that the upper projection or pin, *t*, locks under the line-plate the same time that the cam or lower projection, *e*, impinges against the connecting-strip C below. Obviously, the pins must be in pairs, and must be of various lengths, so as to be adapted to make contact with all the connecting strips or wires. For example, one pair of plugs must be sufficiently long to make contact with the lowest strip, a second pair with the next longest, and so on, with, however, the exception that if the form of plug shown in Fig. 12 be adopted the

plugs will always be of the same length, but will have their lower contact-pieces located at a different horizontal plane for each plug or pair of plugs. It sometimes becomes desirable to use two of the connecting-strips for each connection, looping them together through a "ring-off" instrument. When this is done, the two plugs of a pair will also differ as to the position of their lower contact projection, it being self-evident that one of the projections must be upon the level of one of the said connecting-strips, and the other upon the level with the second strip.

I do not confine myself to any or all of the special conformations of plug herein shown and described, since the essence of my invention lies in the special character of the connecting-strips, in the union of all the strips of the same layer to constitute a single strip, and in the combination of the several elements described to form a switch-board.

The wires constituting the common terminal of each layer of connecting strips or wires are led up at the side or through the substance of the switch-board, and are soldered or otherwise fastened to metal studs *c*. (See Fig. 1.) In order to utilize these terminals for the ordinary operations of a switch-board, I arrange along each side of the board a metal bar, *m*. A series of keys or buttons, *k*, are permanently attached to the said bar and extended over the terminal studs *c*, but do not touch them unless manually pressed thereon. The bar *m* is united by a short wire with a small button-switch, *x*, which may be turned upon either of the two studs *x'* and *x''*, the former leading to earth through a telephone-transmitter, *T'*, and receiver *T''*, and the latter to earth through a generator, *g*. By means of a cord conductor, *E*, the plug *P* is also in electrical connection with the bar *m*, and when inserted in any other of the holes thus brings the line-plates *l* also into connection with the same bar, and thus with the telephones and generator, by which signals may be sent or telephonic communications carried on with any line. The plug may be attached to the cord *E* by friction only—an arrangement provided for by the hole in its handle shown in Fig. 8—and when inserted in the line-plate hole may be left there, the cord end being withdrawn and attached to another plug. Signals may also be sent to any line, and conversation maintained therewith, if said line is already connected by means of the plug *P* with the connecting-strips *C*. This is effected by pressing the key *k* upon the stud *c* belonging to the layer of strips *C* employed, and turning the button-switch *x* upon the stud *x'* or *x''*, as may be desired.

I use the same method of removing the normal ground of the lines as I employ in my former patent. A ground-plate, *J*, is shown from which a series of springs, *j*, stretch. These springs normally press upon the line-plates and form a ground therefor. A hole is bored through the edge of the plate, in which a non-conducting pin, *i*, slides easily. This

projects normally for a short distance into the hole *h*, and when forced out by the insertion of a plug automatically removes the ground. Having now fully described my invention, I claim—

1. In an electric switch-board, the combination of the non-conducting separating-plates, perforated as described, the conducting cross-strips or wires overlapping the edge of the holes through the non-conducting plates, all of the said strips on the same horizontal plane being united electrically, and the line-plates resting upon the uppermost non-conducting plate, as set forth.

2. A switch-board consisting of a series of non-conducting insulating-plates perforated for the reception of plugs, a series of conducting strips or wires interleaved between each two non-conducting plates, and disposed so as to overlap an arc of the holes through the said non-conducting plates, all the strips of each layer being electrically united, a series of line-plates surmounting the whole, and a series of plug-connectors, each adapted to make contact with the line-plates, and arranged in pairs with respect to the conducting-strips, so that each pair of plugs is adapted to present a contact-point and to make contact with its own connecting-strip and with no other, substantially as described.

3. The combination of the interleaved non-conducting perforated plates and conducting connecting-strips, the latter crossing the former and overlapping the edge of the holes perforating the same, with the hereinbefore-described plug-connectors, consisting of a handle and shank, a conducting portion adapted to make contact and interlock with the line-plate, and a spring projection or cam adapted to make contact with the connecting-strip and interlock with the overlapping part thereof, whereby the plug may be inserted and slightly turned to simultaneously make the required contact and to lock itself in position, as specified.

4. The combination, in a switch-board of the character hereinbefore described, of the line-plates provided with line and ground connections, the conducting connecting-strips, the several strips of each layer being united, the interleaved non-conducting plates adapted to insulate the several layers of connecting-strips from one another and from the line-plates, plug-connectors for connecting any wire-plate with any connecting-strip, and means, as indicated, whereby signals may be sent and conversation maintained over the main line, either through the line-plates direct or through the connecting-strip and plug-conductor, as and for the purposes described.

5. In a switch-board of the character hereinbefore described, the combination of the line-plates and connection strips or wires insulated in layers by interleaved non-conducting plates, the line-plates and non-conducting plates being perforated with plug-holes, and the connection-strips arranged to cross the

edge of the said plug-holes, and provided with extension-wires (one for each layer) leading to studs at the surface of the board, with a signaling bar and keys, the said keys being all
5 connected with the bar and extending over the said studs, together with an electrical generator and a telephone set, and a switch for connecting the signaling-bar with either telephones or generator, as described, where-
10 by upon the pressure of the keys signals may

be sent to line or conversation maintained through the connecting-strips, as specified.

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.