

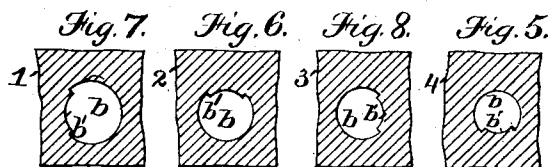
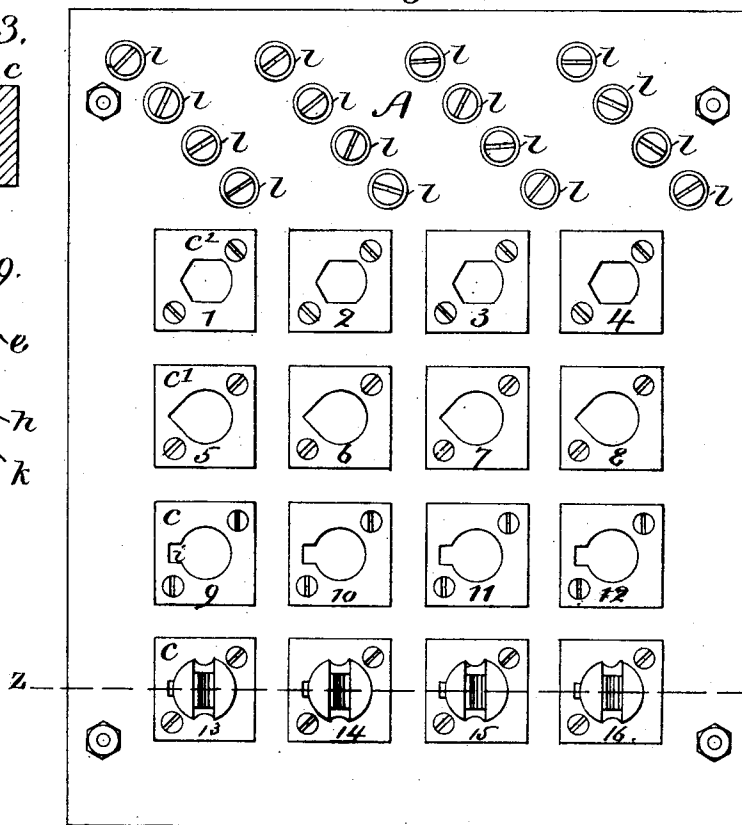
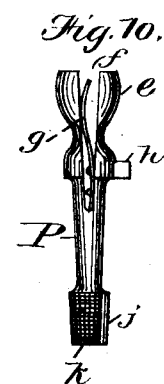
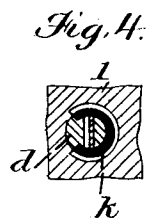
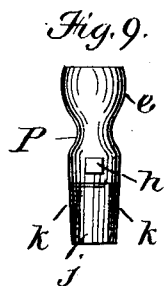
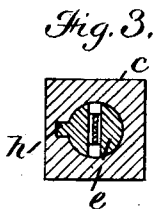
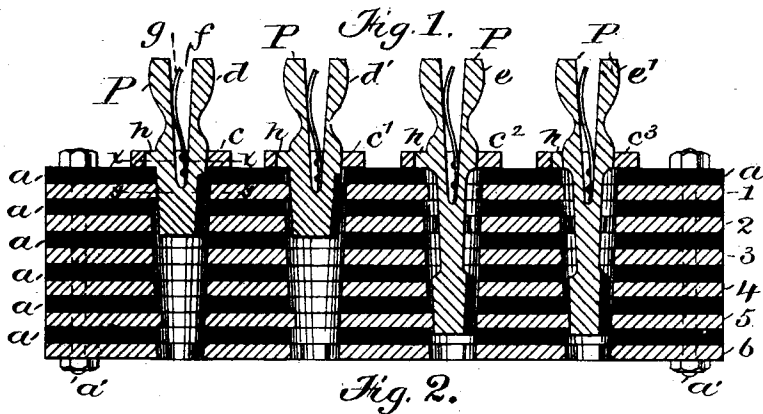
(No Model.)

T. N. VAIL.

ELECTRICAL SWITCH BOARD.

No. 255,056.

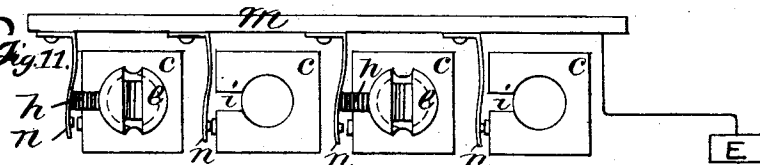
Patented Mar. 14, 1882.



Witnesses.

Mrs J Lockwood

Geo. W. Pierce, Fig. 11



Thos. Nail
Inventor.

UNITED STATES PATENT OFFICE.

THEODORE N. VAIL, OF BOSTON, MASSACHUSETTS.

ELECTRICAL SWITCH-BOARD.

SPECIFICATION forming part of Letters Patent No. 255,056, dated March 14, 1882.

Application filed December 14, 1881. (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 Electrical Switch-Boards, of which the following is a specification.

My invention relates to electrical switch-boards of that class wherein the connection-strips whereby any two circuits are united are represented by sheets or plates of metal insulated one from another by alternate sheets of vulcanite or other suitable non-conducting material, while the several line-circuits are attached to and represented by smaller plates, one for each circuit, these latter being secured to the surface of the uppermost or front non-conducting plate. The connections in such switch-boards are made by the insertion of plugs made in pairs of different lengths, each separate pair of plugs being of the precise length requisite to make contact with one of the connection-plates and with no other, while, irrespective of length, all the pairs are adapted to make contact with the smaller or line plate. Such a switch-board has been patented by Francis Blake, No. 249,574, November 15, 1881, and reference may be made to that patent, upon which my present invention is an improvement.

For convenience I shall hereinafter term the large metal plates, which are interleaved between the non-conducting plates, "connection-plates," and the small surmounting-plates "line-plates."

It is evident that the switch-board described in the said patent of Francis Blake will perfectly perform all the necessary functions of an electrical commutator with exactness and convenience, so long as the circuits entering therein and the required circuit-changes are few in number. Experience has, however, demonstrated that in telephone-exchanges located in cities of any importance, or at great centers of population, the number of circuits of necessity entering the commutator or switch-board is large, and the number of changes and connections of such circuits correspondingly so. It has also been determined by actual practice that in large telephone-exchanges facilities must be provided for the simultaneous connection of at least one-fourth of the entire

number of circuits entering the central station, and also that the extent of such facilities must be increased in a greater ratio than the number of line-circuits, for it is apparent that in a telephone-exchange comprising, we will say, five hundred subscribers the addition of one subscriber is virtually not only one subscriber added to the exchange, but an addition of one to every one of the five hundred—that is, each subscriber of the five hundred has one more to connect with and to converse with, if he so wishes. In view of these facts it is obvious that a switch-board constructed as above and designed for the reception of a large number of line-circuit plates must have a correspondingly large number of connection-plates, and that any considerable increase in the number of connection-plates and the alternating non-conducting plates must tend to the construction of a switch-board of extraordinary and unwieldy thickness, requiring for the manipulation of the hindermost plates plugs of great and inconvenient length. If, for example, the board be prepared for the reception of the hereinbefore-mentioned number of lines—viz., five hundred—it will be requisite also to provide one-fourth of that number of connection-strips, which, even if made as thin as one-sixteenth of an inch, will, with the additional thickness of the alternating insulating-plates, produce a total thickness of fifteen inches. Increasing the number of subscribers' lines to two thousand would produce a switch-board with connecting-plugs of the maximum length of five feet. It becomes therefore a desideratum to reduce extremely the thickness of the connection-plates and of their intervening insulating-plates; but it is found in practice very difficult to accomplish this successfully, inasmuch as the connecting part of the plug must be correspondingly diminished longitudinally, or in addition to making the required contact with the proper plate it will contact also with the adjoining plates, or else the said conducting end of the plug must be cut down to a thickness not exceeding that of one of the plates and its two contiguous insulating-plates. Such a construction would not, however, admit of the plug obtaining a sufficient purchase to form an electrical connection of any value.

To construct a switch-board of the general character of the class hereinbefore described, and to provide means whereby the plates may be reduced in thickness to any required degree, while at the same time the excellence of the electrical connection shall be maintained unimpaired, is one of the objects of my present invention. An additional object is by such construction to provide a switch-board and connecting-plugs therefor, which, while of ample capacity for the accommodation of a large number of lines, may at all times be conveniently manipulated. I attain these ends by forming the holes of each separate connection-plate with a contact-surface upon a portion only of their periphery, and by so arranging the said contact that it shall be at a different portion of the periphery of contiguous plates; also, by the employment of a connecting-plug of special character, which at its inner end is composed of non-conducting material, except at one point, differing in every case from the plugs designed for the conducting contiguous plates on either side.

It consists also in a special conformation of the connecting-plugs at their upper end and of a similar conformation of the holes through the small line-plates, where they are fitted for the reception of the plugs, and of means whereby the electrical connection between the plugs and the said line-plates is improved and maintained intact.

It consists also in means whereby the insertion of the plug breaks the continuity of the normal line-connections to earth, substituting therefor a connection through the predetermined connection-plate to the second line required.

In the drawings by which I illustrate my invention, Figure 1 is a section taken on line zz of Fig. 2. Fig. 2 is a plan of a switch-board constructed according to my invention, showing several plugs inserted therein. Fig. 3 is a section on line xx , and Fig. 4 a section on line yy , of Fig. 1. Figs. 5, 6, 7, and 8 are details showing the relative position in contiguous connection-plates of the conducting arc or segmental contact-piece b' . Figs. 9 and 10 are side views of a long and short plug; and Fig. 11 is plan view, illustrating the method of automatically removing the ground-connection.

I have purposely shown the plates and plug-surfaces in Fig. 1 greatly magnified in thickness in order to aid in the lucid explanation of my invention and the principles therein embodied.

The drawings show a switch-board adapted for the proper accommodation of sixteen line-circuits, but by my invention lines to any number may be added without inconvenience.

My invention contemplates the indefinite multiplication of connecting-plates, which would of course be requisite if the number of line-circuits were greatly increased, and to make this multiplication feasible I construct them of extremely thin metal. I may, for example, use brass or other suitable metal or al-

loy of the thickness of one sixty-fourth of an inch and correspondingly thin insulating plates or dielectrics. I prefer for this purpose thin sheets of hard rubber, vulcanized fibre, or paraffined paper, such as is ordinarily used in electrical condensers.

To provide a means of connection, when desired, between any two of the line plates, which shall be of high electrical value, I provide a slot in the side of the hole through the line-plate, or make the hole of some irregular geometrical figure, and form the shoulder or upper part of the plug, which is designed to fit therein, of similar or corresponding conformation, so that the plug must of necessity always be inserted the same way—namely, with its projecting pin or peg on the same side as the slot or depression in the hole or socket. This forms an electrical contact between the line-plate and any plug, while the complementary contact between any two plugs and a connecting-plate is made by making the holes in the said connecting-plate larger than the plug end, and leaving a projecting conducting-segment in each hole of each plate. This conducting-segment may be equal in length to one-fourth of the entire circumference of the hole, or it may be made equal to but one-sixth of the circumference, or to any other suitable portion thereof. These peripheral contact-pieces, as shown in Figs. 5 to 8, are in successive plates differently placed, so that if in the bottom plate the contact-surface is at the front of the hole in the next conducting-plate it will in every hole be located at the back side, in the next at the right, in the fourth at the left side, after which, if preferred, it may be located again at the front, and so on *ad libitum*. The plug end which is to make contact on these segments I make of sufficient length to obtain a purchase upon some three or four of them; but I surround it with a non-conducting ferrule, except at one point, which is of metal, and which is in permanent connection with the main body of the plug. Now, as the non-conducting ferrule is presented to the metallic projections of every contiguous connection-plate and the metal strip only in contact with its own connection-plate, it is evident that only the designed plate will be connected with the line-plate into which the plug is inserted, and that any two plugs of equal length inserted will connect any two line-plates together through the same connection-plates, and in so doing will not make contact with any other plate, irrespective of its near proximity.

Referring now to the drawings, the rows of small line-plates c c' c^2 are fixed in any desired or ordinary way upon the uppermost non-conducting plate, A , which I preferably make thick enough to provide a substantial base for the said line-plates and their fastenings. Each line-plate is connected by small wires (not shown) with its special binding-screw l . The binding-screws in this case are shown in series at the upper part of the board, and the connecting-wires may be brought from them to

the line-plates by cutting grooves in the under surface of the upper insulating-plate and depressing them therein.

The holes in the upper row of line-plates c^2 are five-sided, but rounded at one side, and those in the second row, c' , are also of peculiar conformation, while those in the two lower rows, c , are circular, but furnished with a slot, i , at one side. The object of each of these peculiar conformations is to make it impossible to fully insert the plug when in any position except that designed for it. Of course in practice it would be undesirable to use more than one shape for the holes in a single board, but any of the forms shown, or any equivalent form, would answer the purpose.

The several connection-plates are shown in Fig. 1, and are represented by the small figures 1, 2, 3, 4, 5, and 6, while the interleaved non-conducting plates are represented by the letters a , the whole be connected together by bolts a' at each corner or other suitable points. Taper-holes are bored through each line-plate, and extend through all the conducting and non-conducting plates, for the insertion of the connecting-plugs, and in each connection-plate the hole is provided with a metallic contact-surface, b' , (shown more particularly in the detail drawings, Figs. 5, 6, 7, and 8.) This contact is the only part of the side of the hole that comes in contact with an inserted plug, and it may be made of a separate piece of metal let into the side of the whole, or may be an integral part of the substance of the plate. It is also essential, as hereinbefore indicated, that the several segmental contacts jutting into the same holes in contiguous plates shall be differently placed as shown in the figures. Fig. 5 being supposed to represent the lowest plate, the projection b' therein extends from the front side into the hole b . In Fig. 6, the next plate, it extends from the rear. In Fig. 7, the third plate, it extends from the left side, and in Fig. 8, the fourth plate, the projection extends from the right, after which a similar series may be recommenced. It is not, however, necessary that any of the segmental contacts shall take up one-fourth of the internal circumference, as they may be made of any suitable number giving sufficient surface for a connection. It will be observed that the internal surface of each segment is concaved, so as to fit accurately on and around its corresponding portion of the perimeter of the plug when inserted.

A separate pair of connecting-plugs, P , is requisite for each connecting-plate, and all of the said plugs are similarly constructed irrespective of length. Each plug consists of a suitable handle, e , a peculiarly-formed upper contact-piece, h , for connection with the line-plate, a comparatively slender shank, and a lower contact-piece, j , for connection with the proper connecting-plate. The handle e of the plug P is split, and a spring, g , fixed in the crotch f , by which the two sides are ordinarily forced apart, but when the plug is inserted in any hole pressure is brought to

bear upon the spring, which is thus maintained tense, and presses the two sides of the plug against the internal surface of the hole and slot of the line-plate. This is shown in Fig. 3, which is a sectional plan of one of the line-plates c .

The lower contact-piece, j , which is the more important part of the plug, is shown in Figs. 9 and 10, and in cross-section in Fig. 4. It consists of a nucleus of metal, j , continued from the main body of the plug, surrounded at all points except one with a ferrule or envelope of some hard non-conducting material k , the entire outside surface comprising the metallic segment j forming a virtual metallic continuation of the body of the plug, and the non-conducting envelope k , being nearly of perfect circular form. The metal part j of the perimeter should preferably extend very slightly beyond the limits of the insulator, to insure a good connection with the corresponding projection b' from the internal surface of the hole b , as clearly shown in Fig. 4. The stud or pin h at the side of the plug-shoulder is to fit into the slot i , and thus insure the correct insertion of the plug.

It is clearly shown in Fig. 1 that the conducting part j of the long plug P , when inserted, passes over more than one of the connecting-plates, yet only forms contact with its own plate 5, the same result being also shown as accomplished by the short plug, which makes contact only with plate 1, although it passes also plate 2.

In practice the plates are much thinner than shown, and the plug end would pass some three or four of the connecting-plates. I have chosen, however, this method of illustration as showing the several functions with greater clearness. If, as hereinbefore indicated, I choose to employ connecting-plates of the thickness of but one sixty-fourth of an inch, this, with a corresponding thickness of insulating-plate, would be but one thirty-second of an inch, and a consecutive series of four connecting plates with their interleaved non-conducting plates would only occupy a space equal in thickness to one-eighth of an inch. It is apparent that this construction is ordinarily impracticable, but by the use of my invention it may readily be accomplished.

Fig. 11 shows a series of line-plates representing line-circuits, each connected by the spring n to a common ground-plate, m , this being connected with the earth at E .

Through a hole, i , in the line-plate c a non-conducting pin, h , slides easily. This projects normally a short distance into the plug-hole, and may be slightly beveled on its upper side, where it so projects. Normally, the line-circuit, after passing to the line-plate c , terminates through the spring n at the common ground-plate m ; but when a plug, P , is inserted in the hole, as shown in two of the line-plates, its action will be to sever the line from the ground spring and plate, and to substitute therefor a new terminal or extension through

the connection-plate, and ultimately to the second line. Of course both holes and pegs are suitably tapered for the easy insertion of the plugs, and, as in the patent hereinafter cited, it is obvious that each connecting-plate will have a single pair of plugs, which can be used with no other connecting-plate, and by keeping each pair by itself two line-circuits can readily be connected with one another by inserting any pair of plugs not in use in the hole which passes through the line-plates belonging to the said two line-circuits.

Although I have described the connecting-plugs as being made in pairs, to make contact only upon a single plate I may, if I choose, connect any two contiguous plates by a loop-wire, including a telephone or battery, and attach, when desired, one incoming line-wire to one plate of a pair and the other incoming line to the second plate by using for each plate one only of the pair of plugs adapted therefor.

I now claim as my invention and desire to secure by Letters Patent—

1. In an electric switch-board, the combination of the perforated connection-plates, the interleaved insulating-plates, correspondingly perforated, and the switch-plugs, constructed and arranged substantially as described, so that said plugs, when inserted, have a bearing extending over two or more such connection-plates, but in electrical contact only with the desired one of said connection-plates, as set forth.

2. In a series of connecting-plates separated by interleaved insulating-plates and piled one upon another, holes provided with conducting segmental contact-pieces, each of said contacts forming the arc of a circle and so arranged that the contacts in the holes of each plate shall occupy a relatively different position in the said circle to that of the segmental contact in the holes of the conducting plate or plates adjacent thereto on either side, for the purpose specified.

3. In a switch-board of the class hereinbefore described, the combination of line-plates having the specially conformed or slotted holes and the connecting-plates having corresponding holes, each provided with a segmental conducting-surface differing in position for each consecutive plate, with the plug-connector, corresponding in shape at its shoulder to the conformation of the line-plate hole, and having its inner extremity adapted to make contact electrically with the desired connecting-plate only at that point of its peripheral surface which, when the plug is properly inserted, faces the said segmental conducting-projection of the connecting-plate hole, for the purpose specified.

4. The hereinbefore-described connecting-plug, adapted by a specially-conformed conducting-shoulder to fit and make contact with the line-plate only when properly inserted therein, and by a conducting-strip at one portion of the longitudinal surface of its foot or inner end (all other portions of said surface being insulated)

to make a complementary contact to the required connection-plate, and consisting of the said conducting-shoulder, a contact-maintaining device therefor, the said foot or inner extremity, a conducting-shank, electrically connecting the said shoulder with the foot or opposite end, and a handle, substantially as and for the purpose specified.

5. In a switch-board comprising a series of conducting-plates, each separated from its contiguous conducting-plate by an alternating succession of non-conducting plates or diaphragms, the whole piled one upon another, conducting-plates perforated with holes extending through the series and provided with segmental contact-pieces, each of said contacts forming the arc of a circle and so arranged that the contacts in the holes of each plate shall occupy a relatively different position in said circle to that of the contact-piece in the holes in the connecting-plate or plates adjacent thereto on either side, combined with a connecting-plug having at its inner extremity a conducting-strip opposite the projection in the hole of the desired connecting-plate, but being at all other points of the longitudinal surface of said inner extremity faced with non-conducting material, whereby contact is made only with the required connecting-plate, the contact-pieces of other contiguous connecting-plates impinging only upon the non-conducting face of the plug end, as described.

6. In a switch-board, the combination, substantially as hereinbefore described, of the connecting-plates, piled alternately with non-conducting plates or dielectrics, and having holes extending through the series fitted with conducting segmental projections, as specified, the line-circuit plates, each perforated with a hole corresponding to and forming part of the holes through the connecting-plates, but specially adapted to fit the shoulder of the plug-connector when properly inserted, and a connecting-plug, constructed as indicated, to make contact when properly placed in the line-plate hole and with that connecting-plate only which presents a conducting projection opposite and on the same plane as its own conducting-surface.

7. The combination, in a switch-board of the class specified, of the line-plate *c*, having the specially-conformed hole extending through the same, a circuit-closer, and a connecting-plug adapted to fit accurately in the specially-conformed hole when properly inserted therein, and by the act of insertion to operate the said circuit-closer and break the continuity of the line, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 8th day of December, A. D. 1881.

THEO. N. VAIL.

Witnesses:

THOS. D. LOCKWOOD,
GEO. WILLIS PIERCE.