(No Model.) 2 Sheets—Sheet 1.

C. W. McDANIEL & A. BARRETT.

ELECTRICAL SWITCH BOARD.

No. 306,414. Patented Oct. 14, 1884.

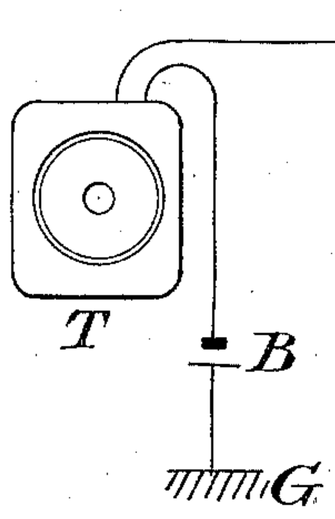


Fig. 1.

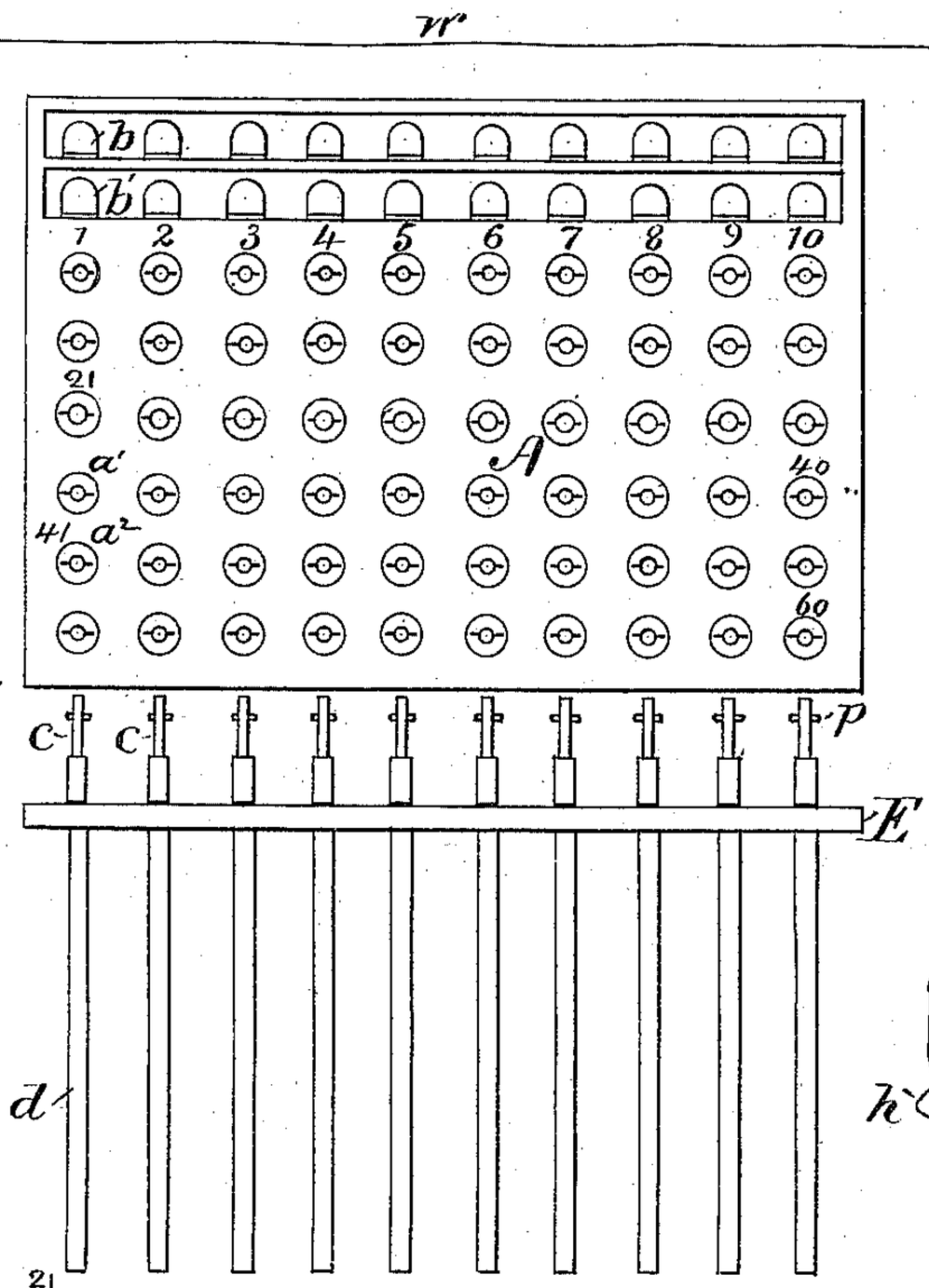


Fig. 3.

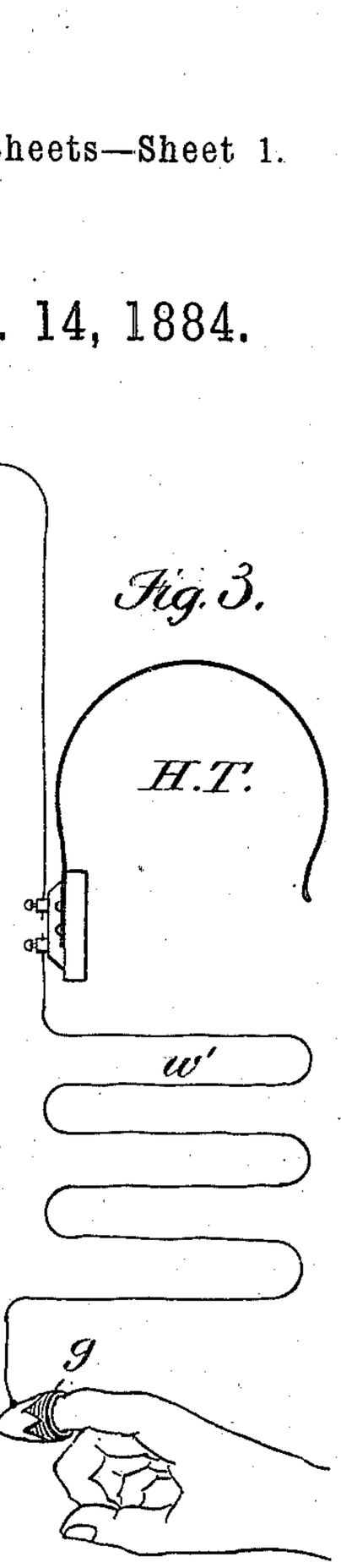
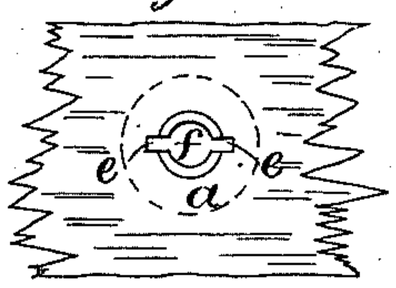


Fig. 4.



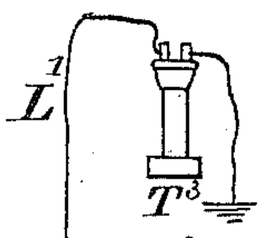
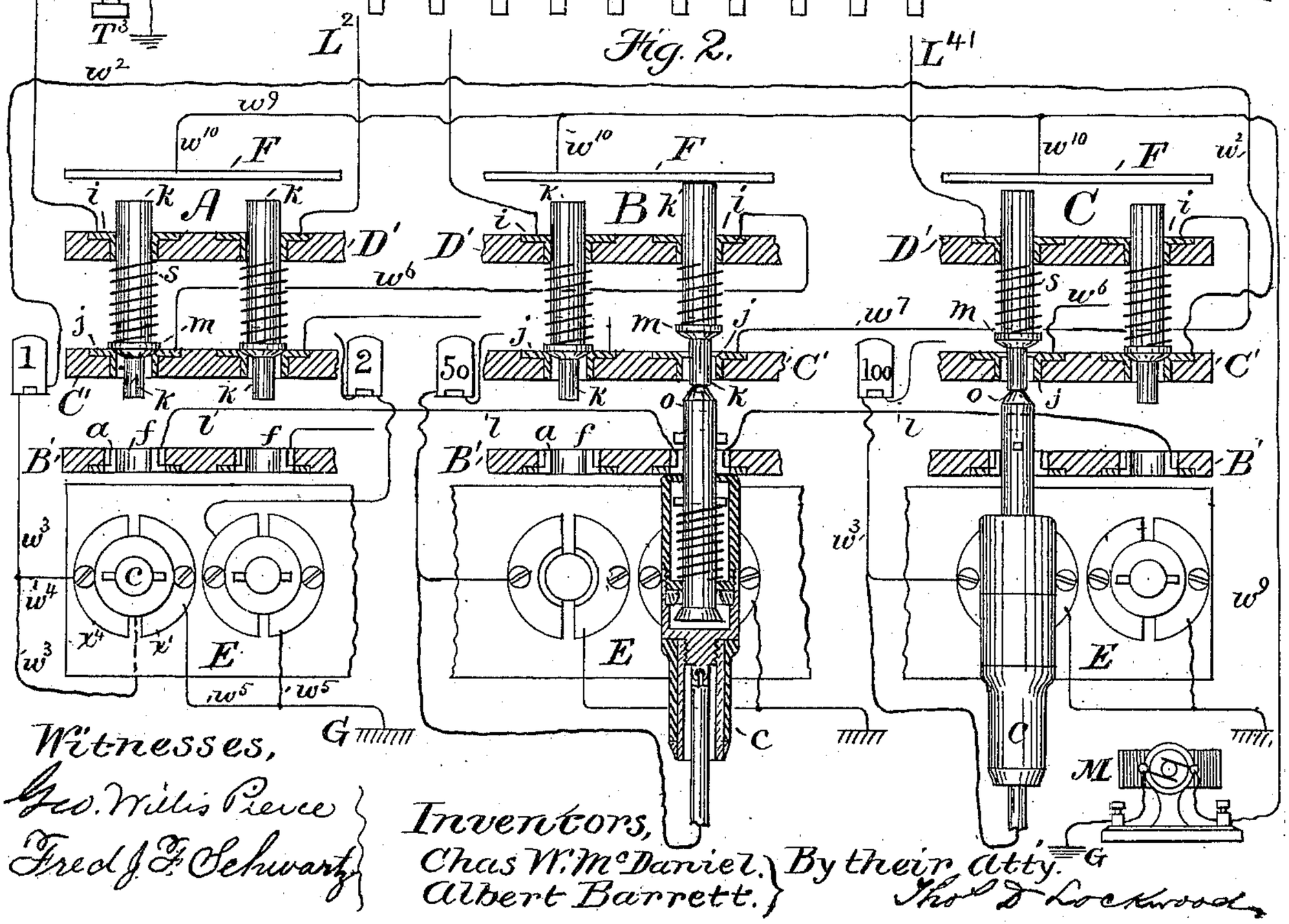


Fig. 2.



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(No Model.) 2 Sheets—Sheet 2.

C. W. McDANIEL & A. BARRETT.

ELECTRICAL SWITCH BOARD.

No. 306,414. Patented Oct. 14, 1884.

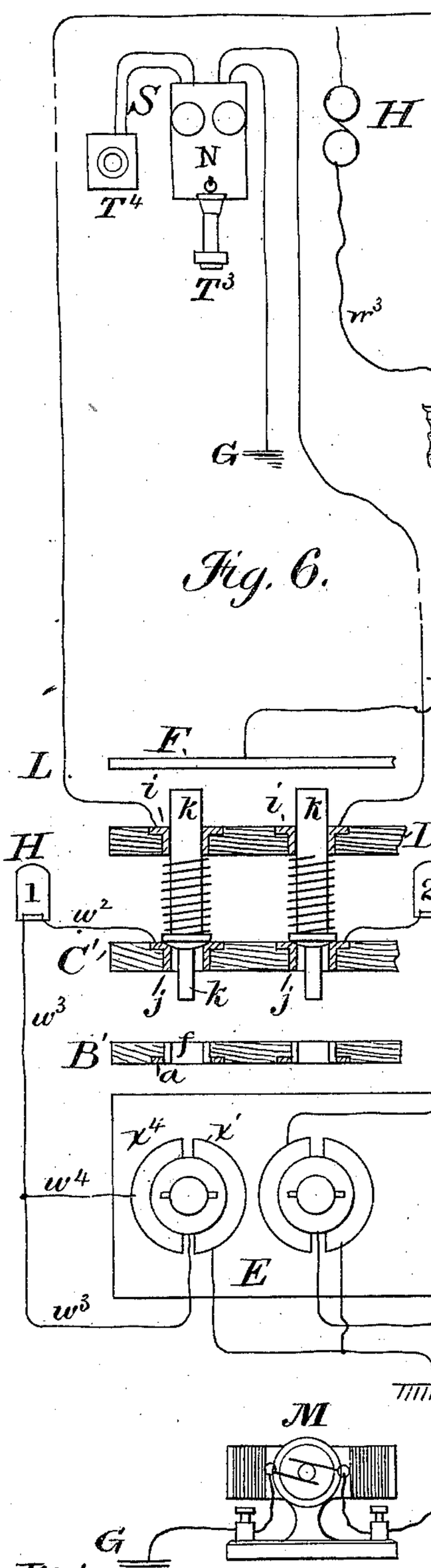


Fig. 6.

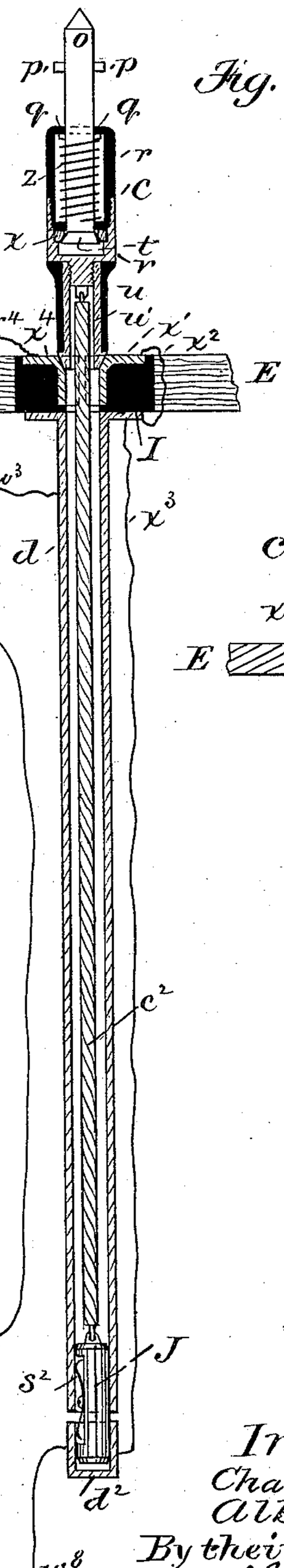
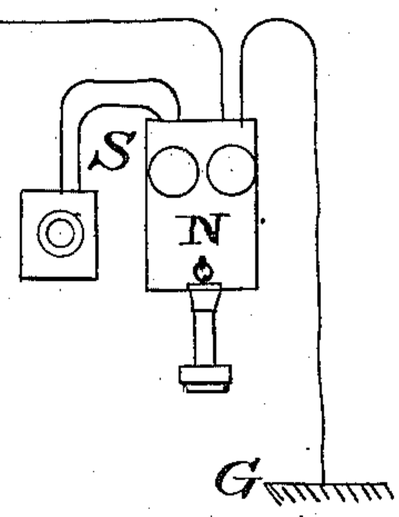


Fig. 5.



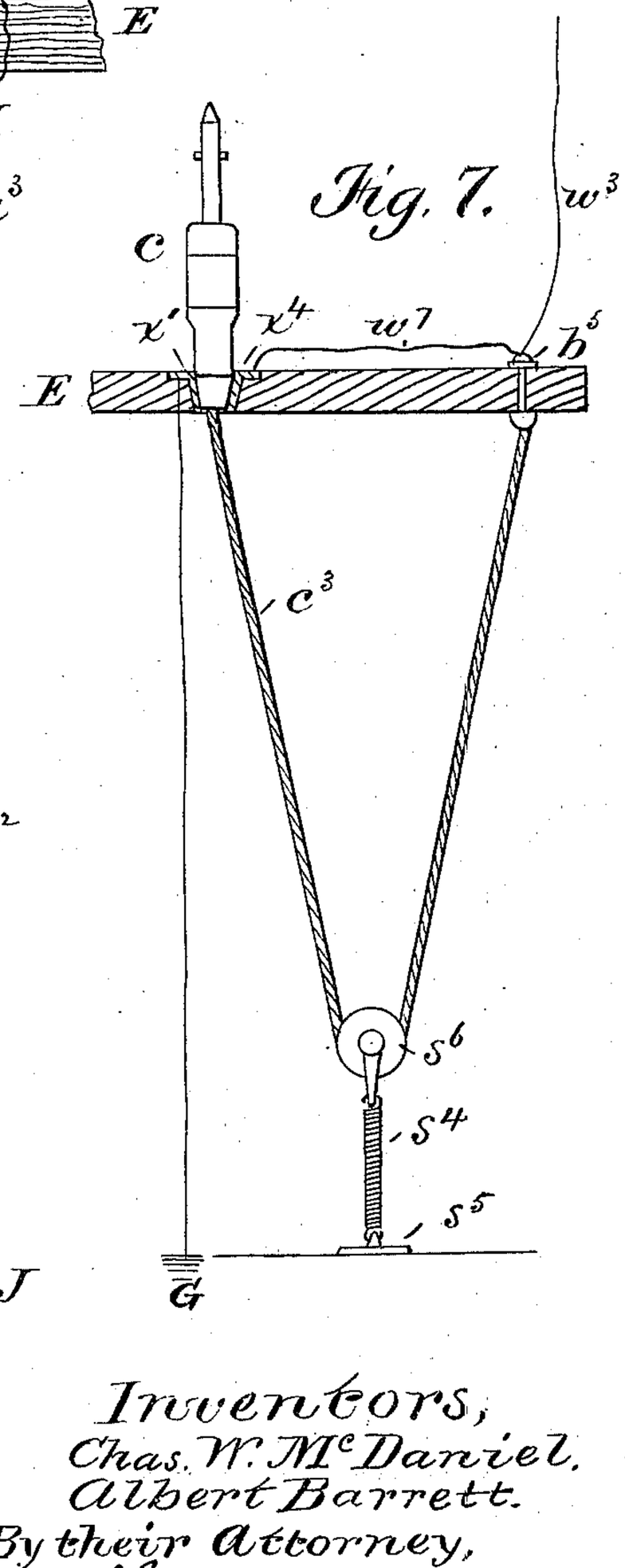


Fig. 7.

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UNITED STATES PATENT OFFICE.

CHARLES W. McDANIEL AND ALBERT BARRETT, OF KANSAS CITY, MO.

ELECTRICAL SWITCH-BOARD.

SPECIFICATION forming part of Letters Patent No. 306,414, dated October 14, 1884.

Application filed March 24, 1884. (No model.)

To all whom it may concern:

Be it known that we, CHAS. W. McDANIEL and ALBERT BARRETT, of Kansas City, in the county of Jackson and State of Missouri, have invented certain Improvements in Electrical Switch-Boards, of which the following is a specification.

This invention relates to an organization of electric circuits and apparatus familiarly termed a "telephone-exchange system."

The arrangement of switching and signaling apparatus upon which our invention constitutes an improvement is that well known as the "multiple switch-board system," in which several switch-boards are employed in the same central station, each so far as the switching facilities are concerned being a duplicate of the others. At each switch-board are the annunciators for a definite number of lines, which are assigned to the special care of the operator of that board, who answers calls and makes connections called for by the line having its annunciator there. In addition to this, as already intimated, each switch-board is connected with all the lines entering the station, and has a spring-jack or other connecting device for each line, so that each operator or attendant may connect the lines under her especial care, which have their annunciators at that board, with any other line entering the station without leaving her place or without communicating with any other operator. The operators at each board are also, by suitable instrumentalities, enabled to send call-signals over each line entering the station, to talk or listen upon any of the lines, or to ascertain whether any line is already in use.

As a due acknowledgement of the state of the art, we now refer to letters patent issued, respectively, to Leroy B. Firman, January 17, 1882, No. 252,576; C. C. Haskins and C. H. Wilson, October 24, 1882, No. 266,287, and John I. Sabin, November 8, 1881, No. 249,262, in which the various features which we have hereinbefore enumerated are shown and described.

The object of our present improvement is to simplify the operation of the various necessary manipulations, and to provide means whereby the time of each special operation may be minimized and the efficiency of the system increased.

Our invention having this aim consists, mainly, in a peculiar construction and arrangement of the spring-jacks of each line as it passes through the several switch-boards, in special forms of connecting-plug, in the circuit-connections, in dispensing with special disconnecting annunciators, and causing the annunciators of but one of any two connected lines to subserve the purpose of a disconnecting signal, and in the method and apparatus hereinafter described whereby oral communication with the sub-station lines may be effected.

Inasmuch as the term "spring-jack" when used in reference to electrical switching apparatus is universally considered to mean a device forming a part of an electric circuit and adapted to receive a plug or wedge attached to and forming a part of another electric circuit, it will be understood that we have employed that term herein in a similar sense.

In the drawings which accompany, illustrate, and form a part of this specification, Figure 1 is a front view of any one of a series of multiple switch-boards adapted for use in accordance with our invention. Fig. 2 is a diagram showing a portion of three multiple switch-boards working in association with one another, and illustrating the operation of our system. Fig. 3 shows, diagrammatically, the telephonic outfit of the attendant operator. Fig. 4 is an enlarged view of one of the plug-sockets, showing the means adopted to retain the plug when inserted therein. Fig. 5 shows one method of constructing the circuit-terminals and of arranging the connecting plug and cord. Fig. 6 is a diagram of a portion of a single switch-board, and Fig. 7 is a second form of connecting plug, cord, and the retractor therefor.

As shown in Fig. 2, A, B, and C represent three different switch-boards, to each of which all the lines L pass, some of the said lines, however, being provided with their annunciators and terminals at one board and some at another—for example, lines No. 1 to 100, after passing through spring-jacks or plug-sockets at boards 1, 2, and 3, return to boards No. 1, there passing through their respective annunciators and terminating at the earth. Lines No. 101 to 200, in the same manner, may pass through all the boards and through an equal

number of annunciators at board No. 2 and thence to earth, lines No. 201 to 300 likewise being provided with annunciators and terminating at board No. 3, and so until all the lines are provided for. In accordance with the above explanation it will then be understood that the switch-board shown in Fig. 1 is adapted for use in a central station to which sixty lines center, and which is provided with three multiple switch-boards. The lines terminating at the board A are provided with annunciator-drops *b*, and may be represented by the plug-sockets *a*, while the lines terminating at the other boards are represented, respectively, by the two sets of plug-sockets or spring-jacks *a'* and *a²*, each numbered socket indicating a loop of the line of the same number. Thus the two upper rows of sockets will be numbered 1 to 20, and are in the same line as the annunciators above. The next two rows would be numbered 21 to 40, and their annunciators located at switch-board No. 2, while the two lowest rows would be numbered 41 to 60, and their annunciators located at board No. 3. At each board we place a number of connecting-cords, constituting the several line-terminals, provided with plugs *c*, the said plugs being adapted for insertion in the several spring-jacks, and provided with locking-pins *p*, so that when inserted in any jack they may be partly turned round, the pin thereupon engaging with the inner surface of the jack-plate, whereby the plug is prevented from a spontaneous and undesired withdrawal. Each spring-jack plate is provided with a narrow space or slot through which the locking-pin *p* passes in the act of inserting the plug. The plugs *c* all have a conducting-plate on the handle end, and while not in use all the plugs are normally retracted by devices to be hereinafter specifically described, and the metal plates on their handles, which are in electrical connection with the conducting-cords, rest on specially-constructed bushings let into the table E. Each bushing is divided into two semicircular parts, x^4 and x', the former being united by wire both to the cord and line-wire and the latter to the ground-wire.

The arrangement of cord-retractor which we prefer is shown more clearly in Fig. 5, where one of the cords and its retracting appliances are shown in section.

E is a portion of the table, to the under side of which a metallic tube, *d*, is suitably affixed. At the extreme lower end of the tube is a blind terminal, d^2, which is electrically insulated from the tube proper, although it may, if preferred, be mechanically connected therewith. Immediately above the superior end of the tube, and totally separated therefrom by the non-conducting ring I, is the split bushing or plug-seat, one part, x^4, being connected with the line-wire by the branch wire w^4, and the other, x', with the ground by the wires x^2 and x^3. The conducting-cord c^2 is provided at its lower end with a weight, J, carrying a contact-spring, s^2, the said spring having electrical connection with the conductor of the cord, and acting normally as a conducting-bridge, whereby the main tube *d* is kept in contact with the extension-tube d^2, the latter being united with the earth by the wire w^8, and with the section x' of the plug-seat by the wires x^3 and x^2. The upper end of the cord c^2 is mechanically and electrically attached to the plug *c*, which is of peculiar construction, consisting of a case-like handle and metallic shank. The cord c^2 passes into the handle, and the conducting-wire thereof is attached to the sleeve *v*. This screws into the tubular metal piece u', the greater part of which, for the protection of the operator from accidental shocks, is covered by a non-conducting sheath, *u*. The extreme outer end of the tubular piece u' is, however, not so protected, as it is required to bridge conductively the hiatus between the two parts of the plug-seat. A metal ring, *x*, the hole through which is taper, flaring toward the handle, is adapted to fit easily the shank and beveled head *t* of the plug-shank *o*, which is inserted therein, the ring *x* being then maintained firmly in place by the non-conducting cap *r*, which is screwed over it and on the metal sleeve *v*. A spiral spring, *z*, surrounds the shank within the cap *r*, being fastened at one end to the pins *q*, and the locking-pin *p* is fixed at or near the end of the shank. The function of this construction of the plug is hereinafter described, and is shown in Fig. 2, where an inserted plug is shown, the beveled head *t* of which is pressed away from its seat *x*, thus opening the circuit of the connecting-cord.

The wire w^3 represents the termination of a telephone-line, which, after passing through the annunciator H, bifurcates, one branch, w^4, being united to the semicircular bushing-section x^4, thus connecting by the metal end u' of the plug with the opposite section, x', and by wires x^2 and x^3, extension-tube d^2, and wire w^8 to earth, while the other branch wire w^3 connects directly with the tube *d* and to earth by spring s^2, extension-tube d^2, and wire w^8. Still a third earth-terminal is furnished through the cord c^2, which, by the spring s^2, is directly connected to earth. It will now be seen that so long as the plug rests in its seat the wire w^3 is connected to earth, but that when the plug is raised from the said seat the earth-connection is broken at all points and a new termination may be made by inserting the plug-socket of any other line. It is not absolutely necessary to provide the several routes to earth, but this construction is adopted as a precautionary measure, and by its use there is no danger of annoyance arising from a defective cord.

Fig. 7 shows an arrangement which may in some cases be substituted for that shown in Fig. 5. The cord c^3, fixed at one end to the screw b^5, passes round the pulley s^6, and is, as

usual, provided at its free end with the plug *c*, which rests as in the first arrangement in the plug-seat x' x^4, let into the table E. One side of the said plug-seat x^4 is united by wire w^7 with the screw b^5, and then by wire w^3 with the annunciator and line. The other side, x', is connected with a ground-wire. The plug-seat is split as in the former plan, and the metal end of the plug-handle forms the connection between the two sides. The cord c^3 is normally retracted and the plug maintained in place by the spring s^4, which is fastened to the bracket s^5. A rubber band may, if preferred, be employed in lieu of the spring. By this plan two routes to earth are shown, both of which are broken by raising the plug.

Referring again to Figs. 2 and 6, it will be seen that the several lines L' L^2, &c., enter the central station from different sub-stations S, situated in various localities. At such sub-stations they are connected with the subscribers' signaling apparatus N, receiving telephone T^3, and transmitter T^4. The lines on entering the central station proceed to the switch-boards.

The switch-boards A, B, and C, of which a plan view is given, consist of three frames or standards, B', C', and D', in which are inserted spring-jacks equal in number to the lines to be served. Each jack comprises the following parts: The glands or bushings *a*, *j*, and *i* in the several frames, and the spindle *k*, adapted to slide in the gland *i*, and provided with a beveled or curved head, *m*, whereby pressure-contact is normally maintained between the spindle and the middle bushing, *j*, by means of the spiral spring *s*. The front bushing *a* is for the reception of the plug *c*, and the said plug, when inserted therein and given a quarter-turn, is locked in position by the locking-pins *p*, which bear against the inner side of the frame B', preventing the spontaneous withdrawal of the plug, and maintaining it in a position where it just presses the spindle *k* away from the bushing *j*, whereby the line connected with the jack is simultaneously opened and brought into contact with the line represented by and connected with the inserted plug.

At the rear of the frame D' and behind and parallel to each row of jack-spindles we place a metal calling-bar, F, connecting the same with a suitable source of electricity, preferably the magneto-generator M, by the wire w^9 and branches w^{10}.

We may trace the route of the line-circuit No. 1 through the switch-boards, premising that all of the lines are similarly arranged, except that some of them have their annunciators and terminals at one board and some at another, as hereinbefore described.

Line No. 1 entering the central station passes first to bushing *i* or frame D' of board A, through spindle *k* to bushing *j* on frame C', by wire w^6 to bushing *i* of switch-board B, through spindle *k*, bushing *j*, then by wire w^7 to bushing *i* of switch-board C, and by spindle *k* to bushing *j*, from which a wire, w^2, leads to annunciator H at board A, and by wire w^3 to earth, as stated in the descriptions of Figs. 5 and 7. Let it be noted that the foregoing refers to the normal path of the line-circuit. At any switch-board the circuit of any of the lines may be broken between the spindle *k* and the bushing *j* by the insertion of a plug, and the line so broken is by the same act connected with the line belonging to the plug inserted. An example of such a connection is given in switch-board C, in which the plug *c* of line 100 is shown as inserted in the spring-jack of line 41, which is by virtue of such insertion opened between the end *m* of the spindle *k* and the bushing *j* of the middle frame. It is also evident that line 41 is also electrically united with line 100 by the pressure between the front end of the spindle *k* under the spring *s* and the point *o* of the plug, the normal ground of line 100 being removed by the removal of the plug from its seat. The spindle *k* is moreover capable of assuming a third position and function, as shown in switch-board B, Fig. 2. The plug there is represented in the act of being inserted and simultaneously sending the call-signal. When the second subscriber is wanted, the operator pushes in the plug as far as he can, this causing the spindle *k* to press against the calling-bar F at the rear. By this operation the generator M is caused to send a current to line to ring the subscriber's bell.

To prevent a portion of the calling-current from proceeding through the plug and cord to the line connected therewith, and also to protect the hand of the operator from possible shocks, the plug is constructed as hereinbefore described, and the spring *s* of the spindle is made slightly weaker than the spring *z* in the body of the plug, so that when the plug is pushed in against the spindle the beveled head *t* thereof will be forced away from its seat, thus opening the plug and cord circuit. The end of the spindle will, however, reach the calling-bar before the head *t* of the plug-shank reaches its uttermost limit at the bottom of the metal sleeve *v*, (or a more advantageous method may be to make the spring *s* of the spindle slightly stronger than the spring *z* in the plug, a button of insulating material being placed in the plug for the end of the spindle *o* to strike upon.) As soon as the call is made, the plug is turned round so that the locking-pins *p* are at right angles to the slot in the bushing *a*, and is then released. The springs *z* and *s* then act in unison, and the plug retreats until stopped by the locking-pin, the plug assuming the connecting position shown in switch-board C. The front bushings *a* of each line upon every switch-board are united to the front bushings of the same line upon every other switch-board, as in Fig. 6, by the wires *l*, and, in connection with the operators' telephones, operate as a test-circuit to see whether lines are in use.

The telephone-circuit is shown in Fig. 3,

a transmitter, T, and receiving-telephone H T, the latter being preferably adapted to be worn on the head, and placed in the circuit of the wire *w* and the flexible conductor *w'*, which terminates in a metallic thimble or finger-piece *h*, insulated from the person of the wearer by the non-conducting lining *g*. This is to be worn by the operator. A single cell of battery B may be also placed in the circuit, which is of course normally open. The operator, desiring to ascertain whether any line is in use, merely touches with the thimble the front bushing *a* of the desired line, thus placing it in contact with the telephone-circuit. If, now, the line represented by the said bushing is at any point in use, the circuit will thus be completed by the inserted plug and a click will be heard in the telephone; or, if conversation is passing, it will be heard in the telephone, the circuit of which constitutes a branch circuit to earth. If, however, the line is not in use, there will be no sound heard in the telephone as though the thimble is brought in contact with the external bushing *a*. None of the bushings *a* are in contact with the line, because no plug is inserted in them. The telephone device serves also to listen to two connected lines for the purpose of ascertaining whether or not conversation is concluded. This operation is identical in character with the test.

The arrangement shown in Fig. 6 is more especially adapted for single switch-boards which are complete in themselves. The mechanical details are similar to these already described. The circuits, however, run from the rear bushing, *i*, via spindle *k* to bushing *j*, thence direct to annunciator H, and by plug-seat and conducting-cord to earth.

The operation of the foregoing system is simple in the extreme. No. 1 drop falls, indicating that No. 1 subscriber desires to communicate with some other subscriber. The operator, having the thimble *h* on her finger, lifts the plug of No. 1 from its seat, touching any metal part thereof with the thimble, which brings the operators' telephones into communication with the line No. 1. She ascertains, let us say, that No. 1 desires to be connected with No. 50. The front bushing *a* of jack No. 50 is touched with the telephone-thimble by the operator, who still retains the plug of No. 1 in her hand. If No. 50 is busy, the operator will hear a click or conversation; if not, she will hear no sound, and may then insert plug No. 1 in jack No. 50, pushing it in until the spindle of No. 50 brings up against the calling-bar. The signal is thus sent to No. 50. The plug is then turned round so as to lock itself in, after which it is released by the operator, and, being retained in the jack of No 50, effects the interconnection of the two lines No. 1 and No. 50, annunciator-drop of the latter being cut out of circuit. The normal route of No. 1 is broken at the plug-seat, while that of No. 50 is open at the junction of the spindle *k* and the middle bushing, *j*. The drop H of the line making the call is uniformly left in circuit. In the use of our system it will of course be understood that the plug also of the calling-line is always to be used to make the connection.

Although we prefer the plug we have hereinbefore described, an ordinary solid plug may be readily used. In such a contingency it would be understood that the calling subscriber would, after giving his order, hang up his telephone. The insertion of the plug will then split the calling-current, which will traverse both lines simultaneously, ringing up No. 1 and No. 50, at the same time conveying the information to No. 50 that he is wanted and is ready.

Having now described our invention, we claim—

1. In a multiple system of switch-boards, a series of telephone-lines, a series of spring-jacks—one for each line on every board—each consisting of three bushings, and a sliding spindle normally in contact with two of the said bushings, a connection-plug for each line terminating at any board, permanently united through a flexible cord with the said lines, and adapted when inserted in the spring-jacks of any line to push back the spindle thereof and transfer the circuit of the said second line from its normal earth-terminal to a connection with the line represented by said plug, substantially as hereinbefore described.

2. In a multiple system of switch-boards, the combination, substantially as hereinbefore described, of a series of telephone-lines, a series of spring-jacks—one for each line on every board—whereby each line is connected with every board spring-jack, consisting of three bushings and a sliding spindle normally in contact with two of the said bushings, a series of connecting-plugs—one for each line—terminating at any switch-board, a metallic plug-seat for each plug, split in half, as described, and acting through the metal heel of the plug to ground the line normally, for the purposes specified.

3. The combination, substantially as hereinbefore described, in a telephone switch-board, of a series of main-line circuits, means, as indicated, whereby any circuit may be connected with any other circuit, the annunciator of the first or initiatory circuit only being retained in the compound circuit thus formed, and other means whereby the normal ground-terminal of the second circuit may be disconnected and the call-signal transmitted over said circuit by the act of connecting the two lines.

4. In a system of telephonic switching and signaling apparatus, a series of spring-jacks forming a portion of a telephone-circuit and connected successively in the said circuit, an annunciator-drop also included in the said circuit and placed between the last drop and the normal ground, a divided ground-plate one side of which is permanently connected with the line and the other with the ground-

wire, and a connecting switch-plug adapted for insertion in the spring-jacks, and, by means of the flexible cord in permanent connection with the line, normally resting by a conducting-surface upon the divided ground-plate and bridging the two plates thereof, whereby the continuity of the line is normally maintained, and whereby when the said plug is removed from the said ground-plate and inserted in the spring-jack of another line the ground is disconnected and the annunciator-drop of the line attached to said plug only is retained in the circuit to act as a disconnecting-drop, substantially as hereinbefore described.

5. In a telephone switch-board, a series of main lines each passing successively through one or more spring-jacks having spring-contacts, as described, an annunciator placed after the last spring-jack, and a flexible conductor terminating in a connecting-plug provided with a metal heel-piece and normally grounding the line by the pressure of said heel-piece upon a divided ground-plate, so that while the said plug is in its normal position the line is connected to earth, and when inserted in the spring-jack of any other line the calling-line being disconnected from its original ground at a point inside of its annunciator-drop and the called line at a point external to its annunciator-drop, thus the two lines are united, leaving the drop of that line only which is connected with the plug in circuit, and reducing the resistance of the compound line, substantially as specified.

6. In a telephone switch-board, the spring-jack formed, as described, with three metal bushings, and a spindle controlled by a spring sliding in two of the said bushings, and the call-plate connected with an electrical generator, combined with the plug-connector, constructed as described, and adapted to open the circuit in which it is included during the moment of insertion, whereby the call-plate current is prevented from flowing to the circuit connected with said plug, and is restricted to the circuit in which the said spring-jack is included, substantially as hereinbefore described.

7. In a telephone main-line circuit, the compound earth-terminal, constituted by dividing the main line at a point inside of the annunciator into two or more earth-branches, of which a connecting-plug and flexible conductor attached thereto is one, while a second is effected through a divided ground-plate adapted to serve as the normal seat of the connecting-plug, one side of the said ground-plate being united permanently to the line and the other to the ground, the two sides being electrically united by the conducting-heel of the plug when in place.

8. The combination of the connecting-plug and flexible conductor therefor, forming the central-station end of a telephone-line, the said plug being provided with a conducting-surface on the handle end thereof, with a plug-seat consisting of two plates perforated in the center for the reception of the flexible conductor, one of the said plates being connected permanently with the main line independent of the said flexible conductor and the other with the earth, the metal surface of the plug end acting when in place to unite electrically the two plates and ground the line, and an automatic take-up or retracting device for the connecting plug and cord, whereby the plug is normally maintained in position, and whereby after being used is, when liberated, caused to resume the normal position, uniting the line and ground-plate, as described.

9. The combination, in a telephone switching and signaling system, of a series of telephone-lines, means for connecting any two of the said lines together, and simultaneously and automatically sending the call-signal to the line desired, and other means whereby the drop of the calling-line only is left in the circuit of the two lines.

10. The combination, substantially as hereinbefore described, of a series of metal-faced spring-jacks in a line-circuit, each spring-jack being located on a different switch-board, and the said metal faces being normally insulated from the main line, but united to one another, with the operator's normally-open telephone-circuit, including the receiving and transmitting telephones, and terminating in a metallic thimble, whereby when the said thimble is applied to the metal faces of any of the spring-jacks the line of said spring-jack may be tested, for the purposes specified.

In testimony whereof we have signed our names to this specification, in the presence of two subscribing witnesses, this 13th day of March, 1884.

CHARLES W. DoDANIEL.
ALBERT BARRETT.

Witnesses:
RODNEY FERGUSON,
G. M. SMITH.