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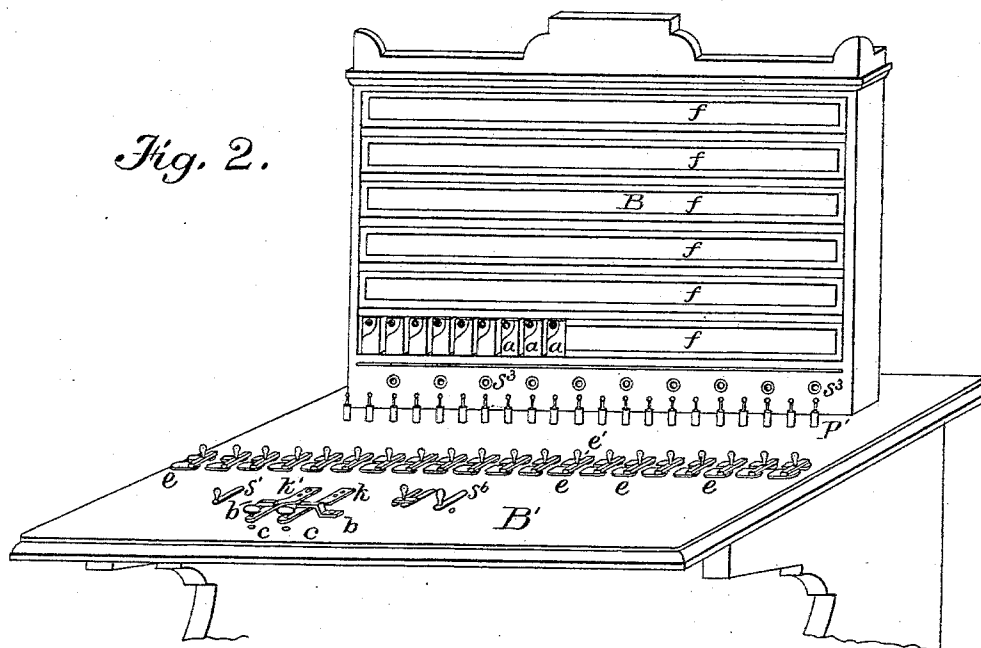
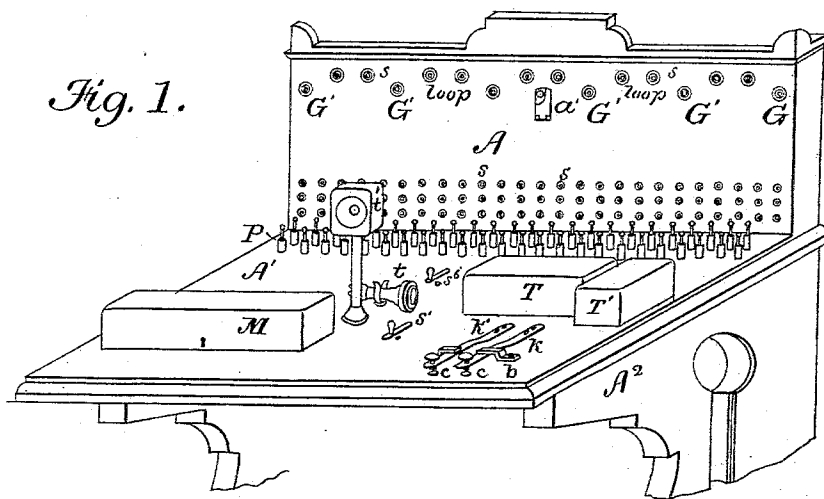
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T. B. DOOLITTLE.

SYSTEM OF TELEPHONIC COMMUNICATION.

No. 339,625.

Patented Apr. 13, 1886.



Witnesses.

Geo Willis Pierce

Geo. H. E. Trowelot.

Inventor.

Thomas B. Doolittle

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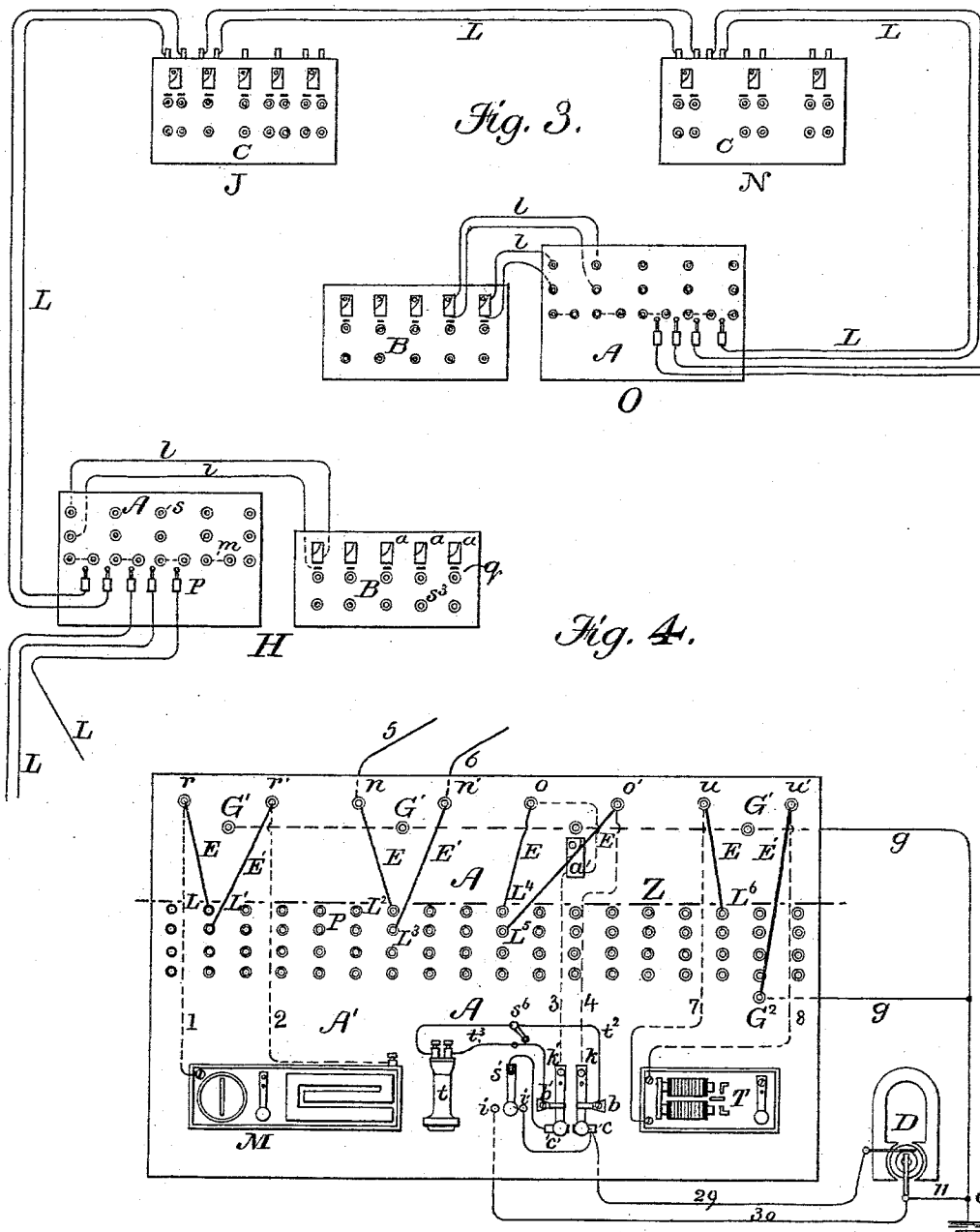
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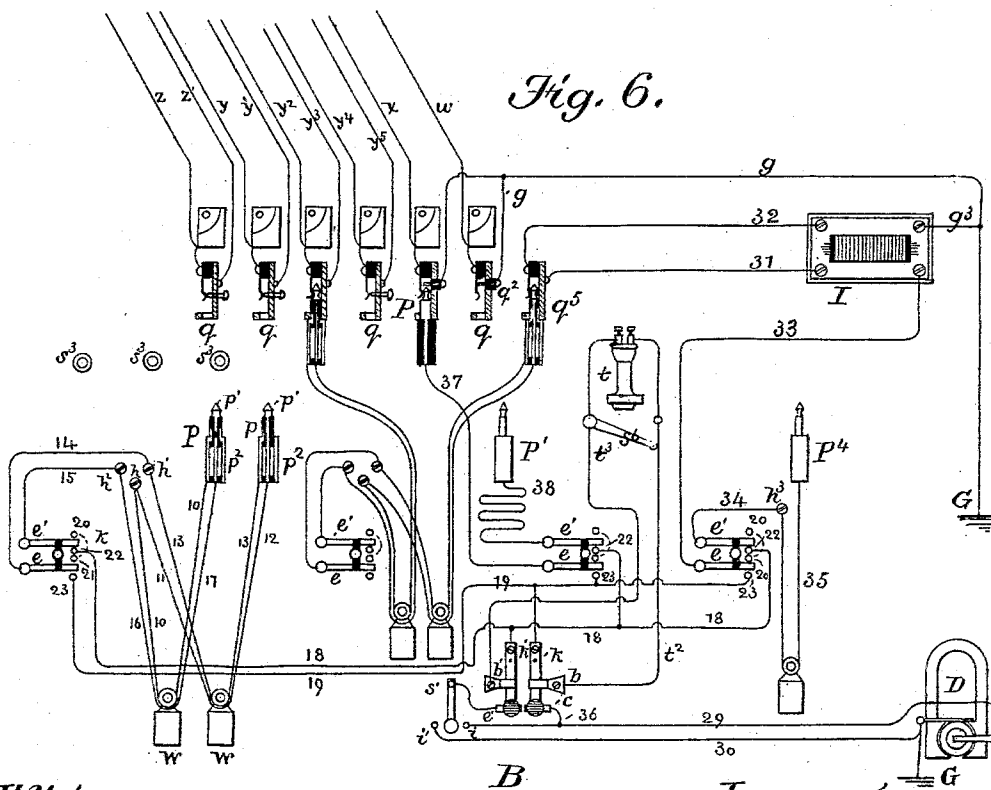
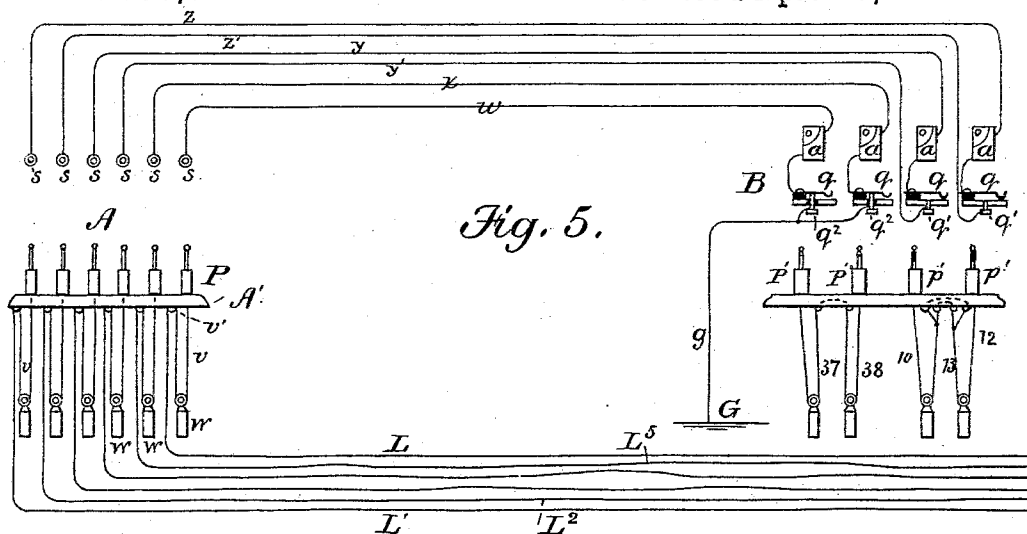
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UNITED STATES PATENT OFFICE.

THOMAS B. DOOLITTLE, OF BRIDGEPORT, CONNECTICUT.

SYSTEM OF TELEPHONIC COMMUNICATION.

SPECIFICATION forming part of Letters Patent No. 339,625, dated April 13, 1886.

Application filed November 28, 1885. Serial No. 184,139. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. DOOLITTLE, residing at Bridgeport, in the county of Fairfield and State of Connecticut, have invented certain Improvements in Systems of Telephonic Communication, of which the following is a specification.

My invention relates to a system of electrical intercommunication and to suitable apparatus for the practical operation of the same. It refers especially to telephonic systems in which different "exchanges" or "central offices" located at a distance from one another are connected by trunk-lines, some or all of which are metallic circuits.

Each exchange organization, it is now well known, consists of a central station, a number of sub-stations, line-wires converging from the several sub-stations to the central station, communicating-instruments at each sub-station, and suitable signaling and switching appliances at the central station, whereby any two of the sub-stations may be placed in direct communication with one another by the attendant at the central station, who, when required, unites the two lines leading to the respective sub-stations, so that they are thereafter enabled until disconnected to communicate with each other directly. Experience gained by the practical operation of such systems has shown that when several line-wires used in the transmission or conduction of electricity are stretched parallel to one another, some or all of them being provided with telephones and employed in the transmission and reproduction of articulate speech, any variation of the electric force in any of the wires affects the telephone-lines adversely and reproduces in the telephones attached to such lines the signals which may be passing in any or all of the other lines, to the detriment of conversation upon the said lines, and also that when two or more separate telephone-lines are supported or laid in close proximity to one another for a considerable distance the articulate speech transmitted upon one line is reproduced on the others by induction or without actual contact of the several lines involved. This is especially the case with long lines extending between cities and towns and used as connecting-links between the subscriber's lines of one city and the subscribers' lines of an-

other, such lines, in addition to the obstacles stated, being also subject to adverse influences due to earth-currents. To avoid, or in great measure to counteract these adverse influences and defects, it has been found necessary to provide for the said trunk-lines traversing the distance between cities a parallel return-wire, thus constituting a metallic circuit, so that the disturbing currents induced in one wire of such metallic circuit will be neutralized by the same current flowing in the opposite direction in the other wire of the circuit, and by such neutralization avoid the objectionable noises which otherwise obtain. It is evident, however, that it is not practicable to construct all the circuits of a telephone-exchange upon the return-wire plan, and, in fact, the majority of exchange systems already in existence comprise but few of such among their local or sub-station lines, most of which are single line or ground return circuits. It has been consequently found to be somewhat difficult to construct suitable apparatus at such stations, whereby the metallic-circuit trunk-lines can be conveniently connected with single or grounded circuits centering at the same station without losing the advantage gained by the metallic-circuit portion, inasmuch as if a single line be caused to make contact with a loop it has the effect of reducing that loop virtually to a similar single line, unless special arrangements are devised for this contingency. I have found in practice that for this purpose it is advisable to provide in connection with suitable switching and signaling devices, an inductorium having two separate coils of approximately equal resistance, but insulated from one another. The two terminals of each of these coils are united to suitable connecting devices, whereby one of them may be included in the metallic circuit, and the other in like manner in the single-line circuit, so that the electrical variations occurring in either will be inductively propagated in the other. I accordingly have adopted this device, and it is shown and described herein, but is not claimed, except in connection with certain specific combinations, inasmuch as it forms the subject-matter of a separate application for Letters Patent filed by me July 9, 1885, and bearing the Serial No. 174,084.

It has been found, also, that long telephone-

lines are subject to contingencies that render frequent cross-connections and the ready application of testing apparatus desirable, and one of the objects of my present invention is to provide at the principal or terminal stations special facilities for such interchanging or making up of circuits, and for testing lines, in addition to the ordinary facilities for intercommunication and signaling.

- 10 Another object is the general simplification of the work of connecting lines, of signaling other stations, and of supervising conversations.

Another object is to enable the same source of electricity to be used for sending call-signals in combination with but one set of keys, upon either single lines or metallic circuits, or, in the case of the latter, upon one or both lines of the circuit, as may be desired.

- 20 It is also my aim to provide a system for general telephone use which is capable of extension to an almost unlimited degree without material variation from its principle of construction, and at the same time to provide one which will be sufficiently elastic to admit of being readily used in association with other types of switch-board, when two or more varieties of switch-board are employed at any central station.

- 30 In accordance with these objects my invention comprises the various combinations hereinafter enumerated and described.

It consists in establishing at certain principal stations at which the greater number of long double and single circuit lines center a testing-board, to which the actual terminals of all such lines are led, and at which the disposition of such circuits can be indefinitely varied, an operating switch-board at which the regular operations of interchanging, signaling, and supervising can be carried on, the said operating-board having suitable annunciators and spring-jacks in the circuit of loop or single wire extensions connecting with sockets on the test-board, and adapted to be connected through the intermediation of such sockets with any desired line or lines terminating at the said test-board.

It further consists in combining with the said testing switch-board suitable appliances for electrical measurement, for telephonic communication, for sending call-signals upon either double or single lines, or for telegraphic communication, and switching devices whereby any of the said appliances can instantly be connected with any line, as required.

It further consists in associating with the terminals of a combined system of metallic and ground circuit lines signal sending devices, whereby call-signals may be transmitted with equal facility over either class of line.

The drawings by which this specification is illustrated are chiefly of a symbolic or a diagrammatic character, although Figure 1 is a line-drawing of the testing switch-board, and Fig. 2 a similar drawing of the operating switch-board at a main station.

The switch-board at intermediate stations partakes of the character of both test and operating board—that is, the lines from either direction run directly to it—while the connections and signaling operations of the exchange system are carried on thereat and duly provided for. The testing apparatus proper, however—*i. e.*, the telegraph and measurement sets—are appropriated by the test-boards at terminal stations only.

Inasmuch as I contemplate the filing of a separate application for the combinations embodied in the said intermediate switch-boards, I have not regarded it as necessary to describe the same in detail in this specification.

Fig. 3 is a diagram of two principal central or testing stations at which many lines center, connected by a double-wire circuit through a number of intervening or non-testing stations. Fig. 4 is a diagram of the principal electric connections of the testing switch-board. Fig. 5 is a diagram of some of the connections between the testing and the operating switch-boards; and Fig. 6 is a diagram of the principal electric connections of the operating-board, showing the connecting, calling, and supervising devices which I prefer to employ.

In Fig. 1, which is a perspective drawing of the testing switch-board, A' is a table on which the apparatus is arranged, the said table being sustained by the upright supports A², and being also provided with a vertical back board, A. The rear portion of the table is perforated with as many holes as may be thought necessary, through which, as indicated in Fig. 5, flexible conducting-cords, constituting terminals of all lines entering the central station, extend and terminate in the connecting-plugs P, the handles of which, being larger than the holes in the table, are supported over the same in a perpendicular position, while the attached conducting-cords are maintained stretched below the table by means of suitable weights hanging in the bight thereof, as herein shown.

In front of the plugs P, which project upward from the table, the several communicating and testing instrumentalities are arranged. These are respectively the Morse telegraph set T T', a galvanometer set, M, for electrical measurement, a telephone, t, and transmitter, t', a pair of signaling-keys, k and k', a single-button switch, s', by which I am enabled to transmit call-signals upon metallic circuits or grounded circuits at will, and a second button-switch, s'', to short-circuit or introduce the telephone t. The upright portion A of this board contains any desired number of plug-sockets, s, connected at the rear of the board with annunciators, and spring-jacks at an operating switch-board, B. Above these is first a row of plug-sockets, G', connected with a ground-wire for testing purposes to ground single-line circuits, or to complete temporarily broken lines, while still higher I place other pairs of plug-sockets, to which the loops

leading to the several classes of testing apparatus and to outlying stations are connected.

In Fig. 2, which is a representation of a partly-filled operating switch-board, B is the vertical or back portion of the board, and is simply a frame-work for a series of shelves, *f*, on which any desired number of annunciators and spring-jacks, *a*, may be mounted. I have shown but a few of such appliances in place upon the lowest shelf, each one representing and being included in one circuit independent of the character of such circuit. I do not of course restrict myself in this specification to any particular form of annunciator or spring-jack, and, in point of fact, for lucidity of illustration, I have in some of the diagrammatic drawings forming a part hereof shown the spring-jack and annunciator as being two well defined and distinct organisms. In practice, however, I prefer a form in which the spring-jack and annunciator are combined in a single appliance, this being indicated by the letter *a* in Fig. 2. I make no claim herein for such a combination appliance, broadly, as I file herewith a separate application for Letters Patent embodying the same; yet I hold such a combined form to be a valuable element in my present invention, inasmuch as by its employment I greatly economize space upon the shelves or recesses of the switch-board. I accordingly prefer to provide standard forms of annunciator with which the shelves of the switch-board may be filled as the number of circuits increases. Immediately below the annunciator-racks I provide a series of metallic sockets, *s*², for a purpose which will hereinafter appear. On the table B' of this board I provide one or more rows of plugs and cords, P', the ends of the cords extending through holes, and being then attached to the plugs, by which they are maintained in position. The cords are kept in place by being weighted, as in Figs. 5 and 6. Instead, however, of each cord being independent, as are the cords used in connection with the switch-board A, they are arranged in pairs, as more clearly indicated in Fig. 6, some of the pairs being provided with double conductors for the interconnection of metallic circuits, and others with single conductors for the interconnection of single-wire circuits. The exclusive function of the cords on this board is to constitute a connecting-link between two circuits, this function being quite distinct from that of the cords of the testing-board, which are in every case actual line-terminals. The double switches *e e'*, extending across the middle portion of the board, are each connected with and form a part of a separate pair of connecting cords. When turned in one direction, their function is to include the operating-keys with the telephones in the circuit of any pair, while, when turned in the other direction, the two bars of the switch *e* are united through a short circuit, the telephonic and signaling appliances being cut out. This switch-board is also provided with the keys *k* and *k'*, and with the

switches *s'* and *s*², which subserve the same end as the keys and switch on the board A, which purpose will be hereinafter specified. 70

Fig. 3 shows a series of my switch-boards combined into a complete system, connecting two principal or testing stations, H and O, there being also two minor or intermediate stations, J and N. The principal stations H and O are each provided with switch-boards of the character I have indicated—*i. e.*, not only with the ordinary operating switch-board, B, by which any two lines may be interconnected, but also with the testing switch-board A, to which the lines are all first brought, and at which terminals can be readily interchanged. The intermediate stations, J and N, have no testing switch-board, but the switch-board C, with which they are furnished, possess really a dual character, and combine in themselves the functions of both classes of switch-board, the main lines entering at the rear of each board, and being interchangeable with respect to the annunciators and spring-jacks, while in front of the said intermediate boards the connecting-cords, as in switch-board B, are arranged. The lowest row of plug-sockets in the board A shows the respective sockets of a pair connected by a wire (represented by a short dotted line, *m*.) I employ this device when it becomes necessary to connect a pair of lines through without communicating with the connecting station at all. Such sockets have no connection with the board B. 100

The incoming lines are in Fig. 3 represented by the letter L. These are shown as converging from various directions to the two terminal offices H and O, which are likewise entered by the two lines L of a metallic circuit which extends between them through the stations J and N. The wires *l*, extending between the boards A and B at the two testing-stations, are purely of a local character, each annunciator *a* and spring-jack *q* on the boards B being connected by either a single wire or a loop-line with a plug-socket, *s*, or, in the latter case, a pair of plug-sockets, *s*, on the board A. 105

It is to be understood that in the ordinary working condition of the system each plug P, constituting a line-terminal, is inserted in one of the sockets *s* at testing-board A, so that the line is continued to the operating-board. In this and other figures, however, the plugs P are represented as resting on the horizontal portion of the board, to indicate that each plug is adapted for insertion in any of the sockets, and not designed for one exclusively. 110

Fig. 5 exemplifies the details of the connection between the testing switch board A and the operating board B. The lines L are the incoming wires, L' and L² being supposed to be the two wires of a metallic circuit, other lines, L, being single wires. Each separate wire terminates at the board A in a flexible cord, *v*, kept in position by the weight W, and provided with a solid metal connecting-plug, P. The metal plug-sockets *s*, placed above, 115 120 125 130

each connect with an annunciator and spring-jack on the board B. Those of the annunciators a and spring-jacks q that are intended for metallic circuits are placed in loops from the boards A. The two wires z and z' , for example, constitute such a loop to the extreme right-hand annunciator a , y and y' forming another to the next, and so on. The wires x and w , on the other hand, being adapted for single-line circuits, each extends to a separate annunciator and jack, the other side of which connects with a wire, g , leading to earth at G. By this construction the two wires of a metallic circuit, L' and L^2 , may be at will connected with any of the loop-annunciators on the board B by inserting the two plugs forming the ends of such wires into the two sockets representing the annunciator desired. Moreover, if one of the wires—say L^2 —of this specific circuit be disabled, any other desired wire may be substituted therefor, until repairs be completed, by withdrawing the plug of L^2 from its socket, and inserting in lieu thereof the patching-line—say L^3 .

I have shown the spring-jacks q as being a separate appliance, simply for clearness of explanation, since as I have hereinbefore stated, I prefer to embody the two appliances in one instrument. A certain degree of difference is, however, required in the internal construction of the spring-jacks, which I shall now describe.

The jack intended for a metallic circuit is adapted to form an electric connection with a double conductor-connecting plug, and to this end not only the spring portion, which is united to one of the wires, z , contributes, but also the lower part, which is in electrical connection with the other wire, z' . The two parts are in contact with one another when the spring-jack is not in operation; but when the plug is inserted between the parts q and q' one of the conductors of the said plug is brought into connection with q and the other with q' , so that the entire metallic circuit is extended through the double cord to the companion plug at the other end thereof.

The single-circuit spring-jacks are adapted to bring but one of the wires x or w into contact with the plug-connector, which acts to dis sever the wire from its normal ground-connection g and to connect the same with the single conductor of the plug. In this style of spring-jack the wire x is connected with the spring or upper portion, q , which, when at rest, presses upon the insulated pin q^2 , this being connected to the ground-wire. The lower part or socket of the single-wire jack bears no part in the electrical connection. Thus, when the plug-connector of a single conductor-cord is inserted, the wire x is extended through the said cord to the plug at the other end. If, for example, the two wires x and w are to be connected at the board B, this may be done by using any pair of the single-wire cords, the two plugs p' of the same pair being inserted in the two jacks q belonging to such

wires, the circuit of w being joined *via* spring q , insulated pin q^2 , plug p' , cord 37, cord 38, and the remaining plug to the jack of wire x . If two of the double-wire circuits are to be connected, the double-conductor cords and plugs p are to be used.

It only remains to describe the special electric connections of the two classes of switch-board. The diagram Fig. 4 shows the arrangement of the several testing devices upon switch-board A. That portion A of the figure above the dotted line Z represents the vertical part or back board of the switch-board, omitting the annunciator plug-sockets s , the arrangement of which has already been described, while the larger portion A below the said dotted line represents the horizontal part or table. Any desired number of pairs of plug-sockets may be fixed in the said back board, these leading by wires below the surface or behind the board to their several objective points. Three of these are the loop-terminals of the switch-board apparatus, while the fourth and each pair which may be used in addition to the fourth constitutes the terminal of a loop or loops leading to subscribers or sub-stations who may have special arrangements for interconnection with metallic-circuit lines. Another series of plug-sockets, G' , are also arranged in line upon the upright back board, to afford facilities for the speedy grounding of any line. These are all united by a wire, g , at the rear of the board, which is connected to the ground G, and their function has been stated in describing Fig. 1. The horizontal or table portion A' of the switch-board is at its rear perforated with a great number of holes, through which, as indicated in Fig. 1, the several line-terminal cords protrude to unite with their several plugs P, these resting by their handle ends on the rim of the said holes. These plugs may be lifted up from their normal positions and inserted in any of the sockets leading to the annunciators on the board B; or, as indicated in Fig. 4, the cords E E' may be connected with the various loop-sockets for testing purposes or for connection with loop-stations. Thus the two terminals L and L' of one metallic circuit are respectively connected by their terminal-cords E and E' and their plugs to the sockets r and r' , which lead by wires 1 and 2 to the electrical measurement apparatus M, which, together with the telephone and signaling appliances and the telegraphic instruments are located in the foreground of the table. Similarly, the two terminals L² and L³ of another metallic circuit are, by the insertion of the plugs of its cords in the sockets n and n' , connected with the wires 5 and 6, leading to some outlying loop-station. The two wires of a third circuit, L⁴ and L⁵, are in the same way united with the sockets o and o' , which lead by wires 3 and 4 to the telephone and signaling keys, while a fourth circuit (in this case a single line, L⁶) is attached to the socket u , leading by the wire 7 to the telegraph appa-

ratus T, the return-wire 8 of the telegraph-instrument leading to the socket u' , to which a plug and cord leading through the special hole G^2 and connecting with the ground-wire g is attached. Such a ground-cord is obviously required to complete the circuit of any of the single-wire lines when such lines are connected with any of the above-described loops; and it is also to be noted that the ground-cord is not required in connection with the telegraph-instruments when metallic circuits are being operated by the said instruments.

Considering now the telephone-loop, the socket o connects by the wire 3, after passing through the annunciator a' , with the key k' , the opposite socket, o' , being connected by the wire 4 to key k . These keys are normally connected through their back contacts, b and b' , and wires t and t' with the telephone t , which, however, may, when desired, be circuited by the switch s^6 . Of course it is usual in practice to use a transmitting-telephone also; but since no change in principle is involved it is not necessary to show such construction. The function of the annunciator a' is to receive test-signals from a distant station when called for, so as to ascertain the condition of a line.

D is a generator of electricity, required for sending call-signals. A magneto-machine, driven either manually or by power, is preferably employed. One of its poles is connected by wire 29 to the anvil c of key k , and also branches to the switch-button i' of the switch s' , the other pole being similarly connected by wire 30 with the button i of the said switch s' , and also by the wire 11 with the ground at G. If it be desired to send a call-signal over a metallic circuit to ring a bell, the magnet of which is included in the said metallic circuit at a distant station, the switch s' is placed on the button i and the two keys are simultaneously depressed. This operation brings the two poles of the generator into contact with the two wires of the circuit, and the current developed by the said generator thus traverses the said wires to ring the distant bell. If, however, it is required to ring a distant bell located in the circuit of a single-wire line, or in the circuit of either one of the two wires of a metallic-circuit line temporarily grounded for the purpose, the switch s' is turned to the opposite button, and that one of the keys is depressed which connects with the wire over which it is desired to ring, the extra ground-wire 11 thus being utilized. Each wire by this plan may, if desired, be separately tested.

The connections of the operating switch-board B are somewhat more complicated, and are delineated in the diagram Fig. 6, it being of course understood that in practice there are many other pairs of plugs connected with each switch-board, the few pairs I have shown being only intended to exemplify the construction. Any suitable number of pairs of circuit-connecting plugs and cords both for metallic and single-line circuits may be provided, and I have for purposes of illustration

shown two pairs of metallic-circuit connectors, one of which is unattached, while the other is in the act of connecting the loop of line-circuit y^2 and y^3 with the spring-jack q^5 of the repeating-coil I. I have also shown one pair of single connectors, one plug of which is inserted in the jack of the single-wire circuit x . The several loops, $z z'$, $y y'$, $y^2 y^3$, and $y^4 y^5$, indicate the wires leading from the corresponding plug-sockets at the testing switch-board. The wires x and w in like manner indicate the single lines leading from their corresponding sockets on board A. I provide an additional spring-jack, q^5 , united to the wires 31 and 32, leading to one coil of the inductorium I. The other coil of said inductorium has one of its ends united by a wire, g^3 , with the ground-wire G, and the other end by wire 33 to one of the bars e of a double-button switch, the other bar, e' , of the said switch being connected by wire 34 and binding-screw h^3 to the conducting-cord 35 and plug P^4 , by which the said coil may, when desired, be brought into connection with the spring-jack of any single-line circuit. Each pair of conducting-cords, whether double or single, is likewise provided with one of these double switches $e e'$, which, when turned in one direction, so as to make contact with the buttons 22 and 23, operates to introduce the calling-keys k and k' , and consequently the entire telephonic and signaling apparatus, into the circuit of the cord-connector between the two plug-terminals thereof, and which, when turned oppositely, so as to make contact with the buttons 20 and 21, disconnects the said apparatus, and connects the two bars of the switch direct through the short wire 22, which unites the said buttons.

The circuit of the double plugs and cords may be traced as follows: Beginning with the metal tip p' of the left-hand plug P, the circuit is through wires 17 and 16 to binding-screw h^2 , by wire 15 to switch-bar e' ; then, if short-circuited, to button 20, wire K, button 21, switch-bar e , wire 14, binding-screw h' , and wire 13 to the outer surface, p^2 , of the companion plug p , the tip or inner conducting-surface of said plug being connected by wires 12 and 11 with binding-screw h , passing thence direct by wire 10 to the outer surface, p^2 , of the first plug. The circuit of the single plugs and cords is much simpler. Beginning at the metal part of the plug P' , it leads by wire 38 to switch-bar e' , and from the other switch-bar, e , by wire 37 to the other plug-conductor P' to the end. That but one pair of keys with their appurtenances need be required for the switch-board, irrespective of the number of cords, I extend the main wires 18, leading from the keys k' in branch circuit, to each of the buttons 22 of the looping-switches, and the main wire 19, leading from the key k , by a second series of branch circuits to each of the said looping-switches. The telephone is included by means of wires t and t' normally in the circuit of the two

wires 18 and 19 through the back contacts, b and b' , and the keys k , although, as in Fig. 5, it is provided with a small switch, s^5 , by which it may, when necessary, be short-circuited.

5 The calling-generator, switch s , and key-anvils, together with their connecting-wires 29 and 30, are arranged exactly as hereinbefore described with reference to the switch-board A, and may all be introduced through the

10 keys and the looping-switches e into the circuit of any pair of conducting-cords. An independent row of plug-sockets s^3 (shown in actual position in Fig. 2) subserves the purpose of uniting the inner and outer con-

15 ductors of either one of the metallic-circuit plugs when the other plug of the pair is employed to answer a call upon any of the loop lines. It is obvious that this is absolutely essential, as otherwise the act of inserting one

20 plug will merely operate to open or break the circuit. The sockets s^3 are metallically lined, and when a call is received upon any one of the lines one of the plugs p is inserted into the said socket, which brings

25 the surface p' into metallic contact with the other surface, p'' , of the same plug; hence, when the remaining plug is inserted in the spring-jack, the circuit, while extended through the cord and thus brought within the range

30 of the office apparatus, is maintained continuous. By attaching a ground-wire to one or more of the sockets s^3 they may in the same manner be used for the single conductor-plugs; or the single conductor-plugs may, in a man-

35 ner well understood, be caused to stand on a ground-plate, the butt of their handle end being shod with a metal ring electrically united to the conducting portion, so that each plug is normally grounded. In the operation of

40 this system it is now evident that all lines are first brought to the testing switch-board, that there some are continued in loops to the jacks and annunciators at the operating-board, others being led thereto in single lines, and others

45 again being united by wires m for through service without passing at all through the operating-board. At the testing-board I also arrange to cross-connect the wires with one another to make up through lines when

50 portions of circuits are disabled, and also provide facilities for galvanometer or telephonic testing, and for telegraphic communication, which is frequently necessary in connection with long telephone-lines. On the operating-board the

55 various operations of calling either over double or single lines by means of the generator D and the keys k and k' and the switch s' , of telephonic communication, and of intercommunication between any two metallic circuits

60 or between any two ground-circuits or between metallic circuits and ground-circuits are effected.

Having now fully described my invention, I claim—

65 1. The hereinbefore-described system of electric intercommunication, comprising a number of central stations, metallic circuit,

and single line or earth return-lines converging to each of the said stations, metallic-circuit trunk-lines connecting the said central stations, a testing switch-board at each principal or terminal central station of a series whereat the several converging lines terminate, and where they may be interchanged, for the purposes described, the said testing

70 switch-boards being provided with apparatus for testing the electrical condition of the said lines, an operating switch-board at the said principal stations provided with annunciators, one for each line, and connecting and signal-

75 sending devices, each annunciator being connected with one or more plug-sockets on the testing switch-board, and a series of intermediate switch-boards, one at each intermediate central station, combining the instrumentalities and functions of the two switch boards at the principal central stations, all substantially

80 as specified, and for the purposes set forth.

2. The combination, in a telephonic testing switch-board, of a series of plugs and cords each constituting a line-terminal, a series of plug-sockets forming singly or in pairs the terminals of loops or branch circuits including annunciators and spring-jacks and adapted to be connected with the plug line-terminals, a normally-open branch or loop circuit including electrical measurement-instruments, a second branch including signaling-keys and telephones, a third branch including telegraph-instruments, and switching devices, substantially as indicated, for connecting any of the

90 said line-terminals with the said loop or branch circuits, for the purposes described.

3. The combination, substantially as hereinbefore described, in a central telephone-station, of a testing switch-board comprising a series of line-terminals, plug-sockets connecting with annunciators and spring-jacks located at a separate operating switch-board, and loops or branch circuits including, respectively,

105 electrical measurement apparatus, telephone and signaling devices, and telegraphic instruments, with an operating switch-board at which the said annunciators and spring-jacks are located, and provided, also, as indicated,

110 with a series of double connecting cords and plugs for the interconnection of metallic circuits, a series of single cords and plugs for interconnection of single-line circuits, and means, as indicated, for signaling at will over either

115 metallic or single-line circuits, as may be required.

4. The combination, in a telephonic switch-board, of a series of pairs of plugs and cords, each pair constituting the line-terminals of the

120 two wires of a metallic circuit, a series of single plugs and cords each constituting the terminal of a single-line circuit, a series of loop continuations each including an annunciator and spring-jack, both ends of each loop terminating in a plug-socket for the reception of the

125 metallic-circuit terminal-plugs, a series of single-circuit continuation or extension wires terminating at one end in plug-sockets for the

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reception of the single-line terminal-plugs, and at the other end connected to ground-terminals after passing through an annunciator and spring-jack, whereby the several metallic-circuit and single main lines may be interchanged at will with respect to their several annunciators and spring-jacks, for the purposes specified.

5. The combination of a metallic telephone-circuit, a conducting-cord and plug-connector constituting the terminal of each end thereof, a series of loop-extensions independent of the said terminal cords and plug each including signaling and switching devices, and a series of conducting plug-sockets arranged in pairs, one pair being connected with and representing the two terminals of each loop-extension, whereby the metallic-circuit terminals may be connected with any of the said loops, as desired, substantially as specified.

6. The combination, in a telephone exchange system, of a series of metallic-line circuits, a pair of conducting-cords and plug-connectors for each of the said circuits constituting the terminals of the two ends thereof, a series of single-line circuits, a conducting cord and a plug-connector for each of the said single lines forming the central-station terminal thereof, a series of pairs of plug-sockets and a series of loop-extensions connected therewith, one loop for each pair of sockets, a series of single plug-sockets, and a single-line wire extending therefrom to a ground-wire, switching and signal-receiving devices for each loop and single-wire extension, and a series of pairs of metallic circuits, and single circuit-conducting cords and plugs placed in proximity to the said switching devices, whereby any of the metallic or ground circuits may be connected to any desired loop or branch extension, and whereby any two of the said loops or branches may then be connected together, substantially as and for the purposes described.

7. In a telephone central station, the combination, with incoming line-wires, each of which terminates in a flexible conducting-cord and plug-connector, of a series of normally-open loops including severally suitable apparatus for electrical measurement, telephonic and signaling apparatus, and telegraph-instruments, one or more separate and independent loops to outlying stations, a series of plug-sockets each connected with a ground-wire, a flexible cord and plug terminal also connected with a ground-wire, and switching devices whereby any of the said loops may be included in the circuit of any of the incoming lines or between any of the said lines and a ground-connection, as described herein.

8. The combination, with a series of electric-circuit terminals representing double-wire or metallic circuits, of a pair of signaling-keys, switching devices interposed between the said keys and the said circuit-terminals, whereby the said keys may be connected with any of the said terminals, and an electrical generator having its poles connected severally with the

anvils of the said two keys, whereby any metallic circuit may be connected in circuit with the said generator by the simultaneous depression of both keys.

9. The combination, substantially as hereinbefore specified, of a series of circuit-terminals representing double or metallic and also single-wire circuits, of a pair of signaling-keys, switching devices interposed between the said keys and the said circuit-terminals, whereby the said keys may be connected with any two of the said circuit-terminals, an electrical generator having one of its poles connected directly with the anvil of one of the keys, and the other connected to ground and also through a switch with the other key-anvil, whereby, when the said switch is turned in one direction, both poles may be connected through the keys with any pair of line-terminals, and when the said switch is turned in the opposite direction one pole only of the said generator is connected with both keys, and the ground-wire attached to the other is brought into action, whereby signals may be sent by either key over a single-wire or ground circuit.

10. The combination, with a series of metallic and single-wire circuit terminals, of a pair of signaling-keys the back contacts of which are united through a telephone or telephones, switching devices interposed between the said keys and the said circuit-terminals, whereby the keys may be connected with any circuit or between any two circuits, an electrical generator having one of its poles permanently grounded, and wires extending from both poles to the keys, and a switch adapted to connect the key-anvils independently to the said two wires or to connect both to the wire connecting with the ungrounded pole, for the purposes herein specified.

11. The combination of a pair of signaling-keys adapted to be connected with an electric circuit, each key having a separate back contact-piece and anvil, of a two-point button-switch, and an electric generator having one of its poles connected directly to one of the key-anvils and to one point of the button-switch, and the other connected with the ground and with the other switch-button, the stem of the said switch being connected with the remaining key-anvil, whereby, when the said switch is turned in one direction, each generator pole is connected with one of the key-anvils, and whereby when turned in the other direction both anvils are connected to the same pole, and the ground-connection only left on the remaining pole, for the purposes specified.

12. The combination, substantially as specified herein, of a series of circuit-terminals representing incoming lines, a pair of signaling-keys, a telephone-loop controlled by the said keys, a call-generator also controlled by the said keys, and a normally-open loop including a test-annunciator extending from the said keys to a pair of plug-sockets by which the said keys may be connected to any two

circuit-terminals or to one of the said circuit-terminals and a ground-terminal, for the purposes described.

13. In a telephonic system of switching and signaling, the combination of a series of metallic and ground circuit line terminals, each including an annunciator and spring-jack, a series of pairs of double conductor cords and plugs adapted to connect any two metallic circuits, a series of pairs of single conductor-cords adapted to interconnect any two single-line circuits, an inductorium having two helices, one of which has its two terminals connected with a metallic circuit spring-jack, the other having one end permanently grounded and the other end connected with a single conductor cord and plug for the purpose of connecting any metallic circuit to a ground circuit, a single pair of signaling-keys united to wires branching to each pair of cords and controlling a telephone and generator-loop, and a looping switch for each of the said pairs of cords adapted to connect one of the wires of said cords to the wires branching from the said signaling-keys, whereby one pair of keys is made to serve a number of the said cords, substantially as described.

14. In a telephonic switch-board, a series of pairs of connecting-cords terminating at each end in plugs and adapted to connect any

two circuits together with a pair of signaling-keys having their back contacts connected through a telephone and their front contacts or anvils connected with a call-generator, a looping-in switch in the circuit of each connecting-cord, and a wire extending in branch circuit from each key to each of a pair of contact-buttons in the range of each of the said looping in switches, whereby the said telephones or generator may be introduced into the circuit of any of the pairs of cords, as described.

15. The combination, with a spring-jack, of a metallic or double-wire circuit, and a pair of double circuit-connecting cords and plugs therefor, of a metal-lined plug-socket adapted to contain one plug of the said pair and to connect the two conductors thereof when the other plug is inserted in the spring-jack to answer a call, whereby the circuit of said pair is closed and continuity maintained, substantially as herein specified.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 23d day of November, 1885.

T. B. DOOLITTLE.

Witnesses:

GEO. H. E. TROUVELOT,
GEO. WILLIS PIERCE.