(No Model.)

J. J. CARTY.

SWITCHING APPARATUS AND TEST CIRCUIT FOR TELEPHONE EXCHANGES.

No. 353,350. Patented Nov. 30, 1886.

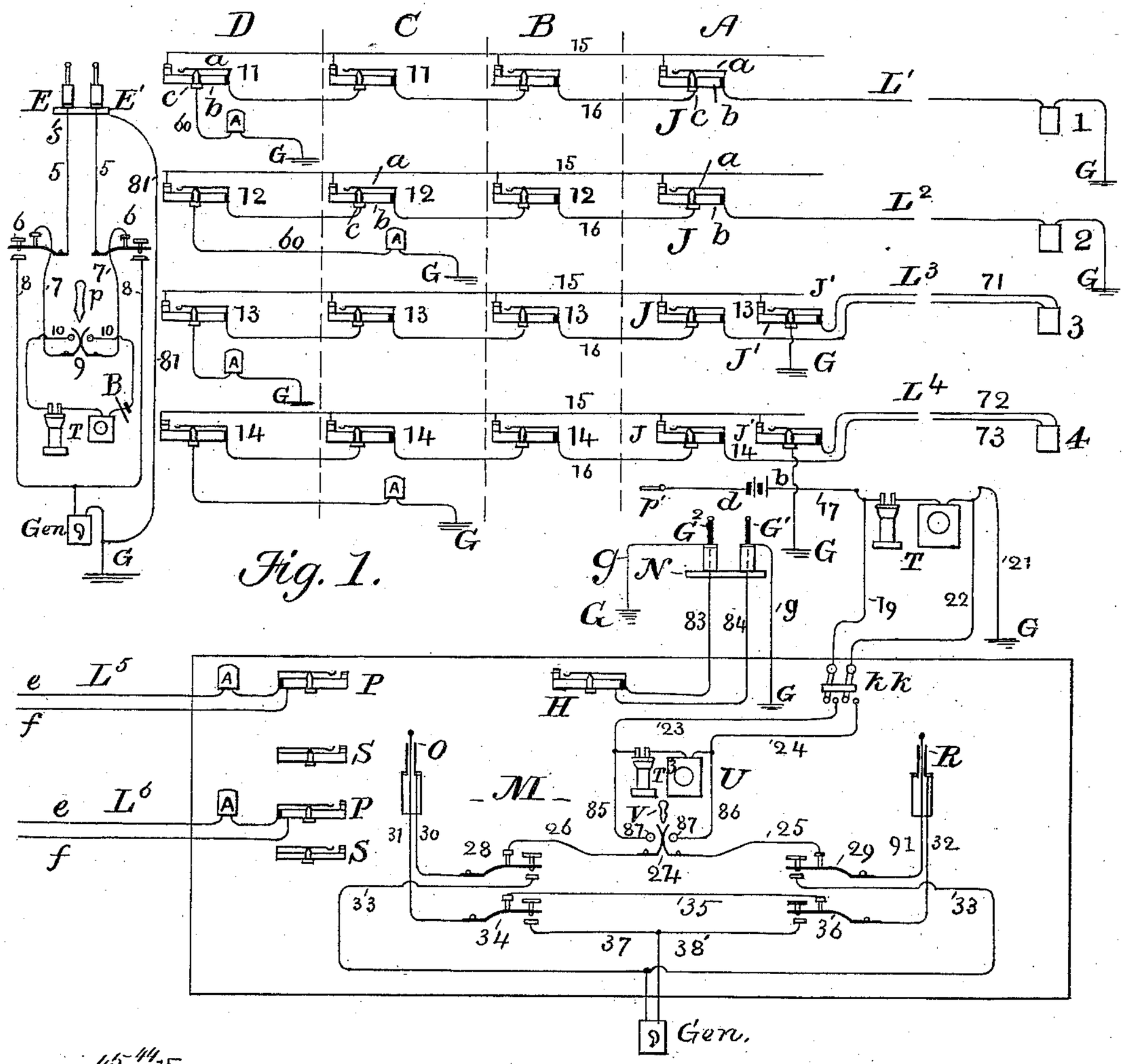

Fig. 1.

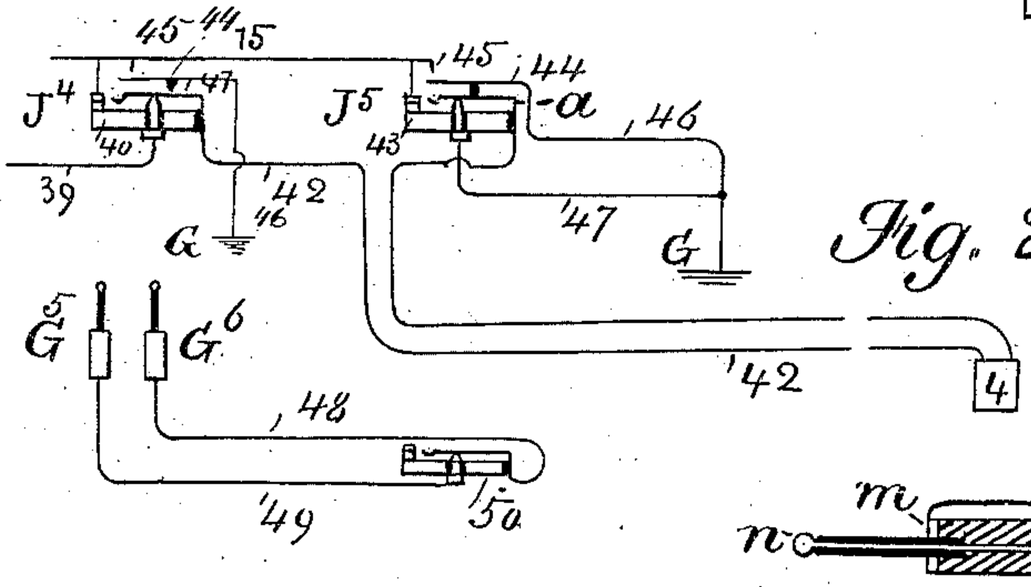

Fig. 2.

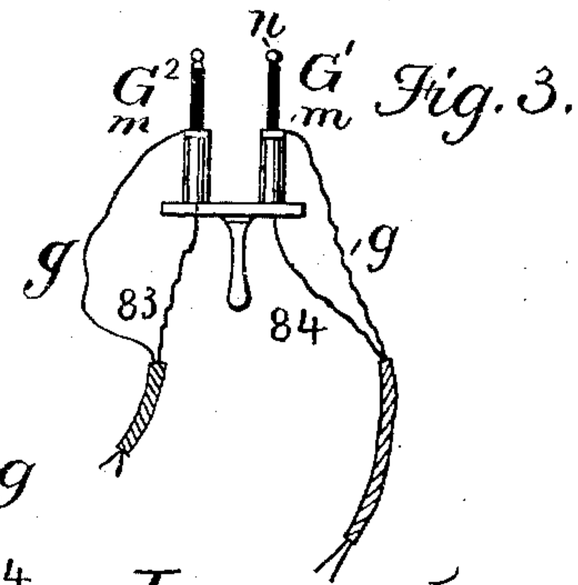

Fig. 3.

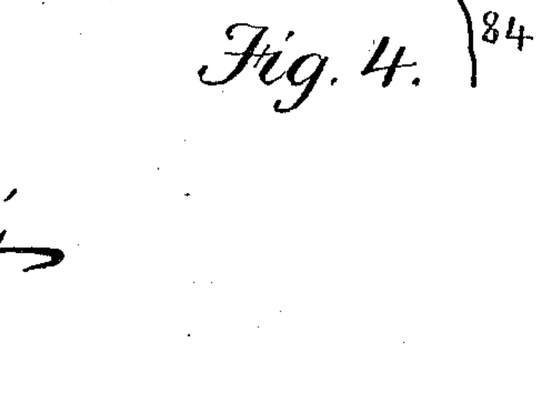

Fig. 4.

Witnesses.
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SWITCHING APPARATUS AND TEST-CIRCUIT FOR TELEPHONE-EXCHANGES.

SPECIFICATION forming part of Letters Patent No. 353,350, dated November 30, 1886.

Application filed September 6, 1886. Serial No. 212,787. (No model.)

To all whom it may concern:

Be it known that I, JOHN J. CARTY, of Cambridge, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Multiple Switching Apparatus and Test-Circuits for Telephone-Exchanges, of which the following is a specification.

This invention relates to the manipulation of the numerous line-wires centering in a telephone-exchange or large telegraph central office. It is especially adapted for use in connection with the present well-established system of interconnecting, by means of suitable apparatus at a central station, telephone-lines which converge from a number of subscribers' stations. The most approved appliance now in use for this purpose is known as the "multiple switch-board." This switch-board is really a number of switch-boards, each complete in itself, and the entering subscribers' line, while provided with an annunciator or other signal-receiving device at but one of the boards, loops successively to each of the others, so that, although a subscriber's call is answered at his own board only, the operators at the other boards may connect their lines with the said loops by means of spring-jacks, and thus each operator is enabled to effect the interconnection of any two lines without moving from one switch-board to another. Each operator has the charge of a certain number of lines, and is required to answer the calls of the annunciators representing that number, and may, moreover, connect any of the said number with any other line entering the office and terminating on other boards, as all of the said entering lines are represented by a spring-jack or looping device upon every one of the switch-boards. It is evident, however, that calls will frequently be made for lines which are already in use, and it is requisite, therefore, to provide means whereby the operator at any one switch-board of a multiple series may instantly and certainly ascertain whether any given line be already connected with another at some one of the other switch-boards of the series. Such appliances are now well known in the art, and are technically termed "try-signals" or "test circuits and signals." The plan which is in most general use is to connect a normally-insulated portion of all of the spring-jacks of each line together by special connecting-wires, and so to arrange the spring-jacks and plugs that the plug-connector, when inserted in any jack, will, in addition to its principal function of connecting one line with another through its conducting-cord, at the same time unite the normally-insulated portion through its own substance with the line-wire which is grounded at its distant end. A battery is included in the operator's telephone-circuit at each switch-board, and by the use of these devices it is easy for any operator to ascertain whether or not any desired line is already connected at any board with another. This is done by touching the end of the connecting-plug to the insulated portion of the spring-jack representing the said line, and at the same time listening at the telephone. If the line be at liberty, the battery in the telephone-loop has no complete circuit, and nothing is heard; but if the line be in use a click will be heard in the telephone, because the normally-insulated portion is connected through an inserted plug with the line at some other board, thus furnishing a circuit for the battery.

Now, the circuit heretofore almost universally employed in telephone and telegraph communication is constituted of but a single metallic wire, the earth being utilized as the return-circuit, the line-wire under these circumstances being grounded both at the central and the terminal subscribers' station. As a consequence, nearly all of the switch-boards at present in use are adapted to the single-wire circuit.

The extraordinary growth and extension of the business of electrical communication, and the contingent multiplication of wires necessitating their grouping together in cables, has aggravated the well-known circuit disturbances, which have been heterogeneously classed under the head of "induction," causing messages passing on the various lines to interfere materially with one another, especially in the case of the telephone. To obviate or neutralize these disturbances, the ordinary laboratory expedient of using a return-wire, substantially equidistant with the main wire from the source

of disturbance, has been resorted to, in which case the earth-return is of course dispensed with, and in the operation of long trunk or inter-urban lines this expedient is now very successfully employed.

With existing systems of telephonic intercommunication it is obviously impracticable to connect the single-wire lines directly with the absolutely metallic or double-wire lines without depriving the latter of their neutralizing function; but it is also evident that if all of the single-wire circuits were converted into metallic return-circuits it would then be possible to interconnect the trunk and local lines. It is, however, found in practice that the general introduction of the return-wire seriously complicates the switch-board, especially in the multiple switch-board system, (to which my invention is particularly applicable,) where it would be essential to extend the return-wire to all of the boards in the system.

It has been proposed, instead of converting the single circuits into complete metallic circuits, to run a return-wire for each circuit, both direct and return wires being furnished with earth-terminals, and the direct or original conductor being connected with the several boards of the system in the ordinary manner. Circuits so constructed can be connected with one another by the ordinary arrangement of switch-boards, and by virtue of the parallelism of their wires are free from induction from other wires. This mode of constructing double-wire circuits commends itself also in view of the fact that in an established telephone-exchange the work of adding the return-wires to the original wires consumes a considerable period of time, and that for a comparatively long interval it is therefore necessary to operate a system which is composed partly of single-wire grounded circuits, partly of double-wire grounded circuits, and partly of absolutely metallic or non-grounded circuits. It may furthermore be assumed that some circuits, by reason of special circumstances, will remain unchanged, so that the three classes enumerated herein must always be counted upon. The invention which I am about to describe is particularly adapted to these circumstances. This plan, without further invention, answers very well when both circuits of two to be united are of the same class or character; but where they are to be connected with absolutely metallic or double-wire circuits of the trunk-lines the same difficulty which has been hereinbefore pointed out still obtains, and for the successful operation of such a compound system additional appliances are required.

The objects of my invention, then, are to provide a system of appliances and manipulation whereby these double-wire earth-terminal circuits may be connected with one another, and also with the continuously or completely metallic trunk-lines; to accomplish this end without interfering with the operation of a trustworthy and efficient "try-signal" or "test-circuit," and to do this while dispensing with the introduction of complicated or intricate appliances.

In pursuance of these objects my invention, broadly stated, consists of a multiple switching system provided with suitable and convenient appliances for the interconnection of double-wire circuits grounded at both terminals either with single-wire ground-terminal circuits or with complete double-wire or absolutely-metallic circuits with equal facility, and in the combination of such a system with a test-circuit and appliances for the manipulation thereof, whereby the connection of any two double-wire circuits with one another may be ascertained at any board in the system, though there be no ground-terminal included in the compound circuit so constituted.

It consists, also, in certain combinations of circuits and instruments and in specific details of construction, all of which are delineated in the drawings, and which I shall now proceed to point out and describe.

In the drawings which illustrate this specification, Figure 1 is a diagram of the arrangement of circuits and appliances involving my invention. Fig. 2 shows a modification of the test-circuit and apparatus. Fig. 3 is a modification of the plug-connector used in connecting grounded double-wire circuits with completely-metallic circuits or two metallic circuits together. Fig. 4 is an enlarged sectional view of the special form of connecting-plug, which involves the testing-ground.

The drawings show my invention applied to a system of multiple switch-boards comprising single-wire grounded terminal circuits L' and L^2, return-wire circuits L^3 and L^4, both ends provided with earth-terminals at the central station, and complete metallic circuits L^5 and L^6. By its use I connect any circuit of either class with any other circuit of the same or of any other class without being necessitated to use intricate or delicate apparatus.

In the lines L', L^2, L^3, and L^4 the sub-stations 1, 2, 3, and 4 are indicated at the extreme right of the drawings, and the several sub-stations are connected with the central station by the single-line wires L' and L^2 and by the double-line wires L^3 and L^4. A break or hiatus is shown in the drawing of each line, indicating that any length of line may be employed, as required. Considering, first, the two single-wire lines L and L^2, it will be seen that, starting from the earth at sub-stations 1 and 2, they pass *via* their respective line-wires L' and L^2 to the central station. There they are provided with a spring-jack at each board.

It may be stated, once for all, that each spring-jack consists of a metal frame, *b*, provided at its front end with a plug-socket, a contact pin or point, *c*, supported in the said frame, but insulated therefrom, and a contact-spring, *a*, supported at the rear of said frame, but likewise insulated therefrom, and normally pressing with its free end upon the extremity of the

contact-pin *c*, and that when a connecting-plug is thrust into the spring-jack its operation is to lift the spring *a* from the pin *c*, bringing it into contact with its own metallic end, thus breaking the original line-circuit and transferring it through the plug to a flexible conductor attached thereto.

All the metal frames of the spring-jacks of each line are electrically united by a separate wire conductor, 15, for the purpose of establishing a test-circuit, as hereinbefore described.

The line-circuit, reaching the first switch-board, A of the multiple series, passes to the spring-jack J, reaching first the spring *a*, which rests upon the pin *c*, this in turn being united to the wire 16, leading to the spring-jack 12 at the next switch-board, B, and in the same manner through all the switch-boards of the series A, B, C, and D. The several single-wire lines, after passing each through a spring-jack at every board, are led by a wire, 60, to some one of the boards, where, after passing through an annunciator, A, they are terminated by a ground wire or connection, the annunciators of the different lines being distributed among the different boards. The line L′, for example, is shown as being terminated at board D, while L^2 is terminated at board C, the division between the several switch-boards being indicated in the drawings by dotted lines.

It is to be understood, of course, that in practice any number of either class of line may be operated.

The lines with wire-return L^3 and L^4 are now to be considered. These are connected with the several boards and spring-jacks in the same way as the single lines, hereinbefore described, with the exception that the outer ends of the lines, instead of being provided with ground-terminal connections at the distant sub-stations 3 and 4, are brought back by parallel return-conductors 71 and 72, and are grounded at the central station, where the original central-station ends are likewise grounded. It will, however, be observed that at board A there is provided for each of the lines of this class an extra spring-jack, J′, (formed in every respect like the other jacks,) which is placed in the circuit of the return-wire 71 or 72, the line being united to the spring of said jack and the return-wire ground-terminal connection with the insulated contact-pin thereof.

The function of the extra jack J′ will be hereinafter described.

At the left side of the drawings may be seen the connecting and controlling devices, which, however, constitute no part of my invention, and are here shown and described solely for the better elucidation of the subject. They comprise two flexible conductors, 5, each terminating in a plug, E E′. Each cord is attached at its fixed extremity to a key, 6, the back contact of which leads by wire to contact-springs 9, which are normally in contact with one another. A normally-open branch circuit, including telephones T and a local battery, B, is terminated by contact-points, one on either side of the spring-jaws 9, so that the telephones may be readily introduced into the plug and cord circuit by simply pressing a button, *p*, by which the spring-jaws 9 are parted and each one brought into circuit at its outer side with the contact-point 10. The front contact of both keys is united by wires 8 with one pole of an electrical generator, the other pole whereof is grounded, so that pressing either key will send a calling-current through the cord and plug to the line to which the said plug may be at the time connected. Finally, the plugs E E′ have each a heel-piece of metal electrically in union with a metal plate or seat, *s*, which is grounded through a wire, 81. When stations upon either of the single-wire lines—say L′—wish to communicate with others of the same class—L^2, for example—the subscriber calls in the usual manner, dropping the annunciator A on the board at which his line terminates—in the present case, D—and makes known his desire, the operator answering him by inserting one plug, E′, in the jack 11. The butt of the other plug being grounded, the operator is enabled to bring his telephones into the circuit simply by pressing the button *p*. Ascertaining that the station on L^2 is the one desired, the operator touches his remaining plug to the metal frame-work of the jack 12, representing the line L^2 on board D, listening at the same time at his telephone. If that line is not in use, the touch will produce no sound in the telephone, and the operator becomes cognizant that the desired line is not already in use at any other board, and unites the lines by placing the remaining plug, E, in the jack 12 of the line desired. Then by pressing the keys 6 either line may be called; or by pressing the button *p* the operator introduces his telephone into the circuit, and may converse with either subscriber. On the other hand, if L^2 should be already in use on some other board, the test-wire 15 of that line is brought into contact with the line of said board through the plug-connector by the insertion of the plug, and a circuit for the battery B in the operator's telephone-loop is thus completed, when the second plug-connector is made to touch the frame of any jack 12 of the same line. A click is thus heard in the operator's telephone, and the line is known to be already in use. This feature is not claimed herein, since it is described and claimed in Letters Patent No. 305,021, issued September 9, 1884, to Chas. E. Scribner, to which patent reference is hereby made. This test-circuit feature has, however, been fully explained here to show that the connection of any two grounded lines on any of the boards establishes through the plug a contact between the said lines and the normally-open test-wire 15, so that when the said test-wire or the jack-frame is touched at any other of the switch-boards by a terminal of a telephone-circuit, including a battery, (the other terminal of the same being grounded,)

the said battery-circuit is closed through the telephone, producing the test-click.

I have now described the operation of connecting any two single-wire grounded lines. The operation of connecting any two of the return-wire ground-terminal lines—such as L^3 and L^4—as also that of connecting any one of the single-wire lines to one of the second class is, in fact, identical with the foregoing, since it is obvious that the only difference in the character of the lines is in the location of the outer terminal ground, and that it cannot be material in practice where that terminal is located, since both classes of circuits are, for the purposes of this specification, in circuits having earth-terminals at both ends. When, however, we consider the problem of connecting the absolutely-metallic or non-grounded circuits with the grounded return-wire circuits, the conditions are different. It now becomes necessary not only to provide appliances for connecting the two ends of the absolutely-metallic circuit with the corresponding two ends of the grounded return-circuit, but also to provide that the act of connection shall dissever the two ground-terminals of the latter and the continuity of the former. Furthermore, it becomes evident that a new try signal or testing device must be devised, since the efficiency of the ordinary test-circuit is dependent upon the fact that the act of interconnection grounded the normally-open test-wire 15 through the jack-frame, plug, and connected lines, and since it is obvious that the act of connecting two metallic or loop circuits, which are totally independent of ground-connections, can have no such effect. It would be comparatively easy to provide such appliances if complicated apparatus were unobjectionable; but I desire to provide appliances of simple, easily-understood, and easily-operated character.

L^5 and L^6 are the loop-terminals of the absolutely metallic trunk-lines.

The multiple switch-board A is provided for use as the special board at which the trunk metallic circuits may be interconnected with the grounded return-wire lines. In view of such connections, each of the said lines is provided at the board A, as hereinbefore described, with an extra spring-jack, J′, through which the return-wire passes to earth.

It is found convenient in practice to terminate the trunk metallic circuits at a switching-table, M, separate from the regular boards, and the conducting cords 83 and 84, with the plugs G^2 and G′ at the board A, connect by suitable wires with an ordinary spring-jack, H, on the table M. There is also placed at the intermediate board, A, a separate telephone outfit, T, connecting by loop-wires 19 and 22 with switches or keys *k k* on the trunk-table M, but having also branches, one, 21, leading from one side of the telephones to earth, and the other, 17, leading from the other side of the telephones through a battery, *d*, to a flexible cord and plug, *p*′, this latter being for test.

O and R are two double conductor-plugs upon the trunk-board, each leading by means of two separate conductors to two keys, R being connected with the keys 29 and 36, and O with 28 and 34. The back contacts of the keys 34 and 36 are united by a wire, 35, and the back contacts of the two upper keys, 28 and 29, are connected by wires 25 and 26 through a jaw-spring, 24, which provides for the introduction of a telephone-loop, U, when a button, V′, is depressed. The telephones T^3 of this loop are adapted to be introduced into the plug-circuit by means of normally-open branch wires 85 and 86, which constitute a closed loop when the button V is pressed, because the spring-jaws 24 are then pressed outwardly against the contacts 87. They may also, by moving the double key or switch *k k*, be brought into circuit with the telephones T at the board A. One of the poles of the electrical generator below is connected by wires 33 to the front contact of the two upper keys, 28 and 29, and the other pole of the said generator is similarly united by wires 37 and 38 to the front contacts of the two lower keys, 34 and 36, so that when any two metallic circuits are united through these keys calls may be sent in one direction by pressing one of the pairs of keys 28 and 34, and oppositely by pressing the other pair.

S S are two spring-jacks or plug-sockets, which are continuous in their circuit—that is, the frame, spring, and contact-point are all in electrical union with one another. These serve to receive and unite the conductors of one double conductor-plug, R, so as to complete the circuit thereof, while the complementary plug O is being used to answer calls by being inserted in the jacks P.

The lines L^5 and L^6 represent metallic trunk-circuits leading from distant exchanges.

Assuming, now, that the distant exchange, desiring to be connected with, say, a sub-station on line L^4, signals the operator at M by throwing the annunciator A. The operator at H answers by inserting the double-wire plug O in the spring-jack P. This connects the two line-wires *e* and *f* with the two conductors 31 and 30 of the plug O, and thus severs the continuity of the line in the spring-jack P, and extends the two wires *e* and *f* thereof to the terminals 91 and 32 of the plug R, where, however, they remain open until or unless the said plug R is inserted in the socket S, which unites 91 and 32, closing the circuit. The operator's telephone, set U, is then connected in circuit by depressing the button V, and telephonic communication is thus established. When the operator at H ascertains that L^4 is the line wanted, he notifies the operator at the special multiple board A by depressing the double-key *k k*, and the operator at A then inserts the plug G′ in the spring-jack J′ and plug G^2 into spring-jack J. This cuts off both ground-terminals of the line L^4 and extends the two wires 72 and 73 of the said line to the spring-jack H on the trunk-table M, which

spring-jack is thereupon connected with the metallic trunk-line L^5 by withdrawing the plug R from the socket S and inserting it in the jack H.

It is obvious that the position of plugs G′ and G^2 can be reversed without affecting the result.

The switch-board A is one specially provided to operate intermediately between the long line metallic trunk-circuits and the local lines. It differs from the regular boards not only in being provided with the extra jack J′, but also in that it is not provided with subscribers' annunciators, and the duty of its operator is to make whatever connections or disconnections are called for by the trunk-line operators.

It is of course essential, whenever a line of the local system is already in at board A, being connected with a totally-metallic circuit through the trunk-board M, that the fact may be readily ascertained at any other board in the station by the ordinary testing system—ordinary, at least, so far as the operator at the other board is concerned. Inasmuch as the test-circuit 15 is not grounded by the act of uniting two metallic circuits, I have devised the following combination of appliances, which operate to establish an artificial ground on the normally-open test-line. To accomplish this, I attach a metallic plate, *m*, to the shoulder of the plugs G′ G^2, which, as shown enlarged in Fig. 4, have their stem covered with non-conducting material, except at their ends *n*, where it comes into contact with the contact-spring of the line. Being thus insulated, the stem of the plug is not brought into contact with the spring-jack frame; but the insulated washer or plate *m*, mounted thereon, is brought into contact with the outer end of said frame. This plate *m* is in permanent connection with a ground-wire, *g*, and the plug, when inserted, is thus enabled to ground the test-line 15, despite the fact that no ground is connected with the circuit. The test for "line in use" can therefore be made by other switch-boards in the usual manner.

It may in some instances be found convenient to form the two plugs G′ and G^2 with a common handle, as shown in Fig. 3, in which case the two jacks J and J′, for each return-wire grounded circuit, would have to be a small and standard distance apart. A modification of this plan of arranging a line in use or test-circuit is shown in Fig. 2. In this case an extra contact-spring, 44, connected with a ground-wire, 46, is mechanically attached to but insulated from the regular jack-spring *a*. The normally-open test-wire 15 is provided with a contact-point within range of the extra spring 44. When the jack-spring is raised by the insertion of the plug G^6, (which corresponds to the plug G′ in Fig. 1,) the extra spring is caused to make contact with the point 45, and to establish a ground upon the test-wire 15. The spring-jack J^4 is also provided with an extra contact-spring for the same purpose and in the same manner as shown in spring-jack J^5.

The function of the continuous socket S on the trunk-board M has been adverted to. It may, however, be dispensed with by providing each of the two plugs G′ and G^2 with metal heel-pieces in electrical connection with the conductors of the said plugs, and by causing the said plugs to rest, when not in use, on a conducting-plate, N. The spring-jack H can then be used, in lieu of the socket S, for the reception of the plug R, while the plug O is being used to answer calls upon the trunk-lines L^5.

Any number of boards A which may be required can of course be used in association with other multiple boards, B, C, and D.

Having now fully described my invention, I claim—

1. In a telephone-exchange system, a series of complete or continously metallic double-line circuits, a series of double-wire circuits, both outgoing and return wires being provided with earth-terminals at a central station, and means, as indicated, for removing the said earth-terminals from both direct and outgoing lines, and for simultaneously transferring the said lines to a connection with the two lines of the complete metallic circuits, substantially as specified herein.

2. In a telephone-exchange system, a series of double-line circuits extending by outgoing and return lines between a corresponding series of sub-stations and a central station, and provided at said central station with earth-terminals for both outgoing and return lines, and a multiple switch-board having upon each of its several sections a spring-jack connected in the outgoing line of each circuit and controlling the earth-terminals of both outgoing and return lines, substantially as hereinbefore described.

3. A series of multiple switch-board sections, one of which is furnished with a number of extra spring-jacks, a series of double-line circuits, one line of each being connected to earth after passing through a spring-jack at each board, the other being connected to earth after passing through the extra jack of the special board only, a normally-open test-circuit for each of the said double-line circuits extending to the several jacks thereof, switching devices for connecting complete metallic circuits with the two ends of the said double-wire circuits at the said special multiple-board section for simultaneously removing the two normal ground-terminals thereof, and for simultaneously connecting an independent ground-connection to the normally-open and detached test-circuit, whereby it may be ascertained at any other switch-board section that the double-line ground-circuit is already in use.

4. In a telephone-exchange system, the combination of a series of double-line circuits, including both continuously-metallic or earth-

completed circuits, of detachable double conductors for uniting the said double-wire circuits, each line of the said detachable conductors including two keys normally united through their back contacts, each pair of keys representing one of the interconnected double lines, an electrical generator having one of its poles connected with the front contacts of two of the said keys and its other pole united with the front contact of two other of the said keys, as shown and described, and an operator's telephone outfit normally disconnected but adapted to be looped into the circuit between two of the said keys, all substantially as and for the purposes described.

5. In a multiple switching system, the combination of a series of single-line ground return-circuits, a series of double-line circuits, both lines being terminally grounded at a central station, a series of complete metallic circuits, a multiple switch-board provided with connecting devices at each section thereof for uniting any two of the single-line grounded circuits or any one of the said single-line circuits with any one of the double-line grounded circuits, an auxiliary switch-board provided with connecting devices for connecting the said double-line grounded circuits with the continuously-metallic double-line circuits, and for automatically disconnecting the earth-terminals of the former, and means, substantially as herein described, whereby a test circuit and connections are provided independent of the said earth-terminals.

6. In a system of multiple switch-boards for the interconnection of metallic circuits, the hereinbefore-described try-signal or testing device, comprising a pair of spring-jacks at a given switch-board, and a single spring-jack at each other board of the system for each circuit, a normally-open and detached line connecting the frames of the several spring-jacks of the said circuits, a pair of plug-connectors and flexible conductors attached thereto, constituting terminals of the other of the said circuits, and an insulated and independent ground-plate attached to the said plug-connectors, and adapted to be brought into contact with the normally-open line connecting the spring-jack frame, and to ground the same for the purpose of affording a line in use test for the other boards.

7. The hereinbefore-described try-signal for multiple switch-boards, adapted for the interconnection of a combined series of absolutely-metallic and double-wire ground-terminal lines, consisting of a spring-jack for each line upon each of a series of switch-boards, a normally-open or detached test-line connecting the frames of the several jacks, a plug-connector adapted to be inserted in the jack for the purpose of connecting another line therewith, and a ground plate or connection attached to the said plug, but insulated therefrom and adapted to make contact with the normally-open test-line through the spring-jack frame when the plug-connector is thrust therein, whereby the said test-circuit may be grounded independent of the connected lines and a test provided for metallic circuits, as specified.

8. In a telephone-exchange system, a multiple switch-board comprising a spring-jack at each section for each entering line, an auxiliary switch-board provided also with a spring-jack for each entering line and with a series of extra spring-jacks, a series of double-line circuits, one line of each being grounded at the central station after passing through a spring-jack at each multiple-board section, including the auxiliary board, and the other line of each of the said series being grounded also at the central station after passing through one of the extra jacks at the auxiliary board only, a series of absolute or continuously metallic double-wire circuits, and intermediate connections for connecting one of the lines of the said metallic circuit with the spring-jack of the outgoing wire, and the other metallic-circuit line with the extra jack of the return-wire of the double-line ground-circuits at the auxiliary board and for automatically removing the ground-connections of both lines thereof, substantially as and for the purposes described herein.

9. The combination, in a telephone-exchange system, with a multiple switch-board and a series of single-line earth-return circuits connected therewith, and represented by spring-jacks on the several sections thereof, of a series of complete metallic trunk-circuits, a series of double-line grounded circuits having both outgoing and return-line terminals grounded at the same central station, the outgoing line of each passing, as described herein, through spring-jacks at each switch-board section controlling the ground-terminal of the said outgoing line, whereby the said outgoing line only may be disconnected from its ground-terminal and united with any one of the single-line circuits, and means for connecting the said double-grounded lines to the two lines of any of the metallic trunk-lines independent of any ground-connections, said means consisting of an auxiliary switch-board of one or more sections, a spring-jack located thereon in the circuit of the outgoing line of each grounded double-line circuit in series with the multiple-board section spring-jacks of said line, and an additional and single spring-jack in the circuit of the return-line, also located at the said auxiliary board and controlling the ground-terminal of the said return-line, each return-wire jack being in close proximity to the spring-jack of its own outgoing line, whereby the two ends of the metallic trunk-circuits (represented by plug-connectors) may be connected with both lines of the double-line ground-circuits, and by the act of such connection disconnect the normal ground-terminals of the said double lines, for the purposes specified.

10. In a telephone-exchange system, a sub-

scriber's circuit composed of outgoing and return lines, both of the said lines being grounded at the central station, the outgoing line of said circuit passing to its ground-terminal through spring-jacks serially arranged in circuit at the several sections of a multiple switch-board, and the return-line of said circuit passing to its ground-terminal through a single and independent spring-jack at but one of the said sections of said multiple switch-board, as and for the purposes set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 1st day of September, 1886.

JOHN J. CARTY.

Witnesses:
THOS. D. LOCKWOOD,
GEO. WILLIS PIERCE.