(No Model.)

W. W. JACQUES.

TELEPHONE EXCHANGE SYSTEM.

No. 263,524. Patented Aug. 29, 1882.

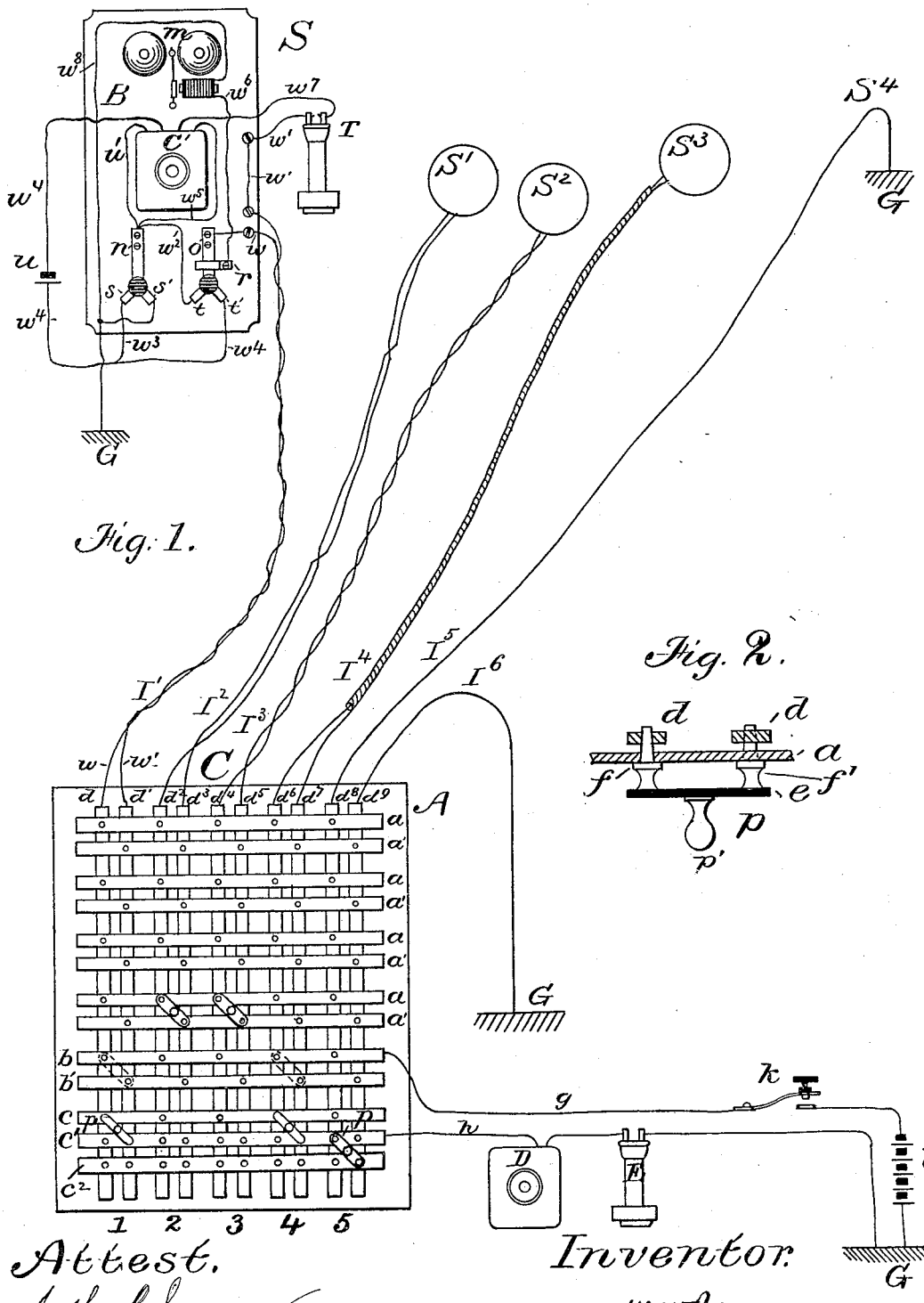

Fig. 1.

Fig. 2.

Attest.

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TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 263,524, dated August 29, 1882.

Application filed May 22, 1882. (No model.)

To all whom it may concern:

Be it known that I, WM. W. JACQUES, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain Improvements in Telephone-Exchange Systems, of which the following is a specification.

My invention relates to a method of and apparatus for effecting electrical intercommunication, known generally as the "telephone district or exchange system." It is well known that such an organization consists of a central station, a number of sub-stations, line-wires radiating from the central station and connecting it with the several sub-stations, 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 at a moment's notice in direct electrical communication with one another through the instrumentality of the attendant at the central station, who, when notified to do so, connects together the two lines leading to the respective sub-stations, so that they are thereafter enabled to communicate with each other directly.

Experience has demonstrated that when several line-wires used in the transmission or conveyance of electricity for various purposes are stretched in parallelism to one another, some of them being furnished 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 telephone-lines themselves; 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. To counteract this defect it has been proposed to provide for each line a parallel return-wire, thus making a metallic circuit, so that the foreign currents induced in one wire of such a 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 dispense with the extraneous signals; but in a telephone-exchange system it is both impracticable and inconvenient to construct all of the line-circuits with a metallic instead of an earth return, and many circuits must then, as heretofore, terminate at the earth, both at the central and sub stations; and it has been found difficult to construct apparatus at such stations whereby metallic circuits can be conveniently adapted for cross or interconnection with single or ground circuits without losing the advantage gained by the metallic form, 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; and to this end the object of my invention is the convenient arrangement of specific apparatus at the several sub-stations and at the central station with reference to the connecting-lines, so that in a mixed system, consisting, as I have hereinbefore indicated, partly of metallic circuits and partly of grounded circuits, the interconnection of any two metallic circuits, or of any two single or grounded circuits, or of a metallic circuit with a grounded circuit, may be readily and rapidly effected without necessitating the use of complex apparatus or the performance of intricate and multitudinous operations.

My invention consists, first, in the combination of a central-station switch-board having two series of conducting bars or strips arranged in pairs thereon transversely to one another, a series of telephone-lines, part of which are metallic and part earth return-circuits, radiating therefrom to a corresponding series of sub-stations, and signaling apparatus of a simple character at the several sub-stations connected with each metallic circuit, by which the central station may signal the sub-station upon one wire of the metallic circuit and the sub-station may communicate with the central station by means of the other wire of the metallic circuit, while, when the circuit is connected with another similar circuit through the apparatus at the central station, both wires are utilized in the act of intercommunication by being temporarily formed into a complete metallic circuit between the two sub-stations connected; or, if one of the two be located upon a single

or earth return-circuit, an additional earth-wire is caused to take the place of the metal return, in a manner specifically hereinafter described.

It also consists in the combination, with a central station and a series of sub-stations, of a double-line wire extending between the said central station and each of the sub-stations, and connected with the apparatus at either terminal in such a manner that one wire of the said double line is normally connected through the signaling-instrument to earth at the sub-station, remaining open or insulated at the central station, while the other is connected through telephones or other signaling-instrument to earth at the central station and is normally open at the sub-station.

It further consists in the combination of the double line with an instrument at the sub-stations adapted to normally maintain one wire of the said double line in connection with the signaling apparatus and the earth and the other wire open, or, when manually operated, to couple the said wires together as a loop, including the sub-station telephone, and with commutating apparatus at the central station, whereby the two ends of the said double line may be electrically connected with the corresponding ends of a similar double line extending to another sub-station, or with a single line and a ground-wire.

In the accompanying drawings is represented, in Figure 1, a theoretical diagram, showing a general arrangement of my improved system; and Fig. 2 is a sectional view of the device for making the connections at the central-station switch.

In the drawings, C is a switch-board at the central station, and is provided with a series of vertical conducting-strips, d to d^9, inclusive. In front of these, and crossing them transversely, but insulated therefrom, is a series of horizontal conducting-strips, $a\,a'$. Both series are arranged in pairs, and the vertical strips are permanently connected with the wires of a series of line-circuits, I', I^2, I^3, I^4, I^5, and I^6. With the exception of I^5 and I^6, these wires all extend in parallel pairs to sub-stations $S\,S'\,S^2\,S^3$. The line-wire I^5 extends as a single wire to ground at a sub-station; but at the central station, A, it is connected in the switch-board C in precisely the same manner as the terminals of the double or metallic circuits are, occupying, as they do, a pair of vertical switch-strips, d^8 and d^9. The wire I^6, leaving the switch-bar d^9, is connected with the ground at the central station.

I have in the drawings shown but one earth return-circuit combined with a series of metallic circuits; but it is well understood that any number of such circuits may readily be arranged on the same plan. I provide a double plug-connector, p, for each line-circuit, and the plugs or connectors may be constructed as shown in section in Fig. 2, and are formed of two metallic pins, f and f', completely insulated from one another, yet held mechanically together by the plate of non-conducting material e, in the middle of which is inserted the handle p'.

d and d' represent sections of the vertical bars of the switch-board, and a is a portion of a horizontal bar. As shown in Fig. 1, the metallic bars of each series are perforated at each intersection with holes for the reception of the plugs p. These holes extend through both horizontal and vertical strips, so that a pin or plug of metal inserted in any of the holes will connect together metallically at the point of intersection the horizontal and vertical bars through which it is thrust. In Fig. 2 the section is taken through the center of the hole of the left-hand vertical strip d and just above the hole in the right-hand strip d'. At the lower edge of the switch-board C are three horizontal bars, c, c', and c^2, also crossing the vertical bars, and perforated, as are the connection-bars d, for the reception of the plugs. The middle bar of the three, c', is permanently connected by the wire h with the transmitter D and telephone E, and thence to earth at G. The upper and lower bars of the three, c and c^2, are insulated, and serve merely as supports or sockets for the unoccupied leg of the plug p. All the plug-connectors of the metallic or two-wire circuits are normally placed in the position shown in the drawings as occupied by those of circuits 1 and 4, while the plugs of single or ground return-circuits are normally placed in the position occupied by that of circuit No. 5. Thus each circuit is normally connected at the central station with the transmitter D and the receiver E, the two-wire circuits by the wires w' passing through the switch-board by the right-hand bar of each pair, and the horizontal bar c', and the single-line circuits by their only line-wire entering the switch-board by the left-hand vertical bar of each pair.

It will be seen from the foregoing description that the plugs of the metallic circuits are invariably placed when at rest on the cross-bars c and c', and the plugs of the single or grounded circuits are under the same conditions placed on the cross-bars c' and c^2. It is obvious that by this arrangement the metallic circuits can be readily distinguished from the grounded circuits by means of the higher level on the switch-board at which their plugs are normally placed. Immediately above the three strips $c\,c'\,c^2$ are two other horizontal conducting-bars, $b\,b'$. The upper bar, b, of this pair is permanently attached to a wire, g, leading to a battery or other source of electricity, l, through a circuit-closing key, k, and the lower bar, b', is insulated, serving only the same purpose as the bars c and c^2 in the lower series—viz., to support the unoccupied leg of the plug-connector.

I may, if I so elect, dispense with the key and connect the battery directly with the bar b; or I may insert in lieu of or in addition to the said key a pole-changer or current-reverser. I may also use any form of magneto-electric generator in place of the battery l, if I find it advisable so to do.

The plugs *p* of circuits 2 and 3 are represented as being placed upon the same pair of horizontal plugs, *a a'*, thus connecting their respective line-circuits together for oral intercommunication.

The instrumentalities at each of the metallic-circuit sub-stations S S' S² S³ are identical in character and operation, each one being a duplicate of the others. Such being the case I have shown but one—that one at station S.

The apparatus used at the sub-stations connected with the single or earth return-circuits may be of any desired character, and therefore, forming no part of my invention, need not here be particularly described.

I will now describe the apparatus at the station S. It consists of a base-board, B, upon which is supported a signaling-bell, *m*, a telephone-transmitter, C', and a pair of keys, *n* and *o*. A receiving-telephone, T, is also provided, which may, when not in use, be placed wherever desired. The key *n* is a strap-key, and when pressed makes contact with two contact-pieces, *s* and *s'*. The key *o*, also a strap-key, is also provided with two contact-pieces, *t* and *t'*, with which it makes contact when pressed, and has in addition to these a bridge-piece, *r'*, forming a back contact or limit, against which, when at rest, it presses by its own resiliency. As hereinbefore indicated, one of the two wires connecting the sub-station with the central station is normally open at the latter point. This wire *w* is at the central station connected with the left-hand vertical strip of any pair, from which it extends outward till, reaching the sub-station S, it enters the apparatus at a binding-screw, makes permanent connection with the key *o*, and by means of the bridge or back contact *r* and wire w^6 it reaches one terminal of the bell-magnet *m*, and, passing through the magnet *m* and wire w^8, terminates at the ground G, forming a line between the central station and the sub-station, normally open at the former and closed to earth at the latter after passing through the bell-magnet coils. This wire is used alone when the central station desires to signal the sub-station, and when this operation is to be performed the plug *p* is taken from its normal position on the horizontal bars *c* and placed on the bars *b b'*, as indicated by the dotted lines, circuit 1. This operation opens wire *w'* and connects wire *w* with the cross-bar *b*, and this being electrically connected with the wire *g* and key *k*, when the said key is pressed the circuit of the battery *l* is closed to line, and its current, traversing the wire *w*, causes the bell *m* to ring, giving the signal. The second wire of each pair, *w'*, is in diametrical opposition to the first, normally open at the sub-station, and closed at the central station. Entering the central station, the wire *w'* is attached to the right-hand bar *d'* of its pair. This bar, by means of the plug *p*, is normally connected with the cross-bar *c'*, and by the wire *h* and through the telephonic transmitter D and receiver E to earth. Its course, after leaving the central station, is over wire *w'* till it arrives at the sub-station S, thence through telephone T, secondary coil of transmitter C, thence to the main stem of strap-key *n*, when it is normally open. When communication with the central office is desired the subscriber presses the key *n*, causing it to make contact with the two contact-pieces *s* and *s'*. The contact of the key *n* with the contact-piece *s'* completes the circuit of the telephone-wire *w'* to earth, and the contact of the same key with the piece *s* closes the circuit of the transmitter-battery *u* through wire u^4, primary coil of transmitter C, wire *u'*, key *n*, contact *s*, wire w^3, and wire w^4 back to the other pole of the battery. The transmitter C is vitalized by the closing of the battery *u*, and the subscriber, continuing to press the key *n*, speaks into the transmitter and gives his order for connection with the desired sub-station. The central-station attendant or operator, who is presumed to be constantly listening for calls at the telephone E, responds to the call and takes the order, making the necessary circuit-changes. The left-hand contact-piece *t* of the key *o* is connected by the wire w^2 with the key *n*, while the right-hand contact-piece *t'* is connected with an extension of the local-battery wire w^4. When the key *o* is pressed the following disposition of circuits is made. The wire *w* is severed from its normal continuation through the bell *m*, and is by means of the key *o*, contact *t*, and wire w^2, connected with the open end of the wire *w'*, the two wires *w* and *w'* thus forming a temporary loop, which includes the sub-station telephones, and the primary or battery circuit is closed by the contact made between the two contact-pieces *t* and *t'* across the metal of the key *o*. Hence the transmitter C is vitalized by the closing of its battery-circuit whenever either key is depressed.

The line as then constituted between the central and sub station is traced from the point *d* at the switch-board over line-wire *w*, key *o*, contact *t*, key *n*, secondary coil of transmitter C, by wire w^5, out by wire w^7 to telephone T, thence by wire *w'* back to the central station at *d'*. Here it is capable of connection with a similar loop-circuit, I³—for example, by placing the plugs of each of two circuits to be connected upon the same pair of horizontal bars, *a* and *a'*, as shown in circuits 2 and 3, which are thus connected. The circuit from d^2, continued downward by the vertical bar, is connected by the plug *p* with the cross-bar *a* to the left-hand bar d^4 of circuit 3, thence over the wire to the sub-station, back to the central station by the parallel wire to right-hand switch-bar d^5, downward to plug *p* and cross-bar *a'*, thence to left-hand bar d^3 of circuit 2, over the line to sub-station S', and back by parallel wire again to d^2; and the two stations, when talking to one another, will be connected by a continuous metallic or ring circuit consisting of two pairs of vertical switch-bars, one pair of horizontal switch-bars, a parallel pair of line-wires to each sub-station, and at the sub-stations the key *o* and contact *t* joining the normally separated

ends of the two wires. By the use of the ring-circuit the effects of inductive interference, which are otherwise troublesome, are eliminated.

To effect the same result where a double line is to be connected with a single line and obtain for such a combination all the advantage resulting from a ring circuit, I have shown such a circuit starting from the earth at sub-station S^4, proceeding over the single line l^5, switch-board bar d^8, plug p, to a normal connection through the central-office telephones to earth. Any preferred form of station apparatus may be used in connection with the said line l^5 at the sub-station S^4. The parallel bar d^9 is permanently connected at the central office with the ground-wire l^6, and at its lower end is normally insulated; but when the circuit is to be connected with a metallic circuit—for example, with No. 2—the plugs of both circuits are placed upon the same pair of parallel bars, a a'. This brings into operation the parallel strip d^9 and its ground-connection l^6 and places the circuit No. 5 in a position to be connected with the metallic circuit No. 2 upon equal terms. When so connected the compound circuit, starting from the earth at sub-station S^4, is over wire l^5, switch-bar d^8, plug p, cross-bar a, plug p, switch-bar d^2, line l^2 to sub-station S', back by parallel wire to switch-bar d^9 and wire l^6, to ground at central station. In operation this method of working is as follows: S wants to talk with S'. He presses key n. This completes the talking-circuit wire w' and closes the local circuit. He then says S wants S'. The operator listening at the telephone E at central office repeats the order, and then puts the plug of 2 on the battery-bars b b' and presses his key k. This sends electrical currents over the wire w of circuits 2 to the sub-station S^2 and rings the bell there. The respective plugs p of circuits 1 and 2 are then both placed on the same pair of strips, a a'. Both sub station operators press their key o and converse.

I claim as my invention—

1. In a telephone-exchange system, a central station, a series of sub-stations, a series of lines extending between the central stations and each of a portion of the sub-stations, each line of the series consisting of two parallel wires, a series of single line-wires extending between the central station and other sub-stations, means at the central station whereby any of the pairs of line-wires may be connected as a loop with any other pair or with any single line, means at the several sub-stations connected with the paired lines whereby signals may be received upon one wire or transmitted upon the other, and connecting devices at the sub-stations whereby the two terminals of the said parallel wires may be connected together to form a metallic loop including the sub-station telephones, all in combination, and substantially as described.

2. The combination, in a telephone-exchange system substantially as hereinbefore described, of a central station, sub-stations, two line-wires extending between the central station and each sub-station, parallel with but normally separated and insulated from one another, one of the said wires being normally adapted by means of devices controlled by the central station for the transmission of alarm-signals to the sub-stations, and the other being normally adapted for the transmission of articulate speech between the central and sub stations by means of devices at the sub-stations controlling such transmission, separate devices at the sub-stations adapted to connect the parallel wires together in a continuous loop, a single-line and ground wire, and switching devices at the central station for connecting the parallel wires from any sub-station with those of any other pair or with said single-line and ground wire, for the purposes set forth.

3. In a telephone-exchange system, the combination of a central station and a sub-station or series thereof, line-wires in pairs extending between the central station and the sub-stations, signal-receiving devices at the sub-station and signal-transmitting devices at the central station connected with one wire of each pair, and telephonic instruments at both termini, but under the control of the sub-station connected with the other wire of each pair, whereby the sub-station is signaled over one wire exclusively and articulate speech between the central station and the sub-station is maintained over the other wire, a circuit-changer at the sub-station adapted to sever the signal-wire from the signal-receiving devices and connect it with the telephone-wire to form a loop, and switching devices at the central station adapted to connect the ends of the said loop with the ends of any other loop, or with a single-line wire and a ground-wire, as described, and for the purposes set forth.

4. In a telephone exchange system, the combination of a series of subscribers' lines, consisting in part of metallic or looped circuits and in part of single or earth return-circuits, with a central-station switch-board constructed, substantially as described, with intersecting vertical and horizontal conducting-bars and double connectors adapted to connect by one motion any pair of vertical bars to any pair of horizontal bars at the intersecting point, and circuit-changing apparatus at the sub-stations located on the line of the metallic circuits, whereby the two lines composing the metallic circuit are operated separately or as one circuit, for the purpose specified.

5. In a system of telephonic communication, the combination, substantially as hereinbefore described, of a switch-board having its line and connecting bars or strips arranged in pairs and provided with double plug-connectors, one for each circuit, circuit-wires extending in pairs from the said switch-board to a series of sub-stations, one wire of each pair being normally open at the central station and closed at the sub-station and the other closed at the central station and open at the sub-station, and

circuit-changing apparatus at the said sub-stations adapted to connect the ends of the two circuit-wires and form thereof a looped circuit including the sub-station telephones, substantially as described.

6. A line-wire extending between a central station and a sub-station, normally open at the central station and closed through a signaling-instrument at the sub-station, signaling devices at the central station, and means for connecting the open end of said line-wire with said signaling devices, combined with a second line-wire extended in parallelism to the first, but normally separate and insulated therefrom, and connected with telephones and the earth at the central station, but open at the sub-station, and means for connecting the open terminal of the second line-wire, through the sub-station telephones, with the earth or in metallic circuit with the first wire, substantially as and for the purpose specified.

7. The combination, at a sub-station of a telephone exchange system, of a main line having in its circuit the sub-station telephone or telephones, and terminating in two normally-open branches, with a second main line normally connected with a branch circuit to earth through a signal-instrument, and means, as indicated, whereby it is severed from the said branch circuit and transferred to one of the open branches of the first main line, substantially as described.

8. The combination, at a sub-station of a telephone-exchange system, of a main line extending from the central station, having in its circuit the sub-station telephones, and terminating in two normally-open branches, one of which is a key, a second main line, also extending from the central station and normally connected with a branch circuit to earth through a signal-instrument, a local-battery circuit normally open, and circuit-changing keys, one for each wire, whereby when one of the said keys is pressed the main line through the telephones is closed to earth and the local-battery circuit completed, and when the other key is pressed the two lines are connected together as a loop, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 13th day of May, 1882.

W. W. JACQUES.

Witnesses:
J. H. CHEEVER,
GEO. WILLIS PIERCE.