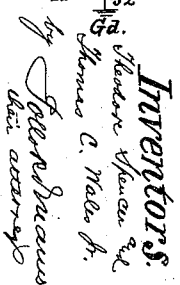


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UNITED STATES PATENT OFFICE.

THEODORE SPENCER, OF CAMBRIDGE, AND THOMAS C. WALES, JR., OF BOSTON, ASSIGNORS TO THE AMERICAN BELL TELEPHONE COMPANY, OF BOSTON, MASSACHUSETTS.

MULTIPLE-SWITCHBOARD SYSTEM.

SPECIFICATION forming part of Letters Patent No. 551,056, dated December 10, 1895.

Application filed March 18, 1895. Serial No. 542,218. (No model.)

To all whom it may concern:

Be it known that we, THEODORE SPENCER, residing at Cambridge, in the county of Middlesex, and THOMAS C. WALES, Jr., residing at Boston, in the county of Suffolk, State of Massachusetts, have invented certain Improvements in Multiple-Switchboard Systems, of which the following is a specification.

This invention relates to multiple switchboards for telephone-exchanges or central stations and to the species illustrated and described in Letters Patent of the United States No. 252,576, granted to Leroy B. Firman, January 17, 1882, in which the main circuits from the sub-stations pass to the several switchboard-sections and are represented on the said sections by independent normally-discontinuous branch terminals in the form of plug-sockets. We associate with this form of switchboard means whereby the subscribers at the sub-stations can call the operator at the central station and whereby the said subscribers' transmitting-telephones are rendered operative, such means consisting of a source or generator of electricity located at the central station in circuit with and common to all of the sub-station circuits connected thereto. A telephone interconnecting system illustrating such means is shown in United States Patent No. 528,040, granted to Theodore Spencer October 23, 1894. In this patent, however, separate generators of electricity are used for calling and conversational purposes.

In the modern telephone-exchange all of the circuits are carried through the central office with double wires or conductors, and the sub-station circuits connected therewith may be either of double or metallic conductors or of grounded conductors. We provide for both kinds of circuits. The conductors thereof extend through the several sections of the switchboard with normally-open branch terminals in a socket at each section, each conductor being connected through a separate coil of the line-annunciator in such manner that the annunciator is operated by means of one coil only, the other coil being magnetically inoperative but present to preserve the balance of the circuit, the said conductors terminating at the opposite poles of a gener-

ator of electricity common to all of the sub-station conductors.

When any sub-station wishes to call the central station, the telephone is removed from its hook, which act closes the circuit of the common generator of electricity, and the operating-coil of the line-annunciator being energized, its target is displayed. The insertion of one of a pair of looping-plugs into the answering-jack of the circuit closes a local battery-circuit through a third coil of the line-annunciator and resets the said annunciator, and by means of a suitable bridging-key the operator's telephone apparatus is brought into circuit with the sub-station. We associate between the cords of each pair of looping-plugs an amplification of the means shown in United States Patent No. 474,323, granted to H. V. Hayes May 3, 1892, for energizing the transmitting-telephones at the sub-stations and for repeating from one sub-station circuit into another.

The local battery-circuit by means of which the annunciator is reset forms a portion of the test-circuit and has branches to each jack-socket of the same sub-station circuit at each section of the switchboard, and also has a connection with one pole of the said common generator of electricity, and when the tip of the test-plug of a pair of looping-plugs is in contact with the test-ring of the socket of a called circuit, if the circuit is busy the usual click is heard inductively in the operator's telephone.

The invention also relates to a form of line-annunciator having three coils, located end to end, two of the coils being connected in with the circuit-conductors, one in each conductor, forming a balance, but only one of them is in a position to operate the annunciator, the third coil serving to automatically reset the annunciator.

The open terminal multiple switchboard, provided with a common generator of electricity for sub-station calling and conversational purposes, represents the latest improvement in interconnecting systems, and in introducing it at places where the ordinary system is in use, in which each sub-station is provided with independent call-sending appli-

ances and an independent transmitter-battery is employed, the change in the sub-station apparatus is of necessity made gradually, all new sub-stations being fitted as they are opened with the more modern devices, while the apparatus at the older sub-stations is replaced by the newer forms whenever found convenient. To meet this transition stage, we have shown herein an arrangement of the circuits and apparatus whereby such sub-stations as are provided with magneto-generators for actuating the line-annunciators, and with independent local batteries for energizing the telephone-transmitters, may still use these appliances, and obtain service through the central-office circuits described herein, all of which we will now proceed to describe and specifically point out.

In the drawings which form part of this specification, Figure 1 is a diagram illustrative of the invention, showing schematically a central office A, to which are connected the sub-stations C and D, arranged to be operated by means of a centralized generator of electricity, and a third sub-station B, provided with a local means for calling and speaking. Fig. 2 is a diagram to illustrate the method of testing, and Fig. 3 is a longitudinal section of the line-annunciator employed in connection with the invention.

A designates so much of the central office as is necessary to show the workings of the invention, and consists in the apparatus shown, comprising a pair of looping cords and plugs P P², having their sleeves connected by wires 11 and 12 through two windings i^3 and i^4 , of a repeating-coil I, and their tips connected together by the wires 10, 15, 14, and 13 through two windings i and i^2 of the repeating-coil I. An electric generator G is connected in between the points 16 and 17, to which the windings i i^2 and i^3 i^4 are also respectively connected. We may wind the four helices i i^2 i^3 i^4 upon one core, one over the other, or we may employ two separate repeating-coils consisting of two helices or windings only.

The ringing and listening keys being well known and standard appliances are not shown.

Contacts 21 and 22, connected at the ends of wire 18, bridging the wires 15 and 11, (but shown as not touching said wires,) indicate that the operator's telephones t and m may be connected in, the wire 18, including winding i^7 of induction-coil P², receiving telephone t and condenser 20.

The battery k and transmitter m are bridged in between the primary windings i^3 and i^4 of the coil P², and i^{10} is a secondary winding included in wires 23 and 24, which include the telephone t in a local circuit.

Conductors 25 and 26 extend from points 16 and 17, respectively, and form continuations from the poles of the generator G to the double conductors 30 and 31 of the sub-station circuits C and D, the former represent-

ing a grounded line and the latter a complete metallic circuit. At each sub-station, when the telephone is on its hook, a circuit is completed through a high-resistance bell r , and when the telephone is detached from its hook a circuit is completed through the telephones m and t . Each conductor 30 comes to each section of the switchboard by branches c , which terminate in tip-springs 2, and each conductor 31 comes to each section by branches d , which terminate in rings y , both the springs and rings being in a socket. The conductor 30 extends through the coil e of the line-annunciator E and connects with the conductor 25, and the conductor 31 extends through the coil f upon the same core and connects with conductor 26.

The locking-coil g of the line-annunciator is connected on one side by wire 6 with the springs 3 and by wire 5 with the test-rings z of each socket and from its other side by wires 50, 39, and 7 to the springs 1 of each socket, including the testing-battery p . From a point 28 on the wire 50 a wire 27 extends to the upper pole of the common generator G. Between the tips of both plugs P and P² may be placed the automatic clearing-out annunciators or signals h and h^2 , similar to those described in Patent No. 536,104, granted March 19, 1895, upon the application of Theodore Spencer.

Fig. 3 is a longitudinal section of the line-annunciator, consisting of two soft-iron cores 40 and 43, provided with brass or other non-magnetic metal ends or partitions 41 and 42, joined end to end in any suitable manner, inclosed in a soft-iron sheath 45, having a head 33 integral therewith. The core 40 is wound with two coils f and e , separated by a soft-iron washer or partition 44, the end of the coil e being closed by a hard-rubber washer 46.

47 is an armature pivoted at 48 and provided with an arm 34, which extends to the opposite end of the annunciator and terminates in a hook, as usual. A pivoted shutter 35 and a pivoted catch 49 for the same are provided in a well-known manner. As there is a complete metallic envelope constituting a magnetic circuit around the coil f by reason of the core 40, the washer 44, and the outer sheath 45, the coil has no magnetic effect upon the armature, its office being to preserve the balance of the circuit, the coil e operating the armature 47.

The operation of the invention is as follows: When the subscriber at a sub-station wishes to converse with another sub-station, the telephone t is removed from its hook, which rises and makes a circuit through its back contact with the wire s , shunting the high resistance of the bell r . Current from the common generator G circulates in the circuit and through coil e of the line-annunciator, causing the shutter 35 to be displayed. The operator introduces the answering-plug into the answering jack or socket of the circuit, the tip of

the plug making contact with the open terminal spring 2 of conductor 30 and the sleeve making contact with the ring y , connected to the other circuit-conductor 31, and also with the ring z , connected with the test-circuit, and the metal ring of the plug unites the open springs 1 and 3 of the local circuit, including the battery p and the coil g of the line-annunciator, energizing its core and attracting and holding the shutter 35 thereto, thus resetting the same. We now have a circuit from one pole of generator G through winding i of coil I, wires 15 and 10 to tip of plug P , spring 2 of the subscriber's jack, wires c and 30 to the sub-station, returning by wire 31 and branch d to ring y , thence by sleeve of plug P , wire 11, and winding i^3 of the repeating-coil I to the other pole of the generator G . As the current from the generator G is now flowing in the circuit thus established, the sub-station transmitter m^2 can be used for conversation. The operator having connected in the telephones m and t the circuit wanted by the subscriber is ascertained. The tip of the plug P^2 is now placed in contact with the test-ring z of the called circuit, and if busy a "click" is heard in the operator's telephone t , and if not busy no sound is heard. Referring to Fig. 2, which shows the operator's outfit and the test-circuit, with the answering-plug inserted in a socket and the test-plug in contact with the test-ring of the called circuit, it will be seen that when the operator's receiving-telephone is connected in between the cord-conductors and when the tip of the test-plug is in contact with the test-ring of the called circuit a local circuit is established from one pole of the battery p by wire 27, winding i^2 of induction-coil I, wire 13, tip of plug P^2 , test-ring z , wire 5 to spring 3, across the uniting metal contact of one of the looping-plugs in the called line to the spring 1, and by wire 39 to the opposite pole of the battery p , and the sudden rush of current through this local circuit from battery p induces in the winding i a current of the opposite sign or polarity and occasions a disturbance in the condenser 20, in the local circuit including the generator G , windings i i^3 of the induction-coil I, wires 10 and 11, and the wire between the contacts 21 and 22, which produces the click in the operator's telephone. If the desired line is found by the application of this test to be not in use, the operator inserts plug P^2 into its socket and by means of the usual ringing-key and continuously-operating call-generator (not shown in the drawings) sends to line a current sufficient to operate the high-resistance bell r , as will be understood, and when the called subscriber removes his telephone from the hook, shunting his call-bell, a talking-circuit is established between the two connected subscribers. We have already traced one side of this circuit through generator G and the windings i i^3 of repeating-coil I. The circuit of the called subscriber now has a section in com-

mon with that of the calling subscriber—to wit, that portion of the circuit which is between the points 16 and 17 and which includes the generator G . The circuit of the called subscriber, beginning at point 16, is as follows: winding i^2 of coil I, wires 14 13 to tip of plug P^2 , thence by spring 2 of the spring-jack of the called subscriber, branch c , and wire 30 to his station, returning by wire 31 and branch d to ring y of the plug-socket. The circuit continues from this point by wire 12 and winding i^4 of the repeating-coil to point 17 on the other side of generator G , which completes the circuit. In this compound circuit the windings i i^3 of the repeating-coil are in the circuit of one subscriber and the windings i^2 i^4 in the circuit of the other subscriber, the two circuits being thus connected inductively for conversation purposes, while the battery is in a section common to the two circuits.

When at either of the connected sub-stations the telephone is returned to its hook, the circuit is closed through the high-resistance bell r , which is substantially like opening the circuit, owing to the high resistance of the coils of the bell, (about five thousand ohms,) and the clearing-out signal h or h^2 is operated to notify the operator to disconnect. The said clearing-out signal will preferably be of the kind illustrated in Fig. 6 of Patent No. 536,104 already referred to. So long as the talking-circuit is closed the signal-plate is withdrawn from view; but when the circuit is opened by hanging the telephone on its hook the signal-plate is automatically displayed, giving the signal to disconnect.

B indicates a sub-station provided with a magneto-generator 70 in a normally-open bridge 71, a high-resistance call-bell 72 in a closed bridge 73, and telephones in normally-open terminals of the conductors a b . At the central station conductor a is closed to conductor b through the coils e and f of the line-annunciator E , which are joined to each other at 9, and conductor a ends in open terminal springs 2 and conductor b in rings y in each socket j . The wires 7 and 8 extend from the opposite poles of the battery p and include the locking-coil g of the line-annunciator and terminate in the springs 3 and in springs 1 and test-ring z , respectively, the locking and testing circuit being the same in arrangement and operation as in sub-station circuits C and D . The line-annunciator E is the same as used at the sub-stations C and D , except that the coils f and e are united, and operating the generator 70 causes its shutter to fall in the usual manner. In this combination of common battery and magneto-generator circuits there is provided a separate clearing-out annunciator for the latter class between each pair of cords and plugs, which can be operated by the magneto-generator 70, as shown in Fig. 1. n is the annunciator in a closed local circuit 19 and is in inductive relation to the induction-coil I by means of the

windings i^5 i^6 , and its operation will be readily understood.

By the above means both classes of circuits can be interconnected and disconnected with facility, the same test system being used for both, and when a magneto-generator circuit is changed to a common battery-circuit the same line-annunciators can be used, the coils f and g being placed in separate circuits, as described, and the temporary clearing-out annunciators n be removed altogether. Where it is specified in the description and claims that the circuit of generator G is normally open at the subscribers' stations, it is meant that the circuit is practically and properly regarded as open until the telephone is removed from its support, the resistance of bell r being such that no appreciable current from the generator can pass through the branch w .

Having fully described our invention, we claim—

1. Two telephone circuits, each extending from a substation to the same central station and completed or closed through a section of conductor common to both, which common conductor includes an electrical generator, and a repeating coil having two sections respectively interposed between the opposite poles of said generator and the two conductors of the said circuits, each section having one of its windings included in each of the said two circuits, respectively.

2. Two telephone circuits, each extending from a substation to the same central station and completed or closed through a section of conductor common to both, which common conductor includes an electrical generator, and four repeating induction coil windings interposed respectively between the two poles of said generator and the conductors of the said circuits having two of the said four windings included in each of the said two circuits, in inductive relation to the other two said windings.

3. The combination of a multiple switchboard at a central station, and two or more substations the circuit conductors of which are provided with normally open terminals at each section of the switchboard and are closed through a common generator of electricity at the central station; with looping cords and plugs bridged by a conductor which includes the said common generator and a repeating coil whose windings are interposed between the poles of the generator and the two conductors of the said cords, and included therein.

4. The combination of a multiple switchboard at a central station, and two or more substations, the circuit conductors of which are provided with normally open terminals at each section of the switchboard and are closed through a common generator of electricity at the central station; with looping cords and plugs bridged by a conductor which includes the said common generator, and a

repeating coil, divided into four windings, interposed between the two poles of the said generator and the conductors of the said cords, the windings being included in the said cord conductors.

5. The combination of a central station and a substation the conductors of which are normally open at the substation and closed through a generator of electricity at the central station; a line annunciator having two coils, one being included in each conductor of the circuit, one coil being magnetically inoperative, and means at the substation including the telephone circuit switch for automatically closing the circuit to send the call signal.

6. The combination of a multiple switchboard at a central station, and two or more substations, the circuit conductors of which are normally open at the substations and provided with normally open terminals at each section of the switch-board, and closed through a common generator of electricity at the central station; with line annunciators having three coils one being included in each conductor of the circuit (one of which coils is magnetically inoperative) the third coil being included in a normally open locking circuit having two open terminals at each section of the switchboard and a battery.

7. The combination of a multiple switchboard at a central station and a substation the circuit conductors of which are normally open at the substation and provided with normally open terminals at each section of the switchboard and closed through a generator of electricity at the central station; with a line annunciator having three coils one being included in each conductor of the circuit, (one of which coils is magnetically inoperative,) the third coil being included in a normally open locking circuit having two open terminals at each section of the switchboard and a battery, and means at the central station, consisting of a plug, for closing the open terminals in the locking circuit at any section of the switchboard.

8. An annunciator consisting of two bobbins having soft iron cores separated by a non magnetic partition; one bobbin being divided by a magnetic partition, and wound with two coils, the other bobbin having one coil; both bobbins inclosed in a soft iron sheath closed at one end, its opposite end being closed by an insulating ring; and a pivoted armature having a hook or catch upon its extremity to engage a pivoted signal shutter.

9. The combination of a switchboard at a central station and two or more substations whose circuit conductors extend to each section of the switchboard and are provided there with open switching terminals, the said circuits including a common generator of electricity at the central station; a plurality of pairs of looping cords and plugs having a bridge conductor between the conductors of each pair of cords including the said common generator of electricity and a repeating coil

as set forth; and an operator's telephone in inductive relation with said repeating coil and with a normally open local test circuit including a battery; adapted to be closed by the insertion of a plug of one pair of cords and the test plug of another pair of cords.

10. The combination of a multiple switchboard at a central station, and two or more substations, the circuit conductors of which are provided with normally open terminals at each section of the switchboard and are closed through a common generator of electricity at the central station; a local test circuit for each substation circuit including two open terminals at each switch board section and a battery with a branch connection to one pole of said common generator; means for closing said two open terminals at any switch-board section to complete the test circuit and for placing the operator's telephone in inductive relation thereto said means consisting of looping cords and plugs bridged by a conductor which includes the said common generator and a repeating coil whose windings are interposed between the poles of the generator and the two conductors of the said cords and are included therein; and a conductor bridged between the two conductors of the said cords including a condenser and the operator's telephone.

11. The combination substantially as hereinbefore described of a series of main telephone circuits converging from a number of substations to a central station; a branch terminal multiple switch-board at said central stations with which the said main telephone circuits are associated; a common generator connected directly in such circuits normally as a source of signaling currents; and in bridge or derived circuit with any two united circuits as a source of voice currents, and a repeating induction coil associated with said battery and adapted to be placed in circuit with said two united substation lines, substantially as described.

12. The combination in a telephone exchange system with a branch terminal multiple switchboard; of a source of current common to a number of circuits, and supplying current for both signaling and for conversation when two subscribers' circuits are connected, and a repeating induction coil adapted to be placed in circuit with two connected substation lines, substantially as described.

13. In combination with a switchboard at a central station and a plurality of circuits ex-

tending therefrom to substations; of a local test circuit for each substation circuit including two open terminals at each switchboard section and a battery, with a branch connection to one pole of a common generator, means for closing said open terminals at any switchboard section to complete the test circuit and for placing the operator's telephone in inductive relation thereto, said means consisting of looping cords and plugs the conductors of which are bridged by a conductor which includes the said common generator and a repeating coil whose windings are interposed between the poles of the said generator and the two conductors of the said cords and are included therein; and a conductor bridged in between the said two conductors of the said cords including a condenser and the operator's telephone.

14. The combination of a multiple switchboard at a central station and a plurality of substations whose circuit conductors extend to each section of the switchboard and are provided there with open switching terminals, a part of the substation circuits being closed through a common generator of electricity at the central station, and the remainder closed through their line annunciators; of a plurality of pairs of looping cords and plugs having a bridge conductor between the conductors of each pair of cords including the said common generator of electricity and a repeating coil as set forth; and an operator's telephone adapted to be placed in inductive relation with the said repeating coils and with a normally open test circuit including a battery, adapted to be closed by the insertion of a plug of one pair of cords and the test plug of another pair of cords.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 14th day of March, 1895.

THEODORE SPENCER.

Witnesses:

HORACE D. REEVE,
JOHN C. STEVENS.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 8th day of March, 1895.

THOMAS C. WALES, JR.

Witnesses:

THOMAS H. LOCKWOOD,
GEO. WILLIS PIERCE.