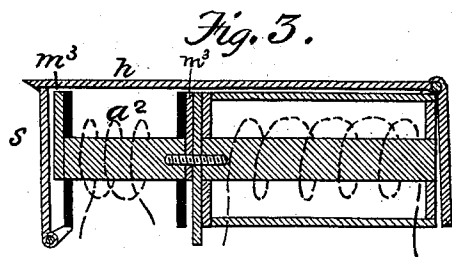
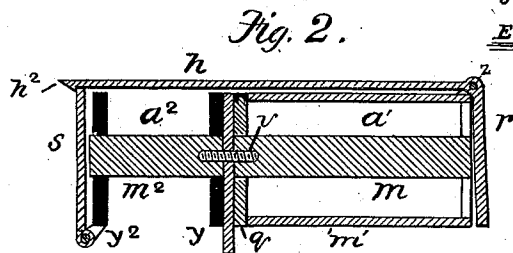
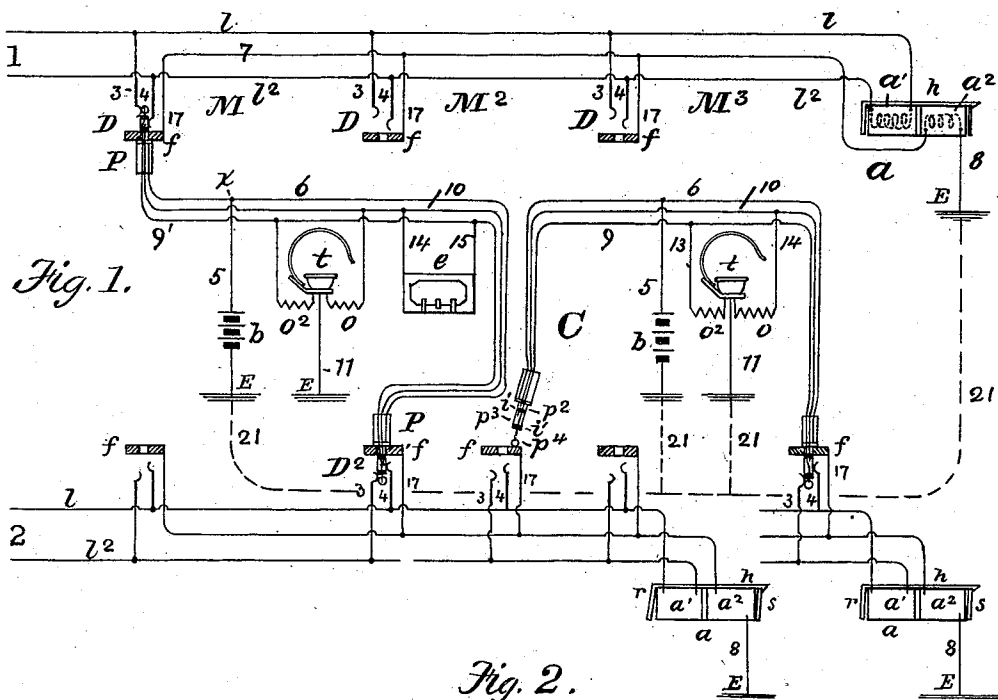


(No Model.)

F. W. DUNBAR & E. S. C. MAY.
SWITCHBOARD CIRCUIT AND SIGNALING APPARATUS.

No. 509,367.

Patented Nov. 28, 1893.



Witnesses.
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UNITED STATES PATENT OFFICE.

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SWITCHBOARD-CIRCUIT AND SIGNALING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 509,367, dated November 28, 1893.

Application filed March 7, 1892. Serial No. 424,080. (No model.)

To all whom it may concern:

Be it known that we, FRANCIS W. DUNBAR and EDMUND S. C. MAY, both residing at Newark, in the county of Essex and State of New Jersey, have invented certain Improvements in Switchboard-Circuits and Signaling Apparatus, of which the following is a specification.

This invention concerns multiple switchboards; and briefly stated, its object is to provide a switchboard for the central office of a telephone exchange in which each substation circuit shall be represented at the several sections by normally discontinuous branches which through the intermediation of suitable link connectors with terminal plugs may be united for through communication with the similar terminals of any other like circuit connected with the switchboard. Each substation circuit, in a manner well understood, is provided at the central station with a call indicating annunciator located at some one of the switchboard sections, it being a matter of common practice to divide the annunciators of the several circuits among the several sections so that the calls of a given number of circuits are answered at each section. But as all lines have plug socket terminals at all sections, the circuit whose call is answerable at but one section, may be united to another circuit with which communication is desired, at the same section where the call was received, without regard to the location of the call annunciator of such called circuit.

It has been customary to so arrange the circuits in multiple switchboards that the several circuit conductors in passing through the several sections were led successively through separable springjack contacts disposed in series in the circuit; and when so arranged it is obvious that the insertion of a plug connector into any springjack would not only bring about the connection of the conductor attached to said plug to the line represented by the contact spring of the jack in question, but would also (inasmuch as it would lift the said spring from its normal contact) break the original circuit through the switchboard, thereby disconnecting the call annunciator from the circuit. But in view of the expense of construction involved in the em-

ployment of such a multitude of springjacks as were required, and also with the purpose of dispensing with the necessity of having a large number of variable contacts in series in the circuit (each of which experience has demonstrated provides the nucleus for a possible fault) it has become desirable to dispense with the serially arranged springjacks, and to adopt the normally discontinuous branch terminals in the plug sockets, to which reference was made in the initial paragraph of this specification.

It is obvious when switchboards are constructed upon the branch terminal plan, that some special construction must be adopted to open the original circuit through the call annunciator, disconnecting the latter; or else to so arrange that the original circuit may without detriment to through communication remain closed, in which case a special construction of the call annunciator is required, whereby it shall be prevented from adversely affecting the operation of the circuit; and whereby it shall be made practically irresponsive to disconnecting signals coming in from the substation. Several modes of doing this have been devised, our invention not being broadly new in this respect. For the purpose of providing that the call annunciator employed shall not act as a short circuiter from one side of the circuit to another, during the transmission of voice currents, which have a high rate of change, we adopt the well known expedient of constructing it in such a way that it shall have a high coefficient of self induction; as is likewise done with the helices of the "clearing out" or disconnecting annunciator, which also during through communication is bridged between the direct and return circuits of the main telephone circuit. But to achieve the object of our invention we provide the call annunciator with two helices, one of which is in the main circuit and made active by the circulation of the calling currents; while the other is in a normally incomplete electric circuit, which is completed by the act of inserting a plug connector into any plug socket of the circuit to which the particular annunciator belongs, and which thereupon energizes the magnetizable core of the

extra helix, setting up a steady magnetization therein, and enabling the said core thereupon to hold the drop shutter in place, preventing it from being responsive to any call currents which may come in, or which are sent out as long as the circuit remains closed; which of course is as long as the plug remains in the socket. This is brought about by uniting one of the terminals of the extra helix with one pole of the battery or other generator, and by extending a conductor from its other terminal to all of the plug sockets of the circuit to which the annunciator belongs, branching it to a connection with the several metal frame-pieces of each. The connecting plug each have three conducting surfaces insulated from each other, two of which correspond with the two main circuit branch terminals, while the third is adapted to make contact with the socket frame piece. This third contact surface of the plug is in permanent union through a suitable conductor with the second pole of the generator in whose circuit is the auxiliary helix of the annunciator, and thus it is, that upon the insertion of the plug a current circulates in such helix and the annunciator drop is prevented from responding to calling or clearing out currents. The shutter or its controlling armature lever is made of iron, and either may be organized to form the armature of the said auxiliary helix and to be held thereby. This extra conductor uniting the frames of the several plug sockets of each main circuit, may and preferably will serve as a portion of the busy test circuit, and at any section of the switchboard, an operator may determine whether a given line is busy at some other section by touching the tip of the plug connector to the frame piece of the socket of the line desired, which operation brings the telephone of the said operator into a derived circuit of the shutter retaining battery, and produces a well defined sound in said telephone; provided the tested line be busy; while, should said line be at liberty, there is no retaining battery connected with any of its socket frames and no such sound will be produced, so that the testing operator will know that the line is not busy.

The invention therefore comprises the provision for each circuit of a multiple switchboard, of an electromagnetic retaining device for the call annunciator which is brought into action through the act of inserting the connecting plug, and which causes attraction to be directly exercised upon the annunciator shutter or its controlling lever as long as the connecting plug remains so inserted.

In the drawings Figure 1 is a conventional diagram of the central office end of two telephone circuits, illustrative of their connections in a branch terminal multiple switchboard, and their annunciator retaining circuits. Figs. 2 and 3 are skeleton forms of two styles of annunciator either of which may be employed.

Two main circuits 1 and 2, are shown as

terminating in a central station C, where each passes through any desired number of multiple switchboard sections $M^1 M^2 M^3$ at each of which they are represented by a plug socket D having three electrical elements or contact surfaces, viz: a contact piece 3 being the branch terminal of conductor l of the circuit, a contact piece 4, forming the terminal of the conductor l^2 of the circuit, and a socket frame piece f , united by a wire 17 to a conductor 7 which extends from section to section uniting electrically all the socket frames of the same circuit. Thus each circuit has three wires through the switchboard. At some one switchboard section, each circuit is provided with a call annunciator a , having two distinct and independent electromagnetic helices a' and a^2 ; with the first of which a' only, however we are at present concerned. One of the ends of the helix a' is united to the circuit wire l , and the other to the circuit wire l^2 so that the helix a' is directly included in the said circuit. The plug socket connections 3 and 4 being branch terminals, the insertion of a plug connector does not disconnect the annunciator helix a' which consequently bridges the circuit when a connection is made with a second circuit, but the said helix having a high apparent resistance, by reason of it being constructed to present a relatively high self induction, does not practically cause a loss of working current.

Figs. 2 and 3 exhibit alternative forms of construction which may be adopted for the annunciator a ; the helices however not being shown. In Fig. 2, m is the central iron core, and m' the tubular iron casing thereof, having an end piece q . On this core and within the tube is wound the helix a' for connection with the main line circuit. The armature r is fulcrumed at z , and has secured at a right angle an armature lever h , which by a retaining hook h^2 at its end, ordinarily engages a signal shutter or drop s , keeping the same from falling and giving the signal; but is capable of disengaging itself therefrom and permitting the same to be freed from its control, when the armature r is attracted by the core m , made magnetic by the circulation round it of calling currents. Mechanically secured to the inner end of the core m , but magnetically insulated therefrom by the plate of brass or like material and the brass screw v , is a second and preferably shorter iron core m^2 formed by the cheek pieces y, y^2 which are made of any suitable material into a spool for the reception of the local helix a^2 . The signal shutter s is made of iron, and is thus susceptible to magnetic attraction. It is evident that if a steady current be caused to circulate in the helix a^2 round the core m^2 , sufficiently strong to practically magnetize the same, the iron shutter s will be attracted thereby and will be upheld, even though freed from the control of the pawl lever h by the attraction of the armature, and that there-

fore when a current is maintained through helix a^2 , calling currents sent through the helix a' will not be able to responsively actuate the annunciator.

5 The annunciator shown in Fig. 3, is of a slightly different type. In many respects the construction is similar, but the shutter s is not, or need not be, magnetic; the shorter or supplementary iron core, is provided at each end with an iron pole piece m^3 ; and the armature lever h in this case is of iron, so that it is attracted and prevented from liberating the shutter when the current flows in the auxiliary helix a^2 .

15 Referring once more to Fig. 1, the wire 7 connecting in each circuit its several plug socket frames f , extends to one end of the auxiliary helix a^2 of the annunciator a of such circuit, the other end of said helix being connected with an earth wire 8.

The two circuits 1 and 2 of the diagram are united together for conversation by a three conductor flexible cord, having plug terminal connectors P. The plug sockets D and D² which are united by these plugs are supposed of course to be located at the same switchboard section M. The plugs P correspond with the plug sockets D in that they each have upon their stem three conducting surfaces, *i. e.*, the tip p^4 to make contact with the branch terminal 3; a front sleeve surface p^3 adapted to contact with the branch terminal 4; and a rear sleeve surface p^2 , arranged to fit in the socket frame f and to make electrical contact therewith; and the said three conducting surfaces are insulated from each other by non-conducting rings i' . The three conductors which extend between each pair of plugs P, are in practice inclosed in a single flexible cord. One of them 9 unites the tip contacts p^4 of the said plugs; a second unites their front sleeve contacts p^3 , while the third 6, unites their rear sleeve contact p^2 , thereby bringing the socket frame wires 7 of any two connected lines also into connection. To any point x on the conductor 6, is joined a wire 5 leading from a generator b , such as a battery of necessary strength, and the other pole of said generator is connected to earth or to an omnibus return to which the several earth wires of the helices a^2 would in that case also be united. Since the conductor 6 is thus connected as described with the said generator b , it follows first that when the plug, or plugs, which terminate the said conductor are inserted into line sockets, as shown, and their conducting surfaces p^2 are thus caused to make contact with the socket frame, the current of said generator will split at the point x , substantially equal parts flowing each way over the conductors 7 through the auxiliary helices a^2 of the annunciators a and to earth or return conductor. The cores m^2 of such auxiliary helices are both thereby vitalized, and the signal shutters s are forcibly held up and prevented from falling (regardless of their engagement

by, or disengagement from the armature lever h) by magnetic attraction exerted either directly upon the shutter itself or upon the controlling lever thereof, as hereinbefore described; and second, that under the same conditions, all of the socket frames f of the line or lines concerned, have their potential altered by the electro motive force of said generator b and are brought into a state of charge; so that when a circuit is completed from any of the said socket frames, a signal may be received upon any suitable device arranged within such completed circuit; and this fact may be utilized as a busy test.

The first of the above recited facts is made available as follows:—A clearing out or disconnecting annunciator e is looped across between each pair of connecting conductors 9 and 10 by wires 14 and 15. This as well as the helix a' of the call annunciator are both during a conversation connection between two lines included in derived circuits of the said two lines, but by being arranged to have a maximum self-induction, their apparent resistance is so high as presented to the high rate of change of voice currents, that there is no material loss due to their presence.

At the conclusion of a conversation it is desirable that a ring off signal shall be sent from the substation, and that the clearing out annunciator shall be responsive, but that the call annunciator shall be perfectly irresponsive thereto. The call signals having relatively a low rate of change do in fact operate the clearing out drop e and give the disconnecting signal; but the line drop a , whether at the same or another switchboard section, does not respond, because the magnetization of the auxiliary helix a^2 by the steady current of the generator prevents the fall of the shutter s .

The second of the above facts is made available as follows: Each switchboard section has an operator's telephone t , usually as shown fitted for headwear. For certain purposes not germane to this invention, it is provided with two helices which are connected for the sake of a perfect balance between the two halves o and o^2 of the secondary helix of a transmitter induction coil. To a point central between the said two helices, or if the telephone t has but one, from a point at the center thereof, an earth wire 11 is connected. The telephone loop is also, as in the case of the "clearing out annunciator," bridged across the two main conductors 9 and 10 of the connecting cord. To ascertain whether any line is busy the operator having in response to a call, inserted one plug of a pair into a socket of the calling line and having received the order orally, now proceeds to test the line wanted, by touching one of its socket frames with the tip of the other plug of the pair. Should the tested line be busy, the said socket frame is charged as before explained, and a current will flow therefrom by way of the plug tip p^4 , conductor 9, tele-

phone branch wire 13 or 14 according to which plug is used, induction coil helix o^2 and o , and one half of telephone helix, to earth wire 11, and earth or return; causing the telephone to emit a characteristic sound which is heard by the operator and which indicates the busy condition of the line. But if the line be at liberty, the touched socket frame not being connected with the battery b is not charged, no such current will flow, and no sound will be heard in the telephone, and the operator knowing therefore that the line is not busy, at once inserts the plug, and perfects the connection. One generator b may of course be used for a number of connection cords; this being a matter largely dependent upon the internal resistance of the generator which in storage cells for example is very low. The common return wire to which reference has been made is indicated by the broken lines 21.

Although for the sake of facility of illustration metallic circuit lines only are shown, it is equally applicable to a mixed system of metallic and earth completed lines; the test circuit being purely local and entirely insulated from the main circuits.

In practice of course the connections of the operator's telephone and clearing out annunciator bridge loops are both controlled by suitable cam switches, there being one annunciator for each pair of cords, and but one telephone for a number of such cords; but we have not thought it necessary to show such appliances and connections, since they are not necessary to a full understanding of the invention and it is sufficient to say that during the progress of a connection the annunciator bridge is invariably connected, while the telephone is connected only during supervision.

Having now fully described our invention, we claim—

1. The combination with each main circuit of a call annunciator having two helices, one included permanently in the main circuit, and adapted, when energized, to give the signal, and the other included with a source of electricity in a normally discontinuous local circuit arranged to be completed by the act of inserting a plug connector in any plug socket of said main line and to remain closed so long as such plug occupies its socket, said second helix acting during such time to oppose and neutralize the action of the first helix and prevent the signal from being given; substantially as described.

2. In a switchboard apparatus, the combination of a main circuit branching from its conductors to terminal contacts in each of a series of plug sockets; an auxiliary conductor uniting the several conducting frames of the plug sockets of said main circuits; plug connectors at each switchboard section, each provided with contact terminals arranged to connect with the main line socket terminals, and auxiliary or socket-frame terminals of

any plug socket when inserted therein; conductors attached to said plug, one for each of the contact terminals thereof; an electrical generator united by one of its poles with that one of said conductors which upon the insertion of the plug connects with the socket frame, the remaining pole thereof being connected to earth, or to the said auxiliary frame-uniting switchboard conductor; and a compound call annunciator having a helix in the main circuit provided with a magnetizable core, and an armature adapted to be attracted thereby, and to display the call signal, and an auxiliary helix in circuit with the auxiliary frame-uniting conductor, provided also with a core adapted to act in opposition to that of the main helix, and to withhold the signal; whereby the insertion of the said plug in any socket is enabled to attach a connection to the main circuit in parallel with the main annunciator helix, and to simultaneously close the local battery circuit through the auxiliary annunciator helix, substantially as described.

3. The combination in a multiple switchboard apparatus, of a compound call annunciator having two independent electromagnetic helices each with its own core, one of which when energized tends to release a drop and give signal; the other when energized tending to maintain the drop in place and to withhold the signal; a main line circuit extending to branch terminal contacts in plug sockets one at each switchboard section, and permanently closed through the main or signal actuating annunciator helix; a normally open or discontinuous auxiliary circuit associated with each main circuit including the auxiliary or signal preventing helix; and a plug connector adapted for insertion into the main circuit plug sockets, and having contact surfaces registering with the corresponding surfaces of said sockets; the said contact surfaces respectively being terminals of link conductors adapted to connect with the main circuit branch terminals, and of a completing conductor leading from an electrical generator and arranged to close the said auxiliary circuit and to energize the said auxiliary helix as long as the plug remains inserted the said plug being attached to the said conductors, substantially as described.

4. The combination of a closed circuit; a normally discontinuous circuit, both being connected with the same plug sockets; an annunciator having an electromagnet permanently included in said closed circuit, and an armature therefor, which when attracted disengages a signal shutter permitting the same to fall and give the signal, and having also an auxiliary electro magnet included in said normally discontinuous circuit, the said magnet having for its armature the signal shutter or the disengaging lever thereof, and acting when energized to attract the same, and to prevent the signal from being given; a battery, or equivalent source of steady current; and a

plug connector adapted for insertion in the
said plug sockets, forming when inserted
therein a circuit changer for the closed circuit,
and a circuit closer for the said normally dis-
5 continuous circuit, closing the same through
the said battery, and thereby exciting the said
auxiliary electromagnet.

In testimony whereof we have signed our

names to this specification, in the presence of
two subscribing witnesses, this 3d day of 10
March, 1892.

FRANCIS W. DUNBAR.

EDMUND S. C. MAY.

Witnesses:

F. DE LYSLE SMITH,

EDWARD W. BELL.