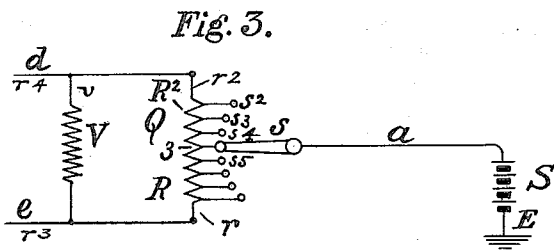
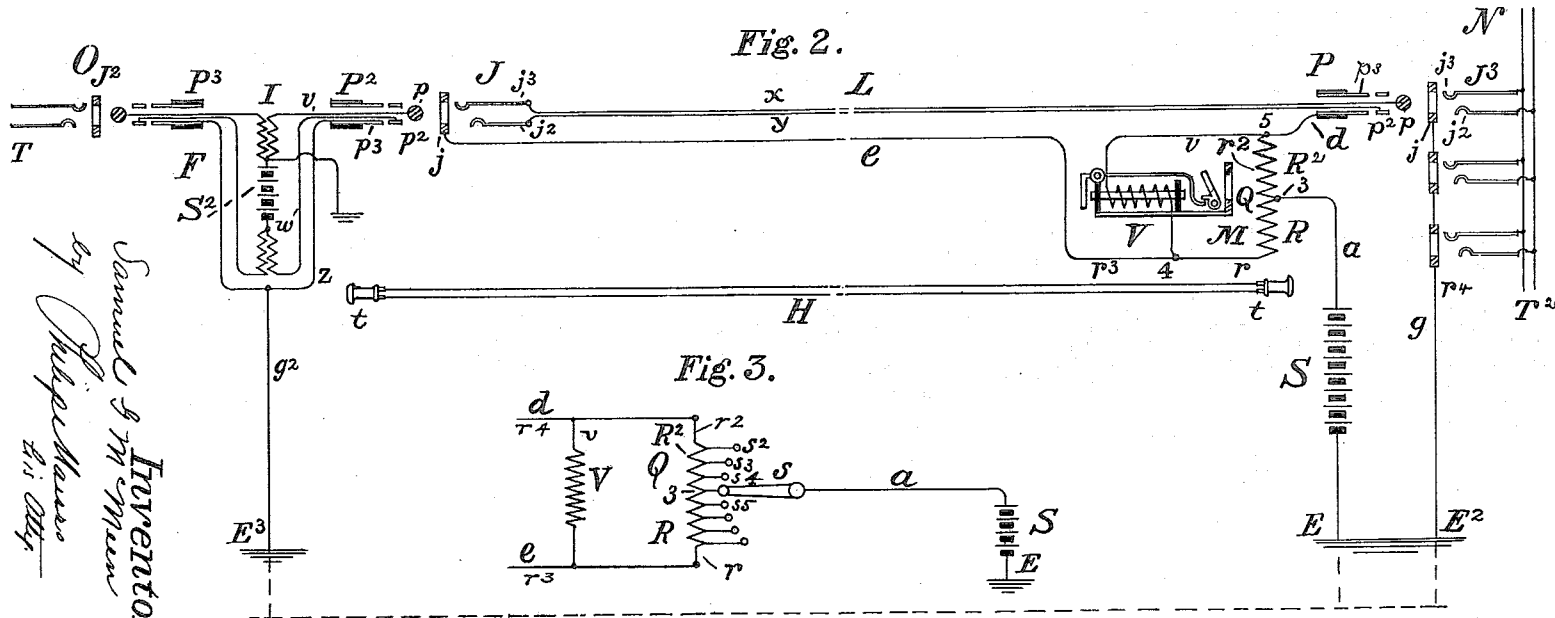
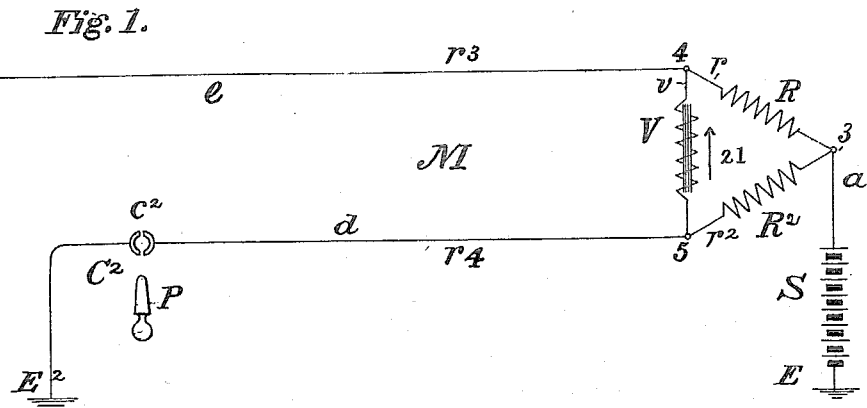


Patented Jan. 2, 1900.

TELEPHONE CENTRAL STATION APPARATUS AND CIRCUITS.

(Application filed July 31, 1899.)



Attest
Your true
W. S. Johnson

Samuel & M^{rs} Mann
by Philip Mann
A's Attys

UNITED STATES PATENT OFFICE.

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TELEPHONE CENTRAL-STATION APPARATUS AND CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 640,404, dated January 2, 1900.

Application filed July 31, 1899. Serial No. 725,645. (No model.)

To all whom it may concern:

Be it known that I, SAMUEL G. McMEEN, residing at Chicago, in the county of Cook and State of Illinois, have invented certain Improvements in Telephone Central-Station Apparatus and Circuits, of which the following is a specification.

This invention relates to telephone central-station apparatus and circuits, and in particular to trunk-circuits extending between central-station switchboards for the interconnection of subscribers' circuits terminating in the said switchboards, respectively, and to signaling-circuits associated with such trunks for the convenient interchange of instructions concerning their manipulation.

Prior to my invention trunk-circuits or circuit-sections have been extensively employed for the interconnection of telephones centering at different switchboards, such switchboards in some cases being in the same office and sometimes in different offices. Moreover, it is not broadly new to associate with the trunk-circuit a signaling-circuit controlled by the operation of the trunk-circuit switch devices and adapted to indicate by the display of its signal or signals at one switchboard the condition of the trunk connection at either switchboard, or both. Furthermore, the said signaling-circuit has in some instances been formed from one or both of the conductors of the trunk-circuit and in others has been formed of entirely separate and independent conductors.

The object of my present invention is to provide a trunk-line circuit or circuit connection extending between two switchboards in the same or different central stations with an independent signaling-circuit, which while adapted for automatic operation and while organized to be operated by the act of making switch connections and disconnections of the trunk-conductors shall be characterized by great simplicity in construction and operation and shall be effectual and certain in result.

My invention assumes two switchboards, to each of which are connected a number of subscribers' or "service" telephone-lines and a double conductor trunk-line extending between them. The said trunk-line has

switch devices at both ends whereby it may be connected with two telephone-circuits centering at, and provided also with complementary switch devices at, their respective switchboards.

In practice trunk-lines are arranged on the double-track plan, and that end of a trunk connecting with the line which has called for another is termed the "outgoing" end, while the end of the said trunk which is or is to be united to the line called for is termed the "incoming" end. It follows that the same trunk-circuit which at one switchboard is an outgoing trunk is at another switchboard an incoming trunk.

Preferably the switch device at the outgoing end of the trunk-circuit is a switch-socket or spring-jack and the switch device at the incoming end a switch-plug. Thus at the switchboard which has the outgoing end of the trunk there is placed an intermediate switch cord and plug connection, and one terminal plug thereof is placed in the socket of the calling-line and the other in the socket of the trunk; but since the other end of the trunk itself terminates in a plug no such intermediate connection is there necessary, and to establish a connection between the trunk and any telephone-line the plug of the former may be inserted directly in the socket of the latter. In either case, however, the plugs and sockets are provided with suitable registering contacts for their respective main-line conductors. This organization in my invention is associated with an independent signaling-circuit which extends between the switching devices of the two ends of the trunk-line and is provided in each with a suitable circuit-closer. Thus in the preferred plan a third conducting-surface or switch-contact piece representing one end of the signaling-circuit is carried by the terminal plug at the incoming end of the trunk-line and is adapted to register and connect with the test-rings or socket-frames of any switch-socket of any line, and as all of the said sockets are grounded it follows that the insertion of the plug in the socket of any line not only unites the trunk with such line, but also grounds that end of the signaling-circuit. Similarly a third contact-surface of the regular cord-connection

plug at the outgoing end of the trunk is permanently grounded, and the socket-frame or test-ring of the said trunk forms the fixed terminal of the signaling-circuit and is electrically united thereby to the signal-circuit plug-conductor at the incoming end. Thus the insertion of the connection-plug in the trunk-socket at the outgoing end of the said trunk establishes connection between the trunk and the main cord-conductors and as at the other end grounds or closes the signaling-circuit. The structure may properly be described by saying that the signaling-circuit is normally open at both switchboards and is provided with circuit-closers in and operated automatically by the trunk-circuit-switching devices.

At the incoming end of the trunk I place in the signaling-circuit a suitable resistance-coil or like device, and from the center thereof is extended an earth conductor, a convenient source of signaling-current, such as a primary or secondary chemical battery, being connected in the circuit thereof. Finally, I provide a signal device and connect the same in a bridge or shunt around the resistance device, the said resistance and signal devices being thus connected in parallel. It will be seen that this organization is a Wheatstones balance or bridge system, wherein the earth extension containing the generator is or may be regarded as the main conductor, which divides at the center of the resistance device, two branches or balancing-arms of the system in series containing, respectively, one-half of the said resistance and the circuit-closer of the incoming trunk-end switch devices, the other two balancing-arms of the system in series containing, respectively, the remaining portion of the resistance and the circuit-closer of the switch devices at the outgoing end of the trunk, and the bridge or cross-wire containing the signal device.

It must of course be understood that in lieu of the several earth connections a return-wire conductor may be employed.

In the drawings which accompany this specification, Figure 1 is a theoretical diagram illustrating the principle of the invention. Fig. 2 is a diagram showing its application to the trunk-line and connections of a telephone-exchange, and Fig. 3 is a diagram of a detail of the resistances Q and an adjusting device therefor.

In the figures, L is a trunk-circuit or circuit-section extending between two switchboards O and N, to which any number of substation-lines T¹ and T² (represented by switch-sockets J² at O and J³ at N) may converge. This trunk-line L is shown as terminating at O in a switch-socket J and at N in a switch-plug P, and its two main conductors *x* and *y* connect, respectively, in the socket at O with contact-springs *j*² *j*³ and in the plug at N with the tip contact-piece *p* and forward sleeve contact-piece *p*². The said trunk-circuit is employed for the establishment of in-

tercommunication between the substation-circuits entering the switchboards O and N, respectively, on calls originating at the substations whose lines connect with O. It therefore is an "outgoing trunk" at O and an "incoming trunk" at N.

At switchboard O the operators are, as usual, supplied with any necessary number of switch-cord connections. F represents such a connection and has terminal switch-plugs P² P³, whose tip and forward sleeve conducting-contacts *p* *p*² are united, respectively, by conductors *v*¹ and *w*¹, the source of current S² employed in common battery systems being, as is customary, bridged between the said conductors and the regular repeating-coil I being also associated with the said conductors and having its four windings arranged, two on each side of the said source, in a manner well understood. The two contact-pieces *p* *p*² of the plug P² engage when the said plug is inserted in the trunk-socket J with the contacts *j*² *j*³ thereof, and the same is the case with the similar contacts of the plug P³ and the socket J² of telephone-line T.

At switchboard N the trunk may be connected directly with any of the telephone-lines T² by inserting its terminal plug P into the switch-sockets J³ of the desired line, when the contact-pieces *p* *p*² of the said plug will register with the contact-pieces *j*² *j*³ of the socket. Thus when the telephone-line T centering at O shall have been united to the outgoing end of the trunk by inserting one plug P³ of the connection-cord into its switch-socket J² and the other, P², into the trunk switch-socket J, and when also at switchboard N the trunk-plug P is inserted in the socket J³ of telephone-line T², through communication is established between the said two lines. The plugs P² P³ at switchboard O are each furnished with a third contact-piece *p*³, adapted to register with the test-rings or conducting socket-frames of their respective sockets, and the said contact-pieces are united to a cord-conductor *z*, which connects by the earth connection *g*² with the ground or other return E³. The test-rings or socket-frames *j* of the line switch-sockets J³ at switchboard N are also grounded by wire G, which extends to earth at E².

Associated with the trunk-circuit is a signaling-circuit M, arranged as a Wheatstone balance or bridge system, one portion of which, *e*, extends from switchboard N to the switchboard O, while another portion, *d*, is wholly at switchboard N. Fig. 1 illustrates the principle on which the said signaling-circuit is constructed and operated. M is the circuit as a whole, which, beginning at E, is provided with a battery or any suitable source of current in its main conductor *a*. At the point 3 the circuit splits into two branches *e* and *d*, extending, respectively, to the same return-conductor at points E² and E³, through circuit-closers C and C², which, as indicated, may comprise plug-sockets *c* and *c*², in which the branches *e* and *d*

are normally open, and plugs adapted to be inserted in such sockets and when so inserted to close the said branches by uniting the two parts of their sockets conductively. The plug of circuit-closer C^2 is marked P and that of circuit-closer C is marked P^2 for the purpose of identifying them with the trunk and connection cord-plugs P and P^2 , as indicated in Fig. 2. Between points 4 and 5 of the conductors e and d is extended a bridge or cross-wire v , an indicating device V being connected therein, and the establishment of the said bridge divides the conductors e and d each into two balancing arms or branches, one on each side of the points 4 and 5 of the bridge connection. The balancing branch r extends from the point of divergence 3 to the bridge junction 4, and its companion branch r^3 in serial connection therewith extends to the return-conductor at E^3 . Similarly the balancing branch r^2 extends from point 3 to the bridge junction 5 and is in serial connection with its companion r^4 , which reaches the return-conductor at E^2 . Resistance-coils or like devices R and R^2 , which in ordinary cases are equal, or substantially so, in magnitude, are connected in the conductors r and r^2 . As long as both circuit-closers C and C^2 are unoperated, so as to leave both of the conductors r^3 and r^4 open, there will be no current through the bridge, because there will be no current in the system, and if both circuit-closers are operated and their conductors both closed there will be no current in the bridge, and consequently no operation of the instrument V contained in the bridge, because in that case the system is balanced; but if the circuit-closer C alone be operated to close its circuit a current will pass through the bridge in the direction of the arrow 21 and will be indicated by the instrument V , because the potential is higher at the point 5 than it is at the point 4, or if circuit-closer C^2 is operated alone and the branch r^4 only closed a current will also flow through the bridge, but this time in the opposite direction, and will again produce an indication upon the instrument V , the potential being now higher at 4 than at 5.

It will be seen that each factor of the arrangement of Fig. 1 has its prototype in Fig. 2. The source of current S is connected in the conductor a at switchboard N , having one of its poles connected to ground at E and the other connected by the said conductor a to the center 3 of the resistance device Q , which by such central connection is divided into two substantially equal parts R and R^2 , contained in and constituting the two resistance branches r and r^2 of a Wheatstone balance system M . One of these branches, r , is continued by the main-signal conductor e to the ground or return connection E^3 at the switchboard O , through the socket frame or ring j of the trunk switch-socket, the rear switch-contact p^3 of the plug P^2 , (which together

form the circuit-closer C), and the conductor z , and the said main conductor is thus made to constitute the branch r^3 of the balance. The other resistance branch r^2 is serially extended as conductor d to the rear sleeve-contact p^3 of the trunk switch-plug P , and when the same is inserted in the switch-socket J^3 of any telephone-line T^2 by way of the conducting-frame j of such socket and its connecting-wire g to earth E^2 or to the return-conductor, to which one pole of the generator S is attached, the conductor p^3 of plug P and the socket-ring j of socket J^3 form the circuit-closer C^2 of this branch, which becomes the balancing-arm r^4 of the Wheatstone system.

The bridge or cross-wire v , as in Fig. 1, is extended from a point 4 between the arms r and r^3 to a point 5 between the arms r^2 and r^4 , and in it is included the supervisory and disconnecting signaling device V , which, as shown, may be an electromagnetic instrument having an armature acting through a lever when attracted to cause the appearance of a signal disk or shutter.

H is an instruction or order circuit extending between the switchboards O and N and furnished at each with an operator's telephone t .

In the operation of this system it is assumed that a call has been received at switchboard O from line T , that the operator at O has answered the same by inserting the plug P^3 in the socket of the calling-line, has received the order in the usual way, and finds that a line T^2 , terminating at switchboard N , is wanted. She selects an outgoing trunk L and at once switches it to the calling-line by placing the companion plug P^2 in the trunk switch-socket, this action at the same time operating to close the main branch of the signaling-circuit by grounding the conductor e through the said plug, its rear sleeve contact-piece, and the wire g^2 . The branch r^3 of the Wheatstone balance thus has its resistance reduced from infinity to a very low figure. A difference of potential is established through the bridge at switchboard N , and the signal device V is operated, displaying the signal to the operator at N . At the same time the operator at O informs N through the instruction-circuit or otherwise of the number of the line wanted, and the latter is thus informed that she is required to unite a given line with that particular trunk whose signal has been displayed. The operator at N places the plug P of the trunk in question in a switch-socket of the said wanted line, and since by doing so she closes the conductor d to ground by way of the contact-piece p^3 of said plug, the socket-frames j of the sockets J^3 , and the conductor g the balance is restored, since the balancing-arm r^4 of the Wheatstone system now has its resistance equally reduced, and the signal disappearing remains withdrawn as long as the plugs P and P^2 continue in their respective sockets. If, however, the

plug at N during the pendency of the connection be withdrawn by inadvertence or misapprehension, the operator will immediately be warned by the reappearance of the signal, because such withdrawal at once determines a difference of potential between the ends of the bridge which contains the signal. When by reason of the communication having been completed the operator at O withdraws the plug P², the reverse operation of the circuit-closer in removing the ground connection from conductor *d* will be promptly manifested by the display of signal V, which is now a signal for disconnection, and when the plug P is withdrawn and disconnection thereby effected the signal will again disappear, and the trunk will be ready for another communication.

If the switchboards O and N, between which the trunk-line L is extended, are in the same central station, the resistances of the two branches *r*³ and *r*⁴ will be about equal and will afford a balance when both branches are closed without any apparatus additional to that which has been described. If, however, the said switchboards are in different stations a considerable distance apart, the resistance of the arm *r*³ of the balance, which contains the main conductor *e*, is likely to be decidedly higher than that of the arm *r*⁴, which reaches its ground at the station of the incoming trunk, and is thus a comparatively short conductor. In this case it will be found advisable to employ in association with the resistance Q some such adjusting appliance as is shown in Fig. 3, where instead of connecting the generator-wire *a* directly and permanently to the center 3 of the resistance it is attached to a switch *s*, which may be moved to points *s*² *s*³ *s*⁴ *s*⁵, &c., so as to readjust the distribution of the said resistance between the balancing-arms *r* and *r*² as may be found advisable or necessary to obtain a balance when both of the arms *r*³ and *r*⁴ are closed by their respective circuit-closers.

I claim as my invention—

1. In a telephone-exchange apparatus, the combination with a trunk-circuit extending between two switchboards and provided at each with switch devices; of an independent signaling-circuit normally open at both switchboards and arranged as a Wheatstone balance or bridge system, comprising a source of signaling-current, two circuit-closers controlled by the switch devices at the two switchboards respectively of the said trunk-circuit and each placed in a different balancing arm or branch of the said Wheatstone balance, and a supervisory signal device at one of the said switchboards in the bridge or cross-wire of said balance; substantially as set forth.

2. In a telephone-exchange system, the combination of a trunk-circuit extending between two switchboards and provided with terminal switch devices at both; of an asso-

ciate signaling-circuit normally open at both switchboards, arranged in the form of a Wheatstone balance, and comprising a source of signaling-current in the main conductor thereof, two closed branches diverging from said main conductor, and containing each a resistance device, two normally-open branches each in series with one of the said closed branches extending to ground through circuit-closers associated with the switch devices of the trunk-circuit at the two switchboards respectively, and a bridge between the junctions of the said serially-connected open and closed branches, containing a supervisory signal at one of the said switchboards; whereby the said signal is enabled to remain quiescent when the circuit-closer branches are both open or both closed, and is made responsive to the closing of either when the other is open, or the opening of either when the other is closed.

3. The combination in a telephone-exchange apparatus, of a trunk-circuit, and an associate signaling-circuit, both extending between two switchboards; switch-terminal devices controlling both circuits at each switchboard; complementary switch devices at both switchboards adapted to register with those of the trunk and signaling circuits to form a through-circuit of said trunk-circuit and any two telephone-lines terminating at the said switchboards respectively, and to ground both ends of the signaling-circuit; with a resistance device interposed in the said signaling-circuit at one switchboard; a source of current grounded at one pole and connected by the other to the center of said resistance; and a supervisory signal in a bridge or branch conductor connected in parallel to the said resistance; substantially as hereinbefore described.

4. The combination in a telephone-exchange apparatus, of a trunk-circuit, and an associate signaling-circuit extending between two switchboards; a switch-socket at one, and a switch-plug at the other of said switchboards, containing or comprising switch-terminals of both circuits; a plug-and-cord connection at the switchboard where is placed the switch-socket end of said circuits, the plug thereof being adapted for insertion into said socket, and thereupon to switch the trunk-circuit to the main conductors of its own cord, and to ground one end of the signaling-circuit; and telephone-line switch-sockets at the other switchboard adapted to receive the terminal plug of said trunk and signaling circuits, and thereupon to connect the trunk-circuit to the line represented by such sockets, and to ground the other end of the said signaling-circuit; with a resistance device interposed in the said signaling-circuit at its plug-terminal switchboard; a source of signaling-current having one of its poles grounded and the other united to the middle point of said resistance; a bridge or branch conductor unit-

ing the two ends of the said resistance device, and constituting a shunt therefor; and a supervisory signal contained in said bridge, substantially as and for the purposes specified.

two subscribing witnesses, this 24th day of July, 1899.

SAMUEL G. McMEEN.

Witnesses:

WILLIAM J. MAIDER,
HARRY H. ROBINSON.

In testimony whereof I have signed my name to this specification, in the presence of