No. 657,315. Patented Sept. 4, 1900.

D. S. HULFISH.

TELEPHONE SWITCHING APPARATUS.

(Application filed Apr. 12, 1900.)

(No Model.) 2 Sheets—Sheet 1.

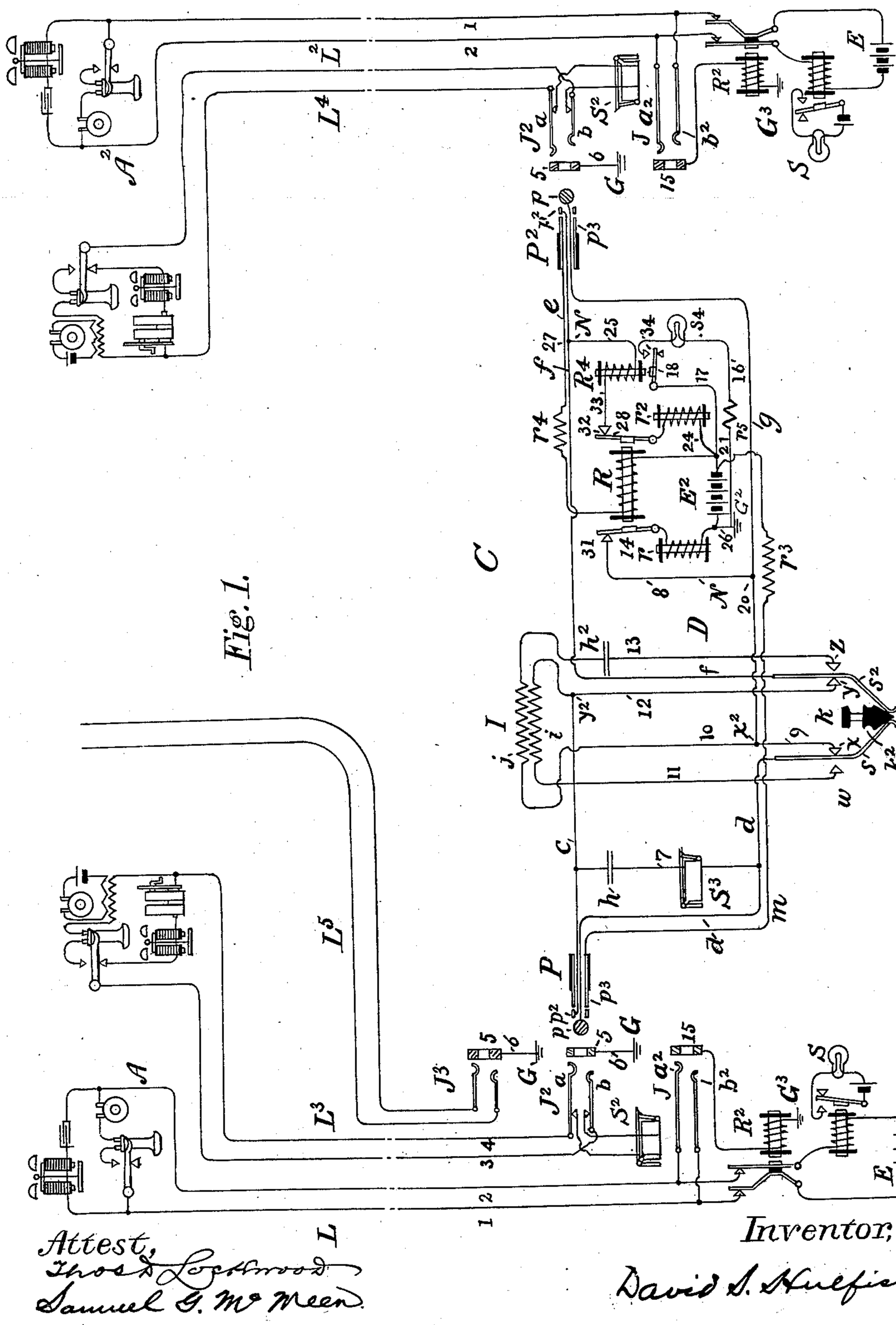

Fig. 1.

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Fig. 2.

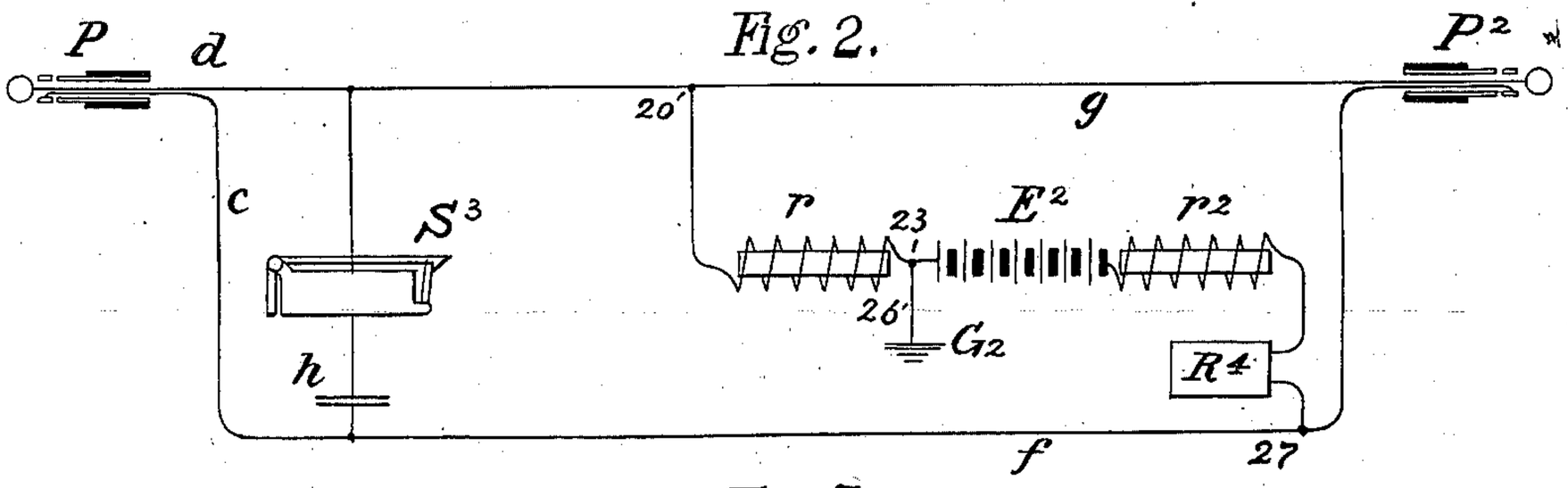


Fig. 3.

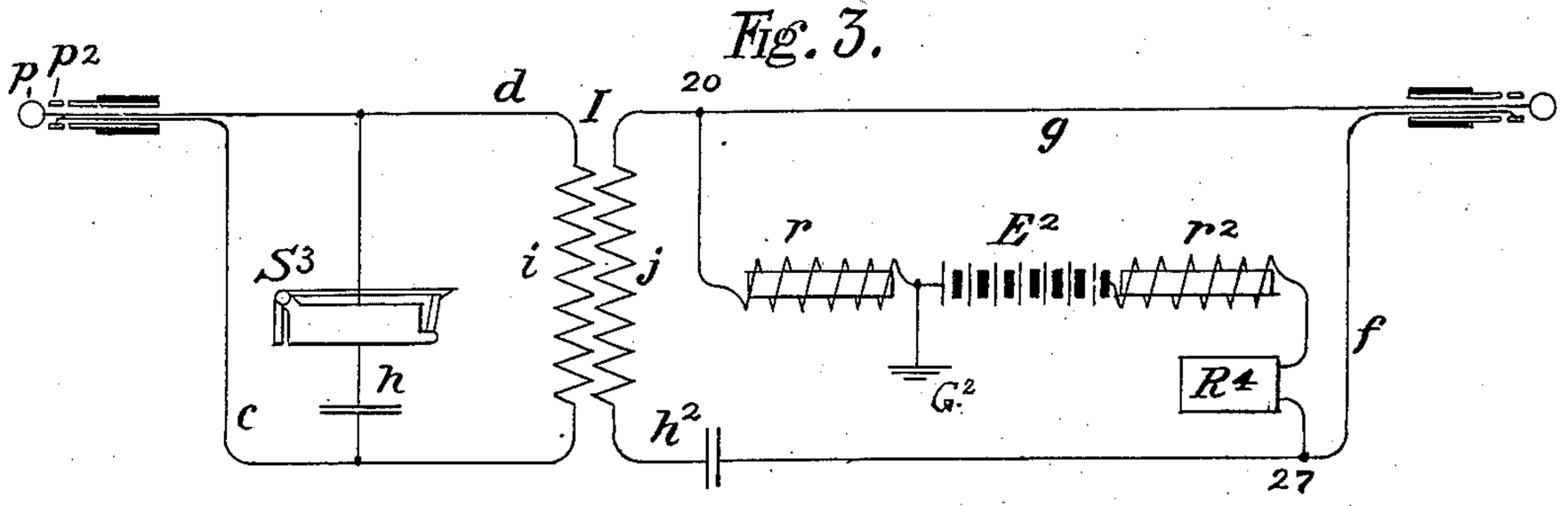


Fig. 4.

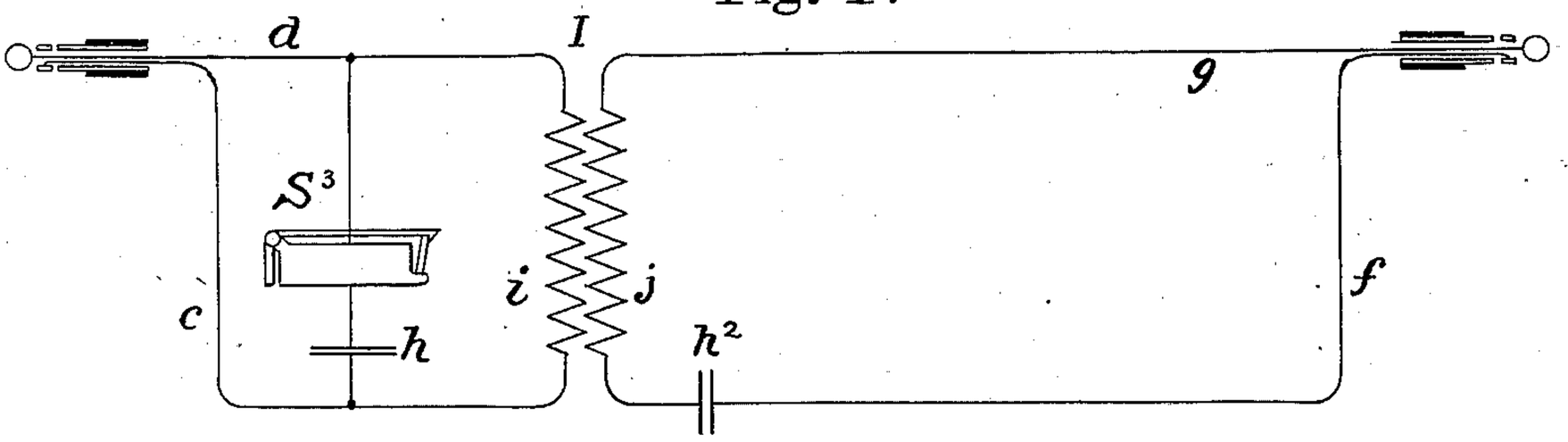
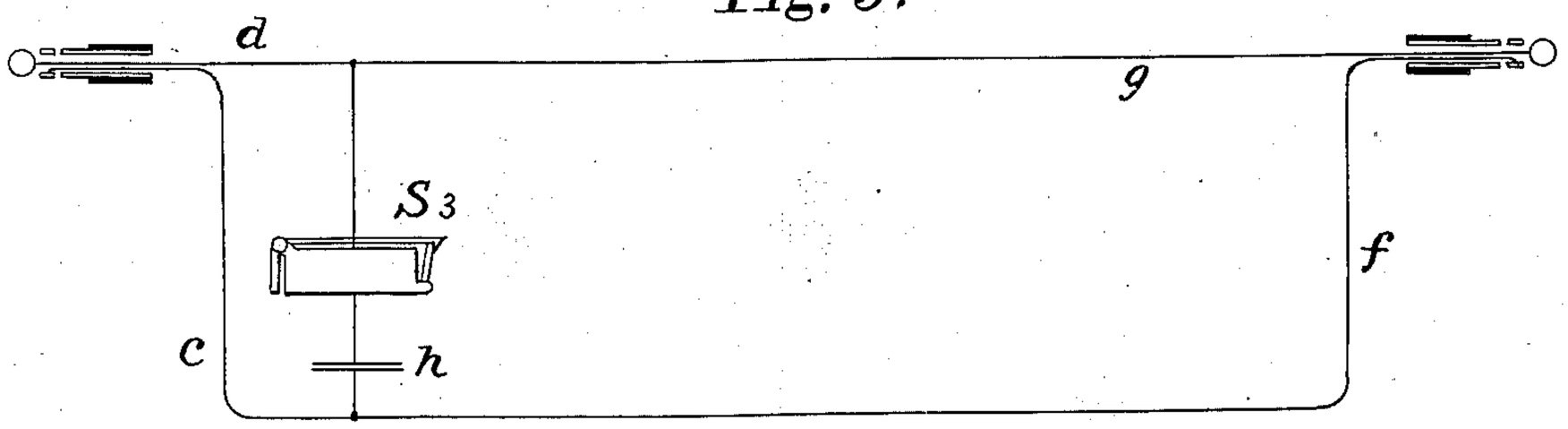


Fig. 5.



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UNITED STATES PATENT OFFICE.

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TELEPHONE SWITCHING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 657,315, dated September 4, 1900.

Application filed April 12, 1900. Serial No. 12,603. (No model.)

To all whom it may concern:

Be it known that I, DAVID S. HULFISH, residing at Chicago, in the county of Cook and State of Illinois, have invented certain Improvements in Telephone Switching Apparatus, of which the following is a specification.

In large towns and cities the telephone-exchange is divided into several central offices located at varying distances from each other which are connected to one another by trunk or toll circuits, and owing to the rapid development of telephonic service and to the improvements made in the systems employed it frequently happens that some of the substation and the toll circuits are provided with magneto-generators to operate call-bells and electromagnetic line-signals, while other substation and toll circuits are equipped with means such as a centralized or common battery for automatically operating bells and signals. When such is the case, both kinds of circuits may have their switching terminals and line-signals upon the same keyboard-sections at the central stations, and in order that the operators may make the switching connections between the terminals of the same or the diverse kind of circuits two or more kinds of linking or cord circuits have had to be furnished.

The present invention relates to special means embodied in linking or cord circuits whereby substation and toll circuits of the same kind or of diverse kinds may be connected to each other at the same section of the switchboard-table and by means of the same pairs of cords and plugs, so that the disconnecting or supervisory signals are readily operated with every possible combination of connections and without requiring switch cords and plugs of diverse character.

By means of the invention it becomes possible to connect two common-battery circuits with each other, a common-battery circuit with a magneto substation or toll circuit, or two magneto-circuits with each other, and to inductively unite the two plugs of a cord-circuit by the introduction of a repeating-coil in order that two connected circuits of the same kind may repeat into each other, and also that a magneto-circuit may be enabled to repeat into a common-battery circuit, and vice versa.

In carrying out the invention the magneto-generator circuits are provided at the central station with socket-switches and a line-signal and the test-rings of the sockets are grounded, and the common-battery circuits are provided with socket-switches, a line-signal, and also with a cut-off relay, all in the usual manner, the apparatus at the stations at the opposite ends of both kinds of circuits being of the ordinary character. It is necessary in order to effect the combination of circuits indicated that a cord-circuit shall be provided having disconnecting or supervisory signals adapted for each class or kind of circuit with means for associating the proper signals with the special combination of circuits interconnected and for operating the same and for suppressing the signals which are not appropriate for said combination, and it is also necessary to provide means whereby current from the central station may flow in the common-battery circuits to energize the transmitters located therein, also to prevent the current from passing to the magneto-circuits and to provide separate means for energizing the transmitters in the magneto-circuits, and it is also requisite that means be provided for introducing and withdrawing a repeating-coil between the conductors of the cord-circuit at the will of the operator, so that the same and diverse kinds of circuits may be conductively separated from one another, all of which relates to the within-described invention, which will now be described and claimed.

In the drawings which accompany and illustrate the specification, Figure 1 is a diagram indicating circuits of diverse character entering a central station, together with a switch-cord circuit arranged to unite any two of either or both kinds for the formation of a circuit for through communication. Figs. 2, 3, 4, and 5 are simplified representations of the main connections of the switch-cord circuit as they are respectively arranged in accordance with my invention when employed in uniting two common-battery circuits, a common-battery circuit and a magneto call-

circuit, and two magneto call-circuits, the latter arrangement being shown both with and without a repeating-coil.

L and L^2 represent common-battery telephone-circuits extending between their respective substations A A^2 and a central station C. They are provided at the substations with telephones in a normally-open bridge between the main conductors 1 and 2, and a standard call-bell in series with a condenser is connected in parallel with said telephones, as usual, the regular telephone-switch being arranged while supporting the receiving-telephone to maintain the normal discontinuity of the telephone-bridge, but to close the same when the said receiver is displaced. At the central station these lines center in a switchboard where they are fitted each with switch-sockets J, a line-signal S, and a cut-off relay R^2, each, moreover, being also in normal connection with a source of current E, such as a battery.

L^3 L^4 represent telephone-circuits of the older class, technically called "magneto-circuits," which circuits have at their substations a magneto-generator to send outgoing signals associated with their signal-receiving bells and a local battery to supply current for their transmitters, the telephone-switch in the usual manner being adapted to transfer the line-circuit between the calling appliances and telephones, according as the receiving-telephone is supported thereon or removed. These circuits also are provided with switch-sockets J^2 and have line-signals S^2, such as annunciators, in a manner well understood.

L^5 represents one terminal of a toll-circuit, a type of circuit usually operated likewise on the local-battery plan. It is provided with a switch-socket J^3 at the central station C, and its outer terminal may be fitted with either a switch-plug or a switch-socket, as preferred, at a distant central station.

In Fig. 1, D represents a switch-cord circuit comprising the elements of my invention and adapted to form an operative union between any two circuits of either type or between one circuit of either type and a second of another type, a repeating-coil being introduced between the circuits or not, as desired or as required by the conditions. The figure shows the several appliances and circuit arrangements employed in carrying out the invention for the purposes hereinbefore indicated in their normal relation to one another.

P and P^2 are the switch-plugs of ordinary structure, having a tip contact-surface p and front and rear sleeve contact-surfaces p^2 and p^3, the former of which is sometimes called the "ring." These contact-surfaces are adapted to register, respectively, with corresponding line and local circuit contact-surfaces in the plug-sockets.

S^3 is an electromagnetic supervisory signal in series with a condenser h in a bridge 7 between the front sleeve or ring conductor c and the tip conductor d of the plug P.

I is a repeating induction-coil, and k a key controlling the relation of the switch-cord conductors c and d with the terminals of the two windings of the said repeating-coil.

E^2 is the source of signaling and transmitter current and may of course be common to a number of switch-cords. It has at one pole a connection to ground G^2. Impedance or retardation coils r r^2 are placed one on each side of said source in a bridge N between the tip conductor g and front sleeve conductor f of the plug P^2.

R is a relay, which by two armatures 14 and 28 or a double armature controls the continuity of the bridge N or is adapted to close or open the same at two different points 31 and 32. A relay R^4 is included in said bridge when the same is closed and controls the operation of a supervisory signal s^4, associated with the plug P^2.

The key k has two contact-springs s s^2, which normally press, respectively, on inner contact-points x and y, but when the key is operated are separated therefrom and made to press upon outer contact-points w and z. In the former or normal condition of said key there is direct conductive continuity between the tip contact-surfaces p of the switch-plugs P and P^2 and also between the ring contact-surfaces p^2 thereof, the same being traceable as follows: between the tips p of the plugs by conductor d, key-spring s, inner contact-point x, conductor 9, junction x^2, and conductor g, and between the rings q^2 of said plugs by conductor c, junction-point y^2, conductor 12, inner contact-point y, key-spring s^2, and conductor f. The rear sleeve-contact p^3 of one of the plugs (shown as plug P^2) has a conductor e extending to the ungrounded pole of the source of current E^2 and including the exciting-coils of the relay R and the resistance r^4. The rear sleeve-contact of the other plug connects with the ungrounded pole of the battery E^2 at 21 by conductor m, which includes the resistance r^3. The object of the resistances r^3 and r^4 is to insure that the current supplied to the conductors containing them shall not exceed the appropriate strength. It is to be noted that the socket frames or glands 5 of the "magneto lines" are all connected directly by conductor 6 to earth at G, while the socket-frames 15 of the common-battery lines are connected to the ground G^3, but include in the earth-connection conductor the exciting-coils of the respective cut-off relays R^2. Indeed, the main function of the battery-connection wire m is to furnish current for the operation of the cut-off relay and to provide a busy-test potential when the switchboard is of the multiple type. The object of the condenser h in the signal-bridge 7 between the tip and ring conductors of plug P is to prevent undesired action of the signal S^3 from the current of the source E^2.

The connection of the repeating-coil I, as

hereinbefore indicated, is controlled by the key *k*. The winding *i* of the said coil terminates at one end by conductor 11 in the outer contact *w* of said key and at the other end in a junction y^2 with the ring conductor *c* of the plug P. The second winding *j* terminates at one end in the outer contact-point *z* of the key and at the other in a junction at x^2, with conductor *g* leading to the tip of plug P^2. When the key *k* is depressed, its springs *s* s^2 are separated from their normal contacts with points *x y* and form new ones with the outer points *w z*. The conductive union of the corresponding contact-surfaces of the two plugs is thus disestablished, the two conductors being respectively opened at the key-points *x* and *y*, and in place of such union a conductive loop is now formed for each plug between the tip and ring contact-surfaces thereof, the repeating-coil windings being included in the said loops respectively. Thus the two plugs and substation-circuits, in whose switch-sockets they may at any moment be inserted, may be inductively united for the transmission and exchange of conversation, while at the same time the battery-current, which may be bridged to the loop of one of the plugs, is prevented from obtaining passage to the other, the conductive connection having, as stated, been disestablished. The loop of plug P (the key having been depressed) is traceable from the tip *p* by conductor *d*, key-spring *s*, contact-point *w*, conductor 11, coil-winding *i*, junction-point y^2, and cord conductor *c* to bring the ring contact-surface p^2 of the same plug. The loop of plug P^2 similarly may be traced from the tip *p* thereof by conductor *g*, junction-point x^2, conductor 10, coil-winding *j*, condenser h^2, conductor 13, outer key-point *z*, key-spring s^2, and conductor *f* to the ring contact-surface p^2 of the same plug. These changes are simply illustrated by Figs. 2 to 5, inclusive, wherein Figs. 2 and 5 indicate the arrangement of the main-circuit conductors when connection is established between two substation-circuits, the key *k* remaining unoperated, and the two plugs consequently being conductively united, while Figs. 3 and 4 respectively represent diverse circuits and similar circuits united by the plug-circuit arrangement, when, the key *k* having been operated, the main conductors are looped to the top plugs, respectively, and the connection between the plug-loops is made inductive only.

The key may be of any well-known self-locking construction, such as the cam-key in extensive use, which when depressed will so remain until manually released, this capability being indicated by the groove k^2 in its shank, which affords a lodgment for the spring ends.

The bridge N between the main-circuit plug conductors, to which reference has previously been made as containing the source of current E^2 and the retardation-coils *r* and r^2, begins at any point 20 on cord conductor *g* and extends by conductor 8, circuit-changing points 31 of relay R, retardation-coil *r*, battery E^2, point 21, conductor 24, retardation-coil r^2, circuit-changing points 32 of relay R, conductor 33, the small relay R^4, and conductor 25 to point 27 on cord conductor *f*. Thus as long as the relay R remains unexcited the circuit-changers 31 and 32 are quiescent and the battery-bridge continues closed, supplying current to the main conductors of plug P^2 and any substation-circuit united thereto, and, provided the key *k* is unoperated, to plug P also. If, however, the said key be operated, the plug P is severed from all connection with the battery, and when the relay R becomes operative the battery is cut off from plug P^2 also. This occurs when the said plug is inserted into the socket J^2 of one of the magneto-lines which have their socket-frames grounded direct; but if the plug P^2 be inserted into a socket J of a common-battery line the current will be so weakened by the resistance of the cut-off relay R^2 that while it is sufficiently strong to operate said cut-off relay it is too weak to operate the bridge-relay R, which has relatively few turns or may be strongly adjusted, and which therefore will not attract its armatures, so that under these last-named conditions the battery-current will continue to be supplied, as required, through the plug P^2 to the common-battery circuit switched thereto.

The small relay R^4 by its armature 18 controls the local circuit of the supervisory signal s^4. This local circuit extends from battery E^2 by wire 17 to the armature 18 and contact-points 34 of relay R^4 and thence to the signal s^4 and return-wire 16. Any desired reducing resistance r^5 may of course be included therein, or the circuit may be made to include such cells only of the battery as may be required to furnish the necessary current.

In discussing the general operation of the invention it does not seem necessary to make extended reference to the suboperations of sending and receiving call-signals, since for each of the classes of circuit under consideration these are performed in the ordinary way familiar to those skilled in the art, and the description will therefore be restricted to circuit organizations arranged for conversation between two connected substations.

Assuming in the first place that two substation-circuits of the common-battery type are thus to be united—as for example, circuits L and L^2 entering the central station from their respective substations A and A^2—and that to this end the plugs P and P^2 have been inserted in the switch-sockets J of the said two lines it is manifest that the ring and tip contact-surfaces of the two plugs will engage the long and short socket springs a^2 b^2 and that the rear or sleeve contact-surface thereof will register with the socket-frame pieces 15. The branch conductor *m* leading from the battery E^2 through the resistance r^3 to sleeve p^3 of plug P will thus be made

to form part of a closed circuit to ground G^3 through cut-off relay R^2 of line L, which, operating, will sever said line from its original terminal and battery connection, and the branch conductor *e* leading from the same source through relay R and resistance r^4 to the sleeve p^3 of plug p^2 will in like manner have its circuit completed through cut-off relay of line L^2, which performs the same office for that line. As hereinbefore stated, the current in this last circuit is under these conditions so regulated that while it is sufficiently strong to work the cut-off relay it cannot work the less-sensitive relay R. Hence the bridge N between points 20 and 27 of the switch-cord main conductors through the local contacts 31 and 32 of said relay remains unbroken, and the source of current E^2 is, as long as the two lines are united, bridged between the cord conductors *f* and *g* to furnish transmitter-current for the substation-telephones at A^2, and since under these conditions the key *k* is not depressed and the repeating-coil continues in a state of disuse it is obvious that the said source E^2 sustains the same relation to line L as it does to line L^2 and supplies current for the transmitter of substation A also. This main-circuit portion of this circuit arrangement is indicated by Fig. 2, wherein, though the annunciator-signal S^3 remains bridged between the cord conductors *c d*, it is inert, because a steady battery-current only is on the line and is prevented by the condenser *h* from affecting said signal. The battery E^2 is shown in its bridge placed between the retardation-coil *r* on one side and the retardation-coil r^2 and signal-relay R^4 on the other, the said devices being all in series in said bridge. The ground connection G^2 at one pole of the battery does not under these conditions exercise any effect on the arrangement. Ordinarily the signal-relay R^4 is excited and produces the display of the signal s^4 as long as the telephone at either of the two substations remains displaced from its switch; but, if desired, the relay may be so adjusted that it becomes operative only when both telephones are displaced from their switches and the external resistance of the battery-circuit through said relay thus reduced. If desired, the signal s^4 may be used to indicate the moment when the called substation A^2 answers by taking his receiver from the switch-hook. This can be done by transiently operating the key *k*, and thereby temporarily disconnecting the source E^2 from plug P and restricting it to plug P^2. If while this is done the signal s^3 appears, the operator is at once apprised that the telephone-receiver at station A^2 has been taken from the switch and the main circuit L^2 thereby closed.

When a substation-circuit of the magneto-call and local-battery type or a toll-line circuit is to be connected with a substation-circuit of the common or central battery class, the plug P is placed in the switch-socket J^2 or J^3 of the former—say circuit L^3 or L^5—and the plug P^2 in the switch-socket J of the latter—say circuit L^2—as in the first case. The key *k* in this instance is pushed in and retained in its depressed position during the pendency of the entire communication, introducing the repeating-coil, and thereby effectuating the conductive separation while establishing the inductive union of the two plugs and the substation-circuits with which they are associated. Fig. 3 indicates the electrical arrangement of the main circuit under these conditions. That portion of the cord-circuit associated as a loop with plug P^2 will in all of its operations conform exactly to the description given of the previous arrangement illustrated by Fig. 2. The plug P makes contact by its tip with the lower socket-spring *b* and line conductor 3 and by its forward sleeve or ring p^2 with the upper spring *a* and conductor 4, and as the plug is forced home the said socket-springs are lifted from their normal contacts and the line-signal S^2 is cut off. During conversation the voice-currents originating at either substation are inductively repeated into the circuit of the other substation by the repeating-coil I. The signal s^4 in this case concerns plug P^2 and substation-circuit L^2 alone and operates to call for a disconnection when on the conclusion of the message the receiver is replaced on its hook at substation A^2, while to indicate the disconnecting signal from the stations of lines L^3 or L^5 in the switch-sockets of which the plug P may be placed the magneto-generator at the said stations is operated, and the current developed thereby actuates the electromagnetic signal S^3, the condenser *h* offering no bar to the passage of said fluctuating currents as these.

The third case is one wherein two magneto-circuits are to be interconnected or wherein a magneto circuit is to be connected with a toll-circuit. In such a connection one of the plugs P is thrust into the switch-socket J^2 or J^3 of the circuit L^3 or L^5, as the case may be, while the other plug P^2 is inserted into the switch-socket J^2 of the called-for circuit L^4. The connections of the registering contact-surfaces of plug P have already been described, but those of plug P^2 require further notice. Since neither of the two circuits concerned in the present case require the use of the central source of current in their normal operations of signaling and talking, the said battery, with its concomitant impedance-coils and signal-relay, is automatically put out of use, this being accomplished by the operation of the relay R, which opens the battery-bridge at the points 31 and 32. When the plug P^2 is inserted in its socket, its main-circuit contact-surfaces *p* and p^2, as with plug P, register with socket-springs *b* and *a*, respectively, and by raising them from their normal contacts act to cut off the line-signal S^2 and to switch the line conductors 3 4 into connection with the cord

conductors *g f*. The third or local cord conductor *e* at the same time is connected directly to ground by the engagement of the sleeve conductor p^3 of the plug with the grounded socket-frame 5. The current in the circuit of conductor *e* thus completed is much stronger than in either of the former cases, because the coils of the cut-off relay are no longer included therein and is, in fact, now strong enough to operate relay R, which, attracting its armatures, opens the bridge N at points 31 and 32, so that for this class of intercommunication the battery, being a superfluity, is disconnected from the cord-circuit, the relay R^4 and its controlled signal s^4 are put out of use, and the electromagnetic signal S^3 is adapted to be operated over both substation-lines from both substations. Under these conditions the main-circuit connections of the cord are represented by the diagram Fig. 5.

It is sometimes convenient to dispense with the auxiliary ground connections G and G^3 and in lieu thereof to provide return-conductors or a common return to the complementary battery-pole. This of course is an immaterial change and may or may not be made, as preferred, by those practicing the invention. In practice it is, however, sometimes desirable, even with lines which are not energized by the current of a central and common source, to employ a repeating-coil placed intermediately between the circuits concerned. Obviously this is readily accomplished by means of my invention and, as in previous arrangements, requires only the depression of the key *k*. The cord-circuit main-line connections are then as in Fig. 4, and when so arranged conversation between the substations involved can be satisfactorily exchanged, and the signal is still responsive to the operation of the call-generators at both substations.

As a matter of course switchboard apparatus containing my invention will comprise as many switch-cord circuits as are necessary for the proper conduct of the business of switching lines together.

I claim—

1. In a telephone switchboard apparatus a switch plug and cord circuit comprising two terminal switch-plugs, each having contact-surfaces adapted to register with corresponding contacts in the switch-sockets of substation-circuits; two switchboard-conductors normally uniting the corresponding main-circuit contact-surfaces of said two plugs; a repeating induction-coil; and a key or switch controlling the relation of said switch-cord conductors, with the terminals of the two windings of the said repeating-coil, and adapted when operated to sever the said conductors, and to connect them in two loops from the two plugs respectively, said loops containing respectively the windings of said repeating-coil, thus dividing the said plugs conductively, and uniting them inductively; substantially as set forth.

2. In a telephone switchboard apparatus, a switch plug and cord circuit comprising two terminal switch-plugs, each having contact-surfaces adapted to register with corresponding contacts in the switch-sockets of substation-circuits; two switch-cord conductors normally uniting the corresponding main-circuit contact-surfaces of the said two plugs; a repeating induction-coil; a key or switch controlling the relation of the winding-terminals thereof to the said conductors, and adapted to sever the latter, and interpose the repeating-coil in such manner that the two windings shall be brought into loops of the two plugs respectively, the said loops being conductively separated but inductively united; a supervisory signal controlled by a relay in a bridge of one of said loops; and a second supervisory signal and a condenser in a bridge of the other of said loops; substantially as described.

3. In a switch plug and cord circuit connection for a telephone-switchboard, the combination of two terminal switch-plugs each having two main contact-surfaces adapted to engage corresponding switch-socket contacts, and a local contact-surface adapted to engage a third or frame-piece contact of such switch-sockets; two switch-cord conductors normally uniting the corresponding main-circuit contact-surfaces of the said two plugs; a repeating induction-coil; a key or switch for severing said cord-conductors and for uniting the two ends proceeding from the plugs with the two ends of the repeating-coil windings respectively, thus forming two divisions inductively united by said coil; a bridge between the conductors of one of said divisions containing a source of current and a signal-controlling relay; a signal device controlled by said relay; a bridge between the conductors of the other division containing an electromagnetic signal device; independent local-circuit conductors one for each of the said divisions, leading from the said source of current to the local contact-surface of the plug of its own division; and a relay in the local-circuit conductor of the first-named division, controlling the continuity of the bridge thereof, and the connection of the source of current contained therein; substantially as described.

4. In a telephone central-station switchboard apparatus, the combination with substation-circuits of two classes, one having its signaling appliances and telephones supplied with current from a central battery, and the other having substation call-generators and local transmitter-batteries, each circuit having a switch-socket at the central station; of a switch-cord circuit adapted to switch together any two circuits of either or both classes, comprising two terminal switch-plugs each having three contact-surfaces adapted

to register with corresponding contacts in the switch-sockets of the said circuits, switch-cord conductors extending between said plugs and uniting the two forward contact-surfaces of each with the corresponding contact-surfaces of the other, a bridge containing the central source of current uniting the said switch-cord conductors, and means for maintaining the continuity and connection of said bridge when one or both plugs are inserted in the switch-sockets of circuits of the common-battery class, and for disconnecting the same from either plug or both plugs when inserted in the switch-sockets of circuits of the other class; substantially as described.

5. In a telephone switchboard apparatus, the combination with substation-circuits of two classes, one having switch-socket frames grounded or returned direct, and the other having switch-socket frames grounded, or returned through a cut-off relay or other high resistance; of a switch-cord circuit comprising two terminal switch-plugs each having two main contact-surfaces adapted to engage corresponding switch-socket contacts, and a local-circuit contact-surface adapted to engage the frame-contacts of said switch-sockets, two strand conductors uniting the corresponding main contact-surfaces of the two switch-plugs, a bridge uniting the said strand conductors, and containing a centralized source of current, and associated impedance-coils, a third strand conductor in a local circuit of said source leading through the local contact-surface of one of the switch-plugs, and when the said plug is inserted in a switch-socket, through the frame-contact thereof, and a relay in said local circuit controlling the continuity of said bridge, and adapted, when the said switch-plug is placed in a directly-grounded switch-socket, to be energized, and to open the circuit of said bridge; substantially as and for the purposes set forth.

6. In a telephone central-station switchboard apparatus, the combination of substation-circuits of two classes, one having directly-grounded switch-socket frames, and the other having switch-socket frames grounded through the electromagnet of the cut-off relay; with a switch-cord circuit comprising two terminal switch-plugs each having three contact-surfaces adapted to register with corresponding contacts in the switch-sockets of said circuits, two switch-cord conductors extending between said plugs and uniting the two forward contact-surfaces of each with corresponding ones of the other, a bridge uniting the said conductors, a centralized source of current, two impedance-coils one on each side of said source, and a signal-controlling relay all included in series in said bridge, a supervisory signal controlled by said relay, a third cord conductor in a local circuit of said source leading through the third contact-surface of one of the switch-plugs, and through the frame and return connection of a switch-socket wherein such plug may be inserted, and a relay in said local circuit controlling the continuity of said bridge and thereby the connection of the source of current, and the said signal and controlling-relay; substantially as specified.

7. In a telephone central-station switchboard apparatus, the combination of substation-circuits of two classes, one having directly-grounded switch-socket frames, and the other having switch-socket frames grounded through the resistance of the cut-off relay-exciting coils; with a switch-cord circuit comprising two terminal switch-plugs each having two main contact-surfaces adapted to engage corresponding switch-socket contacts, and a local-circuit contact-surface adapted to register with the frame-piece contact of said switch-contacts, two strand conductors normally uniting the corresponding main contact-surfaces of the two switch-plugs, a repeating induction-coil, a key controlling the terminals of the two windings thereof in relation to the said strand conductors and adapted when operated to sever the continuity of said conductors and to form them into loops extending from said plugs respectively, and containing the two windings respectively of said repeating-coil, a bridge conductor between the strand conductors of one of said loops, including in series a centralized source of current, impedance-coils and a signal-controlling relay, a supervisory signal controlled by said relay, a third strand associated with said loop and forming part of a local circuit of said source leading through the local contact-surface of the plug of said loop, and on the insertion of said plug in a switch-socket through the frame-piece contact thereof, and a relay in said local circuit controlling the continuity of said bridge, and thereby the connection of the source of current and the said signal and its controlling-relay; substantially as specified.

8. In a telephone central-station switchboard apparatus, the combination of substation-circuits of two classes, that is to say "common-battery" circuits, and "magneto-circuits;" with a switch-cord circuit arrangement comprising two terminal switch-plugs each having two main-circuit contact-surfaces adapted to register with corresponding contacts in switch-sockets of the said circuits, and a local-circuit contact-surface adapted to register with the frame-piece contact of said sockets, two strand conductors normally uniting the corresponding main-circuit contact-surfaces of the two plugs, a repeating induction-coil, means for severing the said strand conductors and for looping the ends of the two proceeding from each plug through the two repeating-coil windings respectively thereby forming the cord main circuit into two inductively-related divisions, a bridge between the conductors of one of the said divisions containing a central source of current, two impedance-coils one on each side of said source and a signal-controlling relay all in

series, a supervisory signal responsive to said relay, a third strand conductor associated with said division and forming part of a local circuit of said source leading through the local-circuit contact of the plug of said division and through the frame-piece contact of a switch-socket wherein such plug may be inserted, a relay in said local circuit adapted to become operative and to disconnect said source of current and signal-relay when the said plug is inserted in a socket of a "magneto-line" but to maintain their connection when said plug is inserted in the socket of a "common-battery" line, and an electromagnetic signal device bridged with a condenser between the main conductors of said other division; substantially as and for the purposes set forth.

9. In a telephone central-station switchboard apparatus, the combination of substation-circuits of two classes, that is to say, "common-battery" circuits, and "magneto-circuits;" with a switch-cord circuit arrangement comprising two terminal switch-plugs each having two main-circuit contact-surfaces adapted to register with corresponding contacts in switch-sockets of the said circuits, and a local-circuit contact-surface adapted to register with the frame-piece contact of said sockets, two strand conductors normally uniting the corresponding main-circuit contact-surfaces of the two plugs, a repeating induction-coil, means for severing the said strand conductors and for looping the ends of the two proceeding from each plug through the two repeating-coil windings respectively thereby forming the cord main circuit into two inductively-related divisions, a bridge between the conductors of one of the said divisions containing a central source of current, two impedance-coils one on each side of said source, and a signal-controlling relay, all in series, a supervisory signal responsive to said relay, a third strand conductor associated with said division and forming part of a local circuit of said source leading through the local-circuit contact of the plug of said division and through the frame-piece contact of a switch-socket wherein such plug may be inserted, a relay in said local circuit adapted to become operative and disconnect said source of current and signal-relay when the said plug is inserted in a socket of a "magneto-line," but to maintain their connection when the said plug is inserted in the socket of a "common-battery" line, a third strand conductor forming part of a similar local circuit associated with the other division of the said cord-circuit, and leading through the local-circuit contact-surface of the plug thereof, and any switch-socket wherein it may be placed, and an electromagnetic signal device bridged with a condenser between the main conductors of said other division; substantially as and for the purposes set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 30th day of March, 1900.

DAVID S. HULFISH.

Witnesses:
SAMUEL G. MCMEEN,
THOMAS D. LOCKWOOD.