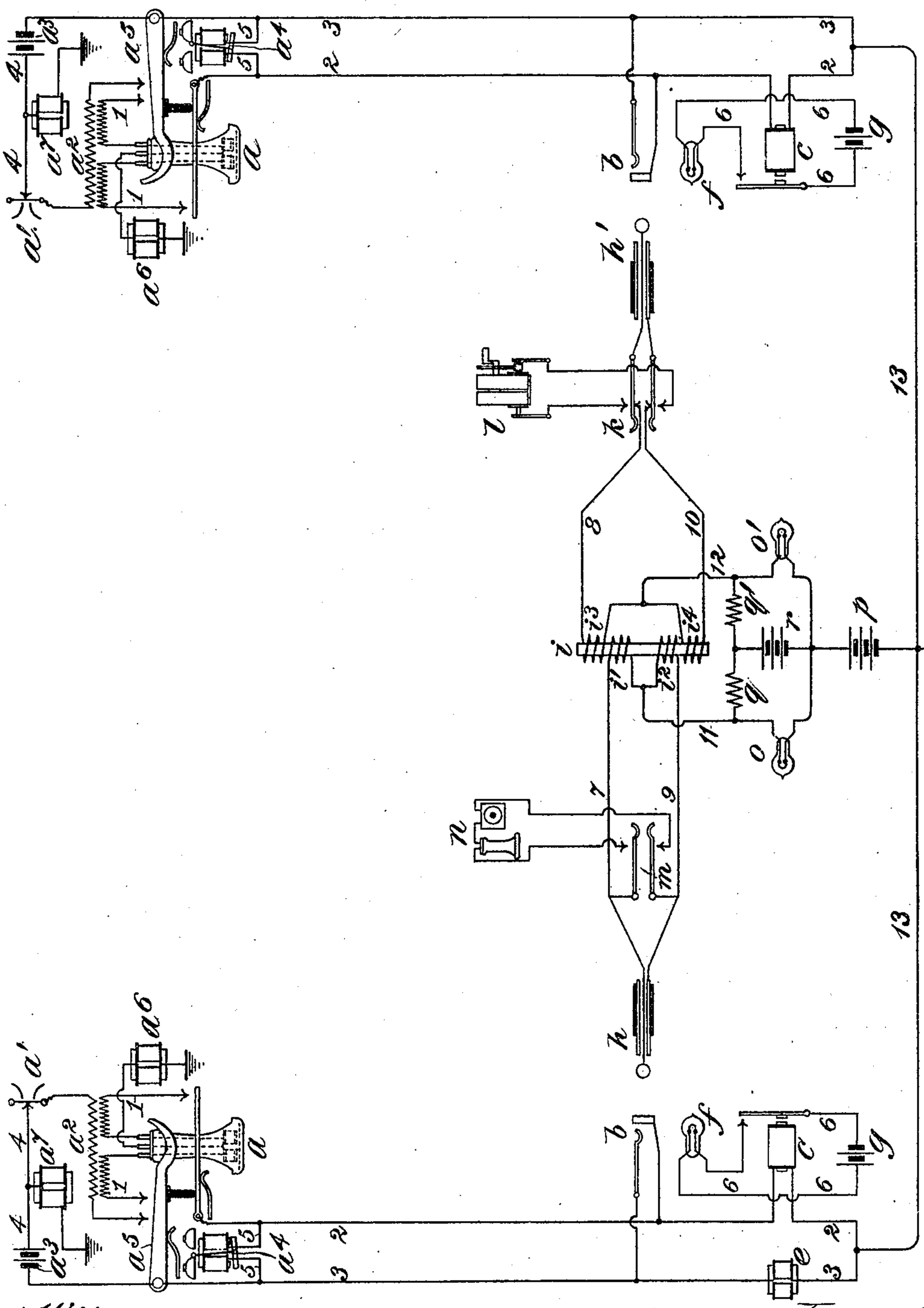
No. 645,571. Patented Mar. 20, 1900.

C. E. SCRIBNER.

TELEPHONE EXCHANGE APPARATUS.

(Application filed Nov. 16, 1896.)

(No Model.)



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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE APPARATUS.

SPECIFICATION forming part of Letters Patent No. 645,571, dated March 20, 1900.

Application filed November 16, 1896. Serial No. 612,270. (No model.)

To all whom it may concern:

Be it known that I, CHARLES E. SCRIBNER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Telephone-Exchange Apparatus, (Case No. 394,) of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention concerns the operation of signaling instruments at the central office of telephone-lines, particularly lines provided with means for supplying substation transmitting-telephones with current conveyed from the central office through the line conductor.

The invention embraces a number of different features, which relate to the charging of a local storage battery over the line conductors, the substation signal-bell, the connections of the return-circuit at the substation, and means for automatically setting a line-signal in the use of the substation-telephone, for effacing that signal in making connection with the line, and for substituting for the line-signal a supervisory signal.

The objects of the several features are to provide a path of low resistance for charging the local battery, to prevent the continuously-flowing charging-current from interfering with the operation of the polarized signal-bell, to control a subsidiary line-signal through the agency of a relay, to prevent excitement of the relay during the idleness of the line by the charging-current, to render the relay inoperative when connection is made with the line, and to operate a supervisory-lamp signal directly in the circuit of the connected line.

In the system constituting this invention the line conductors of a metallic circuit are united at the central office and grounded through the central source of current common to the different lines. The signal-controlling relay, of high resistance, is interposed in one of the line conductors and an impedance-coil of comparatively low resistance is placed in the other line conductor, both of these inductive resistances being located in the line between the source of current and the usual line-terminal spring jack or socket. At the substation the line conductors are united through the windings of the usual polarized signal-bell, of high resistance, and that one which contains the impedance-coil is led to ground or other suitable return-conductor through a path in which the local storage battery to be charged is placed. A switch is provided for bringing the telephone appliances into a bridge of the line in the usual way during the use of the telephone. A branch to the return-conductor is led to the center of the winding of the substation-telephone, a low-resistance impedance-coil being interposed in the conductor to prevent disturbance of the telephonic currents in the line. The members of the pair of connecting-plugs are united inductively through the windings of a repeating-coil, and a conductor is led from the central point of the winding of the repeating-coil to one pole of the before-mentioned common source of current-supply. In a conductor leading from the source of supply to each of the windings is interposed a supervisory signal-lamp arranged in connection with a local circuit and source of current, whereby the lamp is deprived of current while current exists in the line-circuit, being lighted only when the current in that circuit ceases.

In the normal condition of the line the charging-current flows over the line conductors jointly and through the return or ground circuit, including the local storage battery at the substation, thus maintaining the charged condition of that battery. Such a large proportion of the current is diverted from the signal-controlling relay in one conductor through the low-resistance impedance-coil in the other line conductor that the relay remains inert. For the same reason the substation signal-bell is only very slightly magnetized, so that the operation of the bell by alternating signaling-currents in the line is not hindered by the charging-currrent. The removal of the substation-telephone from its switch-hook for use permits the closing of a connection through a low-resistance circuit from each of the line conductors, whereby the signal-controlling relay is excited and causes the display of the corresponding subsidiary line-signal. When connection is made with

the line, the relay and impedance-coil become shunted by the low-resistance windings of the repeating-coil in the plug-circuit, assisted by a properly-directed source of current, the relay becoming inert and effacing the line-signal. A supervisory-lamp signal is substituted for the line-signal of each line, which supervisory signal remains undisplayed until at the replacement of the substation-telephone, and the consequent interruption of the current in the line conductors, the source of current in the local circuit about the supervisory lamp causes its illumination. The two supervisory signals associated with the two plugs of the pair have thus the usual function of indicating to the operator the condition of use or disuse of the substation-telephone of the corresponding lines.

This improved exchange system is illustrated in the drawing herewith. This represents two substations whose lines terminate in a switchboard and pairs of connecting-plugs, with other accessory telephonic signaling and supervisory appliances in the switchboard.

The apparatus at the substation comprises the usual receiving-telephone a, a transmitting-telephone a', an induction-coil a^2, a local storage battery a^3, a polarized signal-bell a^4, and a telephone-switch a^5 for changing the circuit connections when the telephone is brought into use. The winding of the magnet of receiving-telephone a and the secondary winding of induction-coil a^2 are divided, portions being included serially in a wire 1, which terminates in normally-open contact-points of the switch a^5. From the point of wire 1 intermediate of the winding of the telephone the ground or return circuit of the line is connected, an impedance-coil a^6 of low resistance—say twenty-five ohms—being included in the ground branch. The switch a^5 is constructed with contact-pieces, constituting, respectively, terminals of the line conductors 2 and 3, which are closed to the ends of wire 1 when the switch, relieved of the weight of the telephone, rises. The transmitting-telephone a' is contained, together with the primary winding of induction-coil a^2, in a local circuit 4 of the battery a^3. This local circuit is controlled also by switch-contacts of switch a^5, being closed while the telephone is in use. The bell a^4 is connected in a permanent bridge 5 of the line conductor and should be of very high resistance, one thousand ohms being suitable resistance. The local battery a^3 is included in an earth branch from conductor 3, together with an impedance-coil a^7.

The line conductors 2 and 3 are led at the central office to the usual spring-jack b and signaling instrument c in a telephone-switchboard and are connected in multiple with a grounded battery d, which serves to excite the signals under certain conditions. The magnet of the signaling instrument c, which is, in fact, a relay, is included in the line conductor 2. In the other line conductor an impedance-coil e is interposed to prevent the shunting of telephonic currents to earth. The relay c controls the subsidiary signal f, preferably a small incandescent lamp, which is included in a local circuit 6, containing a battery g and normally broken at the switch-contacts of the relay. This signal-lamp f may be associated in the usual way with the spring-jack or terminal socket b of the line.

The switchboard is furnished with pairs of connecting-plugs h and h', whose like parts are united through conductors 7 8 and 9 10, which constitute the plug-circuit, the telephonic connection between conductors 7 and 8 and between conductors 9 and 10 being broken and a repeating-coil i being interposed in the circuit. The conductors 7 and 9 are, in effect, united through two windings i' and i^2 of the repeating-coil. The conductors 8 and 10 are united through other coils i^3 and i^4, wound upon the same core of the induction-coil.

The usual calling-key k is interposed in conductors 8 and 10, leading to the calling-plug h' for connecting a generator l of signaling-current into circuit with the plug mentioned. There is also a listening-key m, by means of which the operator may connect her telephone n with the plug-circuit. Two supervisory signals o and o' are associated with a pair of connecting-plugs, one with each. These signals, which are small incandescent lamps, are connected in branches 11 and 12, respectively, which lead from the points of junction of windings i' and i^2 and windings i^3 and i^4 of the induction-coil through a battery p to the free pole of battery d. About each of these lamps o and o' is a shunt-circuit, including a small resistance-coil (these coils being designated q and q') and a battery r, which is common to both of the circuits.

The satisfactory operation of this apparatus depends to a considerable extent on a certain adjustment of the resistances of the different parts with relation to each other. The necessary relation will become evident in following the operation of the system; but it may be well to state here the resistances found suitable for the different new appliances. At the substation the impedance-coil a^6 may have a resistance of twenty-five ohms. The bell a^4 should be of high resistance—say of one thousand ohms. The impedance-coil a^7, in circuit with the local storage battery a^3, may have a resistance of five hundred ohms. At the central office the magnet of relay c may be of five hundred ohms, while the impedance-coil e would have a resistance not higher than one hundred ohms. The windings of induction-coil i may be of approximately twenty-five ohms each. The resistance-coils q and q' may be of ten ohms. Battery d may be of thirty volts, battery p of ten volts, and battery r of six or eight volts, depending upon varying conditions of line resistance.

In the normal or idle position of the ap-

paratus the current flows from battery d over line conductor 3 and thence to earth at the substation through storage battery a^3. The local storage battery is thus continually charged while not in use. A small portion of the current from battery d finds circuit through relay c and bell a^4 at the substation; but on account of the high resistance of these instruments the current is not sufficient to operate the relay. The removal of the telephone from the switch at the substation brings the conductor 1 into a bridge of the line, and thus closes a ground branch of comparatively-low resistance to each of the line conductors. The current from battery d through relay c then becomes greatly increased, a circuit being now closed from line conductor 2 through one-half the conductor 1 to the center of the telephone a and thence to earth through impedance-coil a^6, and the relay is magnetized, attracting its armature, and thus causing the illumination of line signal-lamp f. The display of this lamp constitutes a call to the operator, to which she responds by inserting plug h into spring-jack b of the line, whereby she is enabled to bring her telephone into connection with the subscriber's line to learn his order. The insertion of the plug into the spring-jack completes a new circuit from battery d to the spring-jack, including wire 11 and conductors 7 and 9 of the plug-circuit, which lead to the conductors 2 and 3 of the line-circuit, respectively. A local circuit is now formed from wire 11, conductor 9, and a part of the line conductor 2, which includes the winding i^2, the relay c, and the battery p. The electromotive force of battery p should be of the proper direction and of such amount in this circuit as to create a condition of no difference of potential between the terminals of the relay with respect to battery d or to approximate such condition. Under that condition the relay c becomes inert and causes the extinction of line-signal f. The current from the batteries d and p flows out through the two windings i' and i^2 of the induction-coil to the substation and through the ground branch there, the circuit being through the conductors 7 and 9 of the plug-circuit to the line conductors 3 and 2, thence to the terminals of the bridge-wire 1, and from that bridge to earth through the impedance-coil a^6. A portion of this current traverses the supervisory signal o, inasmuch as this lamp is in a branch of the conductor leading to the junction of the coils i' i^2; but so much of the current is diverted from this instrument through the shunt about the lamp by means of battery r that the lamp remains unlighted. It will be understood that the function of battery r is to reduce the difference of potential between the terminals of the lamp in the same way that battery p reduces the difference of potential between the terminals of relay c. Thus the act of inserting the plug h into the spring-jack b has brought the operator into communication with the subscriber and has extinguished the line-lamp f and the supervisory lamp o. Having received the subscriber's order for the connection required, the operator inserts plug h' into the spring-jack of the desired correspondent line and operates the calling-key k to ring the bell at the substation. The efficient operation of the bell by the calling-current thus sent is not impaired by current in the line-circuit from the battery d, as in systems heretofore organized, since this bell receives but a very small proportion of the current flowing in the line for charging the local storage battery a^3. The act of inserting plug h' into the spring-jack of the correspondent line brings supervisory lamp o' into a relation to that line similar to that of supervisory lamp o in respect to the calling-line, as before traced. Since, however, there is as yet no complete circuit to earth of low resistance at the called substation, the lamp o' remains still lighted by the current from battery r, in the closed local circuit of which it forms a part. The battery p, which is connected to ground through the battery d, finds circuit through the winding i^4 of the repeating-coil and the strand 10 of the cord-circuit to the sleeve of the plug, whence it passes to the thimble of the spring-jack and to the line conductor 2 of the telephone-line. The electromotive force of the battery p and conductor 2 then tends to produce current through the relay c of the called line and back to the other side of the battery through conductor 13, which conductor is that one which connects all the telephone-lines together to grounded battery d. The balance of electromotive force between batteries p and d, the latter having a higher electromotive force, is, however, such that the battery p, while it may tend to reverse the slight current flowing through the relay c from battery d, does not produce sufficient current in this relay to light the signal-lamp controlled by such relay. A small current from battery p may also flow out over conductor 2 of the telephone-line to a substation through the signal-bell a^4, conductor 4, through the impedance-coil a^7 to ground, the return-circuit then being through to earth and back to the other side of the battery p through the grounded battery d at the central office. The supervisory signal o' therefore will be lighted by current flowing in the local circuit from battery r until the called subscriber responds—that is, so long as no appreciable current flows from batteries d and p through the plug-circuit. It may be mentioned that during the idle condition of the plugs the supervisory signal-lamps will be lighted by current from battery r, flowing in their local circuits, and that a supervisory lamp will be extinguished only when the plug with which it is associated is connected with a telephone-line grounded at the substation by the removal of the substation-telephone from its hook. When the subscriber at the called sub-

station removes his telephone from the switch, current is permitted to flow from batteries *d* and *p*, acting in series through the conductor 12, including the supervisory signal *o'*, and thence to earth at the called substation. The conditions of potential are thus produced in this circuit requisite for extinguishing the signal-lamp *o'*. The obscuring of this lamp is therefore a signal to the attendant that the called subscriber has responded and has removed his telephone from its switch-hook. When both telephones are thus removed, the apparatus is in position to permit conversation between the subscribers. Telephonic currents created at either substation and flowing in the circuit made up of the line conductors and a portion of the plug-circuit are inductively propagated or repeated into the other circuit to affect the receiving-telephone therein. When the telephone at either station is replaced on its switch, the current from battery *d*, through the corresponding supervisory signal and its associated conductors, is interrupted and the supervisory signal becomes excited by current from battery *r*. The simultaneous lighting of both signals may be accepted by the operator as signifying the termination of conversation, and she may then remove the plugs from their spring-jacks and return them to their normal positions.

My invention is defined in the following claims:

1. The combination with a metallic-circuit telephone-line extending from a substation to a central office, of a source of current at the central office included in a branch from both limbs of the line in multiple to a return-conductor, a signal-controlling instrument included in one limb of the line at the central office, a local storage battery at the substation included in a branch from the other limb of the line to the return-conductor, and a switch at the substation for controlling the flow of current through the limb which includes the signal-controlling instrument, substantially as and for the purpose set forth.

2. The combination with a metallic-circuit telephone-line, of a central source of current in a circuit composed of both limbs of the line in multiple in conjunction with a return-circuit, a local storage battery at the substation of the line in the circuit, a signal-controlling instrument in one line conductor, said line conductor or signaling instrument being of high resistance, the other line conductor being of comparatively low resistance, whereby the operation of the signal-controlling instrument by the normal charging-current is prevented.

3. The combination with a metallic-circuit telephone-line, of a central source of current in a circuit formed of the line conductors thereof in multiple and a return-conductor, of a signal-controlling instrument and a conductor of high resistance in one of the line conductors, a local storage battery in the other of the line conductors, and a switch at the substation adapted to cut out the said conductor of high resistance, whereby the signal may be operated from the substation, as described.

4. The combination with a telephone-line connected with a source of current at the central office, including a signal-controlling magnet, and provided with a switch controlling the current in the line from the said source, and a terminal socket of the line, of a plug and cord for making connection with the line, a conductor terminating in the plug adapted to be brought into shunt of the magnet when the plug is in the socket, and a second source of current in the conductor of proper polarity and strength to produce a condition of no difference of potential between the terminals of the magnet when the said shunt is complete, substantially as described.

5. The combination with a metallic-circuit telephone-line and the telephone thereof at the substation, of a return-circuit for the line connected with the central point of the winding of the substation-telephone, and an impedance-coil in the return-circuit, a bridge of the line-circuit at the central office, a signaling instrument associated with the line to respond to current therein, and a source of current in the return-circuit for operating the said signaling instrument, as described.

6. The combination with a telephone-line and a switch controlling the continuity of the line at the substation, of a relay and a source of current in the line at the central office, a spring-jack connected with the line, a plug for making connection with the spring-jack, a conductor attached thereto adapted to be brought into parallel circuit with the relay when connection is made with the line, a source of current in that conductor of proper strength and polarity to reduce the difference of potential between the terminals of the relay to substantially zero, a supervisory-lamp signal in the conductor, a shunt about the signal and a source of current in the shunt adapted to reduce the difference of potential about the supervisory lamp substantially to zero, while the line-circuit is complete, as described.

In witness whereof I hereunto subscribe my name this 3d day of October, A. D. 1896.

CHARLES E. SCRIBNER.

Witnesses:
ELLA EDLER,
PEARL CLENDENING.