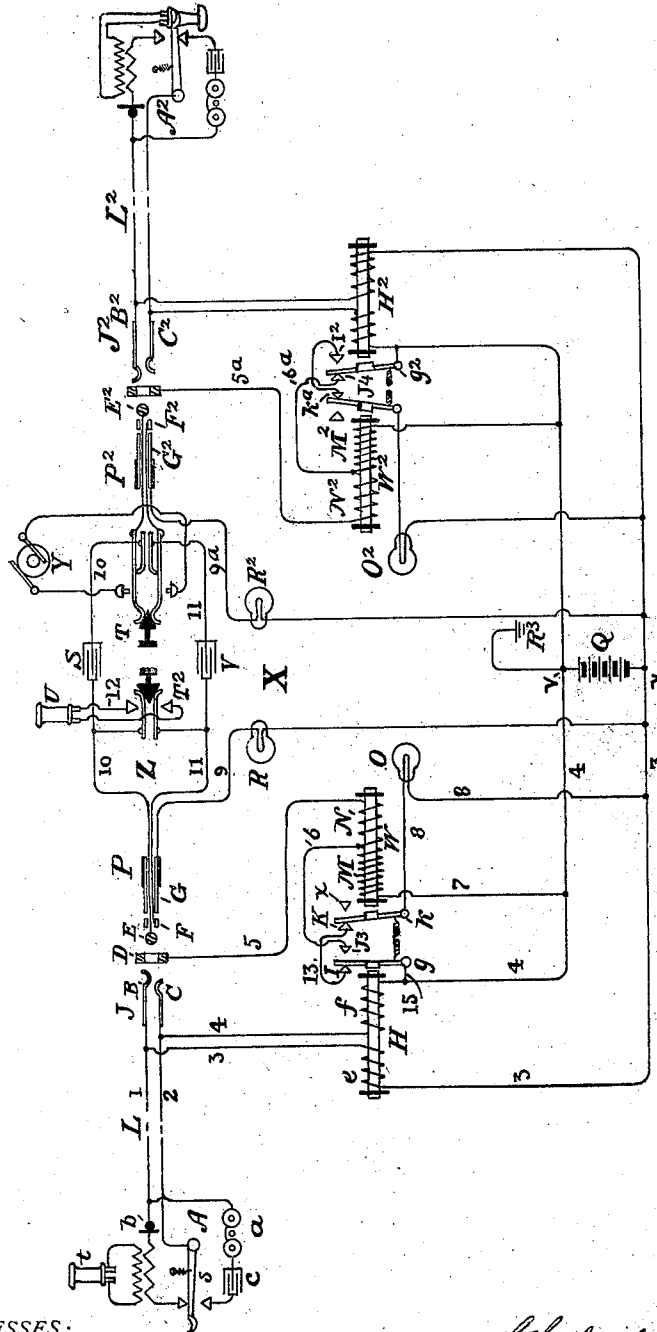


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PATENTED MAY 8, 1906.

C. L. BOYCE.
TELEPHONE SYSTEM.
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WITNESSES:

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TELEPHONE SYSTEM.

No. 820,176.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, CHARLES L. BOYCE, a citizen of the United States, residing at Detroit, county of Wayne, State of Michigan, have invented a certain new and useful Improvement in Telephone Systems; and I declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same, reference being had to the accompanying drawings, which form a part of this specification.

This invention relates to that class of telephone-exchange systems which employ a central source of current for the substation-transmitters and for the central-station call and switch board signals, and more specifically relates to an improved plan and an improved arrangement of circuits and apparatus for the operation and control of such signals. Its objects are to carry out the various sub-operations of receiving call-signals, the withdrawal of said signals in due season, and the appropriate display and withdrawal of supervisory and disconnecting signals in an improved and highly-efficient manner; to dispense with relays in the main circuit-conductors of the switch-cord; to control the supervisory signals without the employment of shunt-circuits, and to provide that the relays concerned in operating the call and supervisory signals of each substation-circuit shall belong to such line-circuit, and shall therefore be independent of the switch-cord circuits, thus aiding in the avoidance of faults and facilitating their location and removal when they occur. For the attainment of these objects this invention, while dispensing with switch-cord relays, does not involve the employment of any greater number of permanently-associated relays than have heretofore been used. The helices of the line or call relay are divided into substantially equal portions which are connected in the two sides of the main circuit, respectively, and since these serve when the line is switched for talking purposes as impedance-coils in the circuit of the battery which supplies current for the substation-transmitters the said relay may be and is permanently connected with the circuit. There is also provided a second or auxiliary relay, not, however, in the line-cir-

cuit, but in a local circuit associated therewith and adapted to be completed when the switch-plug is inserted in a switch-socket of said line through registering local-circuit contacts of the said socket and plug. The supervisory signal associated with the switch-plug is also in the local circuit which contains the said second relay, and in addition thereto there is a resistance adapted under different conditions to be included in said local circuit or short-circuited therefrom, and thereby to vary the strength of the current flowing therein and to determine the display or non-display of the supervisory signal.

The invention therefore consists in combining the call-signal and its local circuit with a line-relay permanently in the line-circuit and an auxiliary relay in a local circuit completed through switch-plug and socket contacts in such manner that the said signal local circuit shall be closed and its signal displayed when the said line-relay is excited and the said auxiliary relay unexcited and that the said signal-circuit having thus been closed and the said signal displayed shall be opened for the withdrawal of said signal whenever the said auxiliary relay shall likewise be excited and become operative.

It also consists in combining the supervisory signal, its local circuit, and a resistance governing the strength of current in such circuit, and consequently the display or non-display of said signal with the line-relay, in such manner that the said resistance shall be short-circuited and withdrawn from the supervisory-signal circuit when the line-relay is unexcited, but shall be introduced into said circuit on and during the operation of said line-relay, so that the display of said supervisory signal can only occur when its circuit shall have been completed through the switch-socket of a substation-circuit whose line-relay has not previously been excited by the closing at the substation of the main circuit including said line-relay. Obviously when the said supervisory signal is associated through its switch-cord with any substation-circuit which has thus been closed it is adapted to serve as a disconnecting-signal therefor. Since on replacing the receiver at such station on its switch-hook the said main circuit is opened, the excitation of the line-relay

thereof ceases and the resistance controlling the current of the supervisory-signal circuit is short-circuited.

It consists also in combining the supervisory signal and its local circuit with the line-relay, the winding of the auxiliary relay, and a shunt or short circuit round a portion of said winding constituting a considerable portion of the resistance thereof in such manner that the said shunt shall be open when the said relay is excited and closed when the said relay is unexcited, thereby rendering the relation of such high-resistance portion of said winding to the supervisory-signal circuit and the display of said signal dependent upon the condition of the said line-relay.

The drawing which accompanies this specification is a diagram showing the electrical connections of two substation-circuits and switching devices at the central station provided with call and supervisory signals comprehending my invention.

Referring to said drawing, L L^2 are substation-circuits converging from substations A A^2 to a central station X . At said substations the usual apparatus is provided and comprises the receiver t , the transmitter b , the call-bell a , the condenser c , and the suspension-switch s , these devices being arranged and associated in a well-known manner. When the line is unemployed, the receiver t hangs on the hook of the suspension-switch and the circuit leads through the bell; but since the condenser is included the circuit is open for steady currents while the rapidly-alternating currents which operate the bell readily pass. When, however, the receiver is taken from the hook, the main circuit is closed conductively through the transmitter and the steady current from the central-station battery is enabled to circulate through the circuit. To reduce the resistance of the circuit, the receiver t is connected therewith by means of an induction-coil in a manner frequently adopted, the low-resistance primary of said coil being in the main circuit, together with the transmitter. The receiver at substation A^2 is resting on the hook, showing that circuit L^2 is disengaged; but the receiver at substation A has been taken from the hook, so that the switch s has assumed its upper position, has closed the main circuit through the transmitter, and has manifested a call (as presently will be explained) at the central station.

The apparatus now to be considered is wholly at the central station. Each substation-circuit has certain individually-appropriated appliances comprising a permanently-connected line-relay, a call-signal, an auxiliary relay, a resistance device which may and preferably does consist of a portion of the winding of said auxiliary relay, and as many switch-sockets as may be necessary ac-

cording to the size of the switchboard. The remaining portion of the central-station switch apparatus is comprised in or associated with switch-cords, sufficient of course in number for the efficient transaction of business. For each switch-cord provided with the usual answering and companion plugs there is also a listening-key, a calling-key, and a supervisory signal. The central source of current Q may be common to a large number of main circuits and switch-cords, and the call-generator Y and operator's telephone U are common also to a large number of switchcords, being under the control of the ringing and listening keys thereof.

H is the permanently-connected line-relay with its magnetizing-coil in two half-windings e f , connected, respectively, in the two sides 1 and 2 of the main circuit L by means of extension-conductors 3 and 4, which after passing through the said relay-coils continue to the poles of the battery Q . The half-windings e and f are connected to reinforce one another for the excitation of the relay when the circuit is closed by taking up the telephone from the substation-switch.

W is the auxiliary relay, which also has its winding in two portions M and N . Winding N may have a moderate resistance—say one hundred and twenty ohms—and is in series with winding M , which has a much higher resistance—say four hundred and eighty ohms—and, in fact, constitutes in itself a resistance device forming, as will presently be explained, an important feature of this invention. It is not necessary that the resistance-winding M shall actually be a part of the exciting-coil of relay W . It might, if desired, be formed of German-silver wire wound over the exterior of winding N of relay W or might be formed into a special resistance-coil independent altogether of the relay, but connected serially therewith and connected in the circuit thereof in the same place that it now occupies. The construction shown, wherein it does form a part of the relay-magnet coils, is, however, preferable, and is a convenient way of increasing the efficiency of said relay under certain conditions.

I and J^2 are the front and back limit-stops for the armature g of line-relay H and are both electrical contact-points.

K and x are the back and forward limit-stops of the armature k of the auxiliary relay W , the back or resting stop alone being an electrical contact-point.

O is the line or call-signal device, shown as a small glow-lamp, the same being connected in a local circuit passing through the said resting-contact K of the auxiliary relay and the forward or working contact I of the line-relay, the said points K and I being united by a conductor 13. The said signal O can therefore be displayed only when the line or

call-signal relay becomes excited and operates while the auxiliary relay remains passive. Again, should the said line-relay have acted to display the signal O, the said signal can obviously be withdrawn by the subsequent excitement and operation of the auxiliary relay W.

The switch-sockets J have long and short contact-springs B and C, representing and connected with the main circuit-conductors 1 and 2, respectively, and the frame-piece D constitutes a third or local-circuit contact-piece normally connected with one pole of the battery Q through conductor 5, the low and high resistance windings N and M of relay W, and conductors 7 and 4. A branch conductor 6 extends from the point where the said low and high resistance windings join each other to the back contact of armature *g* of relay H, and the said armature *g* has an electrical connection 15 with the main conductor 4, and thereby with the pole *v* of the battery. The local circuit of the line-signal may be traced from said pole *v* by conductors 4 and 15, armature *g*, contacts I, conductor 13, contact K of armature *k* of relay W, conductor 8, including lamp O to main conductor 3 and pole *y* of said battery.

The high-resistance winding M, connected at one end with its associate winding N and branch conductor 6, is connected at its other end with conductor 7, which joins main conductor 4, leading from pole *v* of the battery. Substation-circuit L², as will be seen, has similar and similarly connected and arranged apparatus, the same parts being marked by like reference letters or numerals, to which, however, index characters are added. It is, however, to be observed that since line L is supposed to be initiating a communication, the receiver *t* having at its substation been taken from the hook-switch its line-relay H is excited and the armature *g* attracted forward to close the local circuit of the lamp-signal O. Circuit L², however, being as yet disengaged, its relay H² has not become excited, and the armature *g*² thereof remains unattracted and in connection with its resting-contact J⁴.

Z is a cord-circuit, as many such as are necessary being of course employed.

P is the answering-plug with its conducting-tip E, ring F, and sleeve G, adapted when the plug is thrust into socket J to register and connect electrically with the socket members C, B, and D, respectively, and P² is the companion plug similarly constructed and provided.

T is the ringing-key; T², the listening-key, both of usual construction and arrangement.

S and V are condensers, and R and R² supervisory signals. The cord conductor 10 unites the tips of the two plugs through the condenser S, and the cord conductor 11 similarly unites the ring-contacts F F² thereof

through condenser V, and these constitute the main switch-cord conductors through and by means of which the main conductors of substation-circuit L are united to those of L² when the plugs are respectively placed in sockets of the said two circuits. Each plug has its own local or supervisory-signal circuit conductor, and these 9 and 9^a, respectively, lead through their associated signals R and R² to the pole *y* of battery Q, the local circuits of said signals being completed when the plugs controlling them are placed in their sockets. The local circuit thus completed may, however, be continued to the other pole of the battery through either one of two different paths, and the display of the signal depends upon which of these two paths can be taken by the current, this again depending upon the position of the armature *g* of the line-relay. The said local circuit of plug P, for example, the plug being inserted, continues from the frame-piece D by conductor 5, through winding N of relay W, then through the high-resistance winding M, and by conductors 7 and 4 to the battery at pole *v*. When the supervisory-signal circuit is completed through this path, the current flowing therein is in virtue of the included high resistance M too small for the operation of the signal R, which accordingly is not displayed; but if the line-relay H had not been previously excited and if its armature had not been attracted, but had remained in connection with its resting contact J³, the said high-resistance winding would have been short-circuited through conductor 6, contact J³, armature *g*, and conductors 15 and 4, the current then being strong enough to operate signal R, which would accordingly be displayed. In the apparatus of line L² the relay H² has not attracted its armature *g*² forward, and the local circuit is therefore shown as being closed through the back contact J⁴ and the short-circuiting connection 6^a. Thus when the plug P² is thrust into socket J² the supervisory signal R² will be displayed, and such display will continue until substation A² responds to a call by taking the receiver from the hook. Such action resulting in the excitement of relay H² and the attraction of armature *g*² will of course open the local circuit at J⁴ and withdraw the signal.

The operation of this system is simple. Substation A desiring to talk with substation A² has removed his receiver *t* from the hook, which has moved to its upper contact and closed the line-circuit. The current flowing from battery Q through the reinforcing windings of relay H excites said relay, which has attracted its armature *g*, closing the circuit of call-signal O for the display thereof and opening the short circuit through conductor 6 round the high resistance M, which is thus brought into the supervisory signal circuit of

line L. Responding to the display of signal O the central operator inserts the answering-plug P into socket J and pressing the listening-key T² receives the order. The insertion
 5 of the plug has connected the main conductors 10 and 11 thereof with the main conductors 1 and 2 of circuit L and has completed the local circuit of the supervisory signal R, which includes the auxiliary relay W. The
 10 said relay operates and attracting its armature *k* opens the local circuit of call-signal O at K, thus withdrawing said signal, although the relay H remains excited its two coils *e* and *f* continuing in the battery-circuit and serving
 15 as choking-coils to prevent the passage that way of the voice-currents. The signal R does not operate, because the high resistance M being in its circuit the current is too weak. Ascertaining the line wanted, the
 20 plug P² is inserted in the switch-socket J² thereof, and the signal R² is at once displayed, the high resistance M² of its circuit being shunted by conductor 6^a and the back or resting contact J⁴ of the armature *g*² of relay.
 25 H². The display of this signal indicates that the receiver at substation A² thus far has not been removed from its hook. The operator now presses the ringing-key T and sends a call-current over circuit L². The subscriber
 30 at A² lifts the receiver from the switch, thereby closing the line-circuit L², and answers. This action excites relay H², which attracts its armature *g*², causing it to break the supervisory circuit at J⁴ and to withdraw signal R².
 35 The attraction of armature *g*² does not, however, bring about the exhibition of line-signal O², because the circuit thereof has already been opened at *k*^a. The two substations are thus brought into communication, and the
 40 replacement of the receiver on the suspension-switch at either station operates to transmit a disconnect-signal—that is, when A replaces his receiver the signal R is displayed,
 45 because the main circuit L is broken, and the relay H, losing its excitement, allows the armature *g* to be retracted and to close the short circuit round the high resistance M, and when A² replaces his receiver the signal R² is in like manner displayed, so that
 50 the plugs may be pulled out, which permits all of the mechanism to resume its normal condition. With the exception of the windings of relay W, for which suitable magnitudes have been stated, the magnitudes of
 55 the several relays and signals and of the battery may all be such as are customarily employed. It will be seen that when my improvement is adopted the talking-circuit through the cord-conductors 10 and 11 is
 60 freed from the impedance of supervisory relays, which heretofore have been connected therein. In practice, for purposes not directly involved in the operation of this inven-

tion, a ground connection R³, extending from the pole *v* of the general battery, is employed. 65

I claim—

1. The combination in a telephone central-station switchboard apparatus, of a line-relay in a main telephone-circuit; a supervisory signal associated with a switch-cord; a local
 70 supervisory circuit containing said signal; an auxiliary relay with a winding of high resistance also included in said local supervisory circuit to reduce the strength of current therein and prevent the operation of said signal; and a shunt or short circuit round a portion
 75 of said high-resistance winding leading through contacts of said line-relay, and controlled by said line-relay, to cut out said portion, and permit the display of said supervisory signal when said relay is unexcited,
 80 and to leave said portion in said circuit and prevent the display of said signal, when the same is excited; substantially as described.

2. The combination in a telephone-exchange system, of a main substation-circuit controlled by a switch at the substation; a switch-socket for said main circuit and a switch-plug adapted to be inserted therein,
 90 the said socket and plug having registering main and local circuit contacts; a local supervisory circuit at said central station adapted to be completed through the local contacts of said socket and plug; a local call-circuit at the central station; a supervisory-signal device
 95 in the supervisory circuit; a call-signal device in the local call-circuit; and two relays, one a line-relay having its winding in the main substation-circuit at the central station and the other an auxiliary relay having its winding in
 100 the supervisory circuit, said relays cooperating to control the supervisory circuit and the local call-circuit and the operation of the supervisory and call signals therein.

3. The combination in a telephone-exchange system, of a main substation-circuit controlled by a switch at the substation; a switch-socket for said main circuit and a switch-plug adapted to be inserted therein,
 105 the said socket and plug having registering main and local circuit contacts; a local supervisory circuit at said central station adapted to be completed through the local contacts of said socket and plug; a local call-circuit at the central station; a supervisory-signal device in
 110 the supervisory circuit; a call-signal device in the local call-circuit; and two relays, one a line-relay having its winding in the main substation-circuit at the central station and the other an auxiliary relay having its winding in
 115 the supervisory circuit, said relays having associated armature-contacts in the local call and supervisory circuits respectively whereby said circuits are controlled to effect the operation of the supervisory and call signals
 120 therein. 125

4. The combination in a telephone-exchange system, of a main substation-circuit controlled by a switch at the substation; a switch-socket for said main circuit and a switch-plug adapted to be inserted therein, the said socket and plug having registering main and local circuit-contacts; a local supervisory circuit at said central station adapted to be completed through the local contacts of said socket and plug; a local call-circuit at the central station; a supervisory-signal device in the supervisory circuit; a call-signal device in the local call-circuit; and two relays, one a line-relay having its winding in the main substation-circuit at the central station, its forward contacts in the local call-circuit and its back contacts in the local supervisory circuit, and the other an auxiliary relay having its winding in the local supervisory circuit and its back contact in the local call-circuit, whereby said relays cooperate to control the local call and supervisory circuits and the operation of the call and supervisory signals therein.

5. The combination in a telephone-exchange system, of a main substation-circuit controlled by a switch at the substation; a switch-socket for said main circuit and a switch-plug adapted to be inserted therein, the said socket and plug having registering main and local circuit contacts; a local supervisory circuit at said central station adapted to be completed through the local contacts of said socket and plug; a local call-circuit at the central station; a supervisory-signal device in the supervisory circuit; a call-signal device in the local call-circuit; and two relays, one a line-relay having its winding in the main substation-circuit at the central station, its forward contacts in the local call-circuit and its back contacts in the local supervisory circuit, and the other an auxiliary relay having its winding in the local supervisory circuit; and a shunt or short circuit of the supervisory circuit round a portion of the winding of the auxiliary relay and through the back contacts of the line-relay, to cut out said portion and permit the operation of the supervisory signal when said line-relay is unexcited and to leave said portion in said circuit and prevent the operation of said signal when the same is excited.

6. In a telephone-exchange system, the combination with a telephone-line extending from a substation to an exchange, of a line-relay at the exchange, a source of current adapted to be closed through said line-relay through the agency of substation apparatus, cord connecting apparatus for connecting said line with another for conversation, a cut-off relay included in a high-resistance circuit controlled by the cord connecting apparatus, a line-signal jointly controlled by said line and cut-off relays, a supervisory signal in-

cluded in said high-resistance circuit, and means whereby the deenergization of said line-relay causes a decrease in the resistance of the circuit through said supervisory signal.

7. In a telephone-exchange system, the combination with a telephone-line extending from a substation to an exchange, of a line-relay at the exchange, a source of current adapted to be closed through said line-relay through the agency of substation apparatus, cord connecting apparatus for connecting said line with another for conversation, a cut-off relay included in a high-resistance circuit controlled by the cord connecting apparatus, a line-signal in a local circuit including the armatures of said relays, the circuit through said line-signal being closed when the line-relay is energized and the cut-off relay is deenergized, a supervisory-signal included in said high-resistance circuit, and means whereby the deenergization of said line-relay causes a decrease in the resistance of the circuit through said supervisory signal.

8. In a telephone-exchange system, the combination with a telephone-line extending from a substation to an exchange, of a line-relay at the exchange, a source of current adapted to be closed through said line-relay through the agency of substation apparatus, cord connecting apparatus for connecting said line with another for conversation, a cut-off relay included in a circuit controlled by the cord connecting apparatus, a resistance in said circuit, a line-signal jointly controlled by said line and cut-off relays, a supervisory signal included in the circuit controlled by the cord connecting apparatus, and means whereby the deenergization of said line-relay closes a low-resistance shunt-circuit about said resistance.

9. In a telephone-exchange system, the combination with a telephone-line extending from a substation to an exchange, of a line-relay at the exchange, a source of current adapted to be closed through said line-relay through the agency of substation apparatus, cord connecting apparatus for connecting said line with another for conversation, a cut-off relay included in a circuit controlled by the cord connecting apparatus, a resistance in said circuit, a line-signal included in a local circuit containing the armatures of said relays, the circuit through said line-signal being closed when the line-relay is energized and the cut-off relay is deenergized, a supervisory signal included in the circuit controlled by the cord connecting apparatus, and means whereby the deenergization of said line-relay causes the closure of a low-resistance shunt-circuit about said resistance.

10. In a telephone-exchange system, the combination with a telephone-line extending from a substation to an exchange, of a line-relay at the exchange, a source of current

adapted to be closed through said line-relay
through the agency of substation apparatus,
cord connecting apparatus for connecting
said line with another for conversation, a cut-
5 off relay included in a circuit controlled by
the cord connecting apparatus, a line-signal
included in a local circuit containing the ar-
matures of said relays, the circuit with said
line-signal being closed when the line-relay is
10 energized and the cut-off relay is deenergized, and a supervisory signal included in the

circuit controlled by the cord connecting apparatus, the operation of said supervisory signal being controlled by said line-relay, substantially as described.

In testimony whereof I sign this specification in the presence of two witnesses. 15

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Witnesses:

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