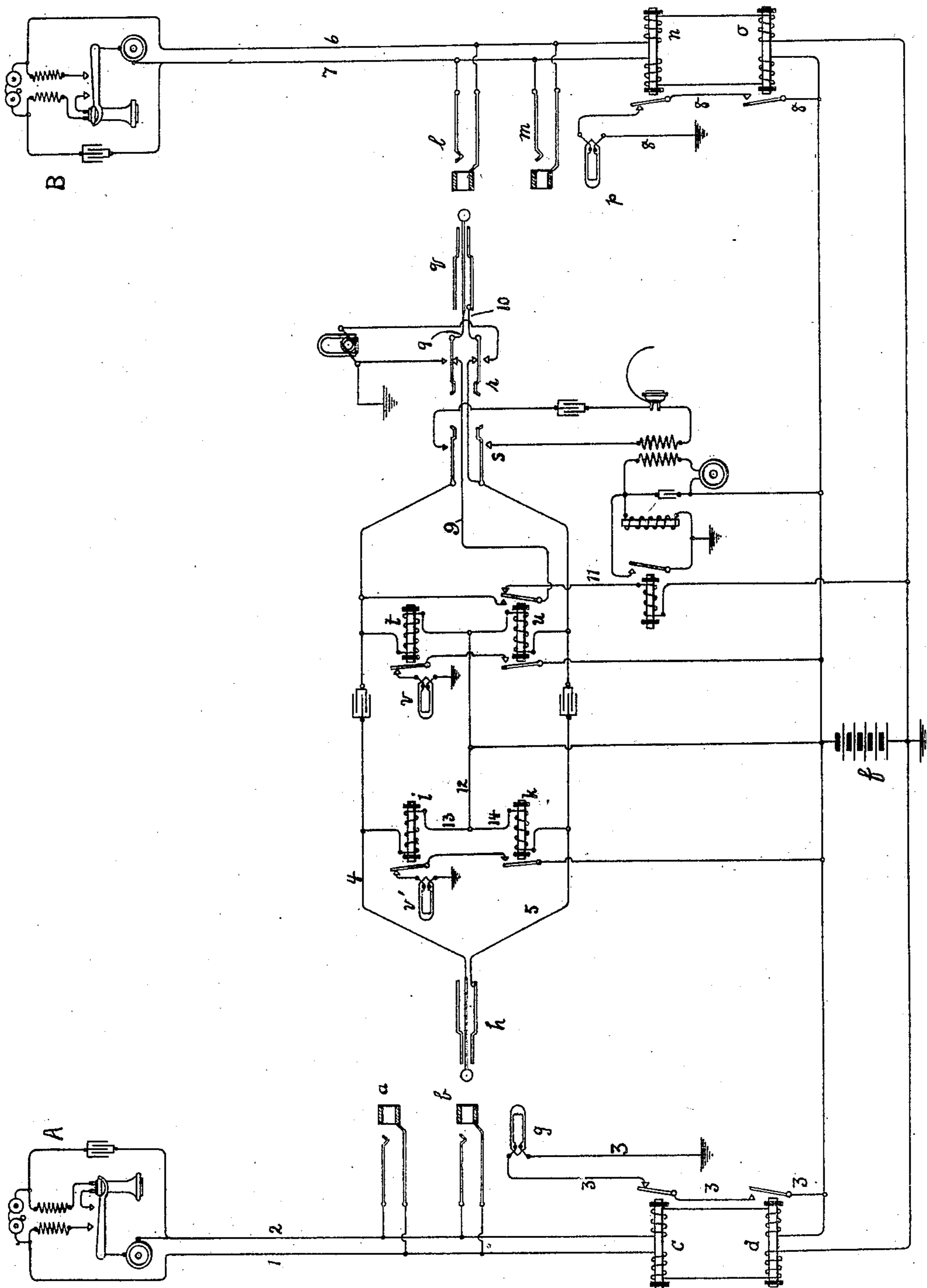


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CENTRAL ENERGY SYSTEM FOR TELEPHONE EXCHANGES.

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UNITED STATES PATENT OFFICE.

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CENTRAL-ENERGY SYSTEM FOR TELEPHONE-EXCHANGES.

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To all whom it may concern:

Be it known that I, JOHN G. ROBERTS, a citizen of the United States, residing at Evanston, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Central-Energy Systems of Telephone-Exchanges, of which the following is a full, clear, concise, and exact description.

My invention relates to telephone-exchange systems in which the battery for supplying the current to the subscribers' telephones is located at the central station.

The switchboard employed in connection with my invention is of the type sometimes termed a "two-wire" switchboard, since the spring-jack switches and the corresponding connecting-plugs require each only two contacts.

My improvement relates more particularly to the line signaling apparatus and the combination thereof with the cord-circuit.

In telephone-exchange systems of the character in question it is usual to provide means whereby a subscriber on taking down his receiver from its switch closes circuit with the battery through electromagnetic apparatus, which acts to disclose the line-signal as an incandescent lamp. This being observed by the operator at the board where the signal is placed, she will immediately make connection with one of the cord-circuits by inserting the answering-plug in the proper switch of the line indicated by the signal. It is desirable that this initial connection should immediately withdraw the line-signal and at the same time bring about such a condition of the cord-circuits as to put a disconnect-signal in position to become active when the subscriber who has called hangs up his telephone. This statement as to clearing out applies not only to the use of the answering-plug, as above stated, but also to the use of the companion plug.

My invention relates more particularly to the combination in the circuit of a telephone-line of two relays, one of which is differentially wound, the differentially-wound relay having its armature-contact adapted to withdraw the line-signal when the magnet is excited, while the other relay is adapted on the subscriber taking down his telephone to attract its armature and cause current to flow to disclose the

line-signal. When the operator sees the line-signal thus disclosed and inserts the answering-plug in the jack of the line, current is directed through one of the differential windings of the differential relay of the line, while the other is partially shunted or short-circuited, so that the differential magnet becomes excited and its armature is attracted, thus diverting the current, which causes the line-signal to be withdrawn. With each cord and its plug of the cord-circuit are associated two relays. The circuit of each pair of relays is so arranged that when its corresponding plug is inserted in the switch of a line and the subscriber's telephone is being used for conversation both of the relays will be excited, one of them serving to close a contact of a circuit leading to the clearing-out signal, but the other serving to hold such circuit open. When, however, the subscriber is through talking and hangs his receiver upon its switch, thus opening the circuit of the telephone-line to battery-current at his station, one of the pair of relays which was holding the circuit of the clearing-out signal open becomes neutral, and thus causes current to be directed through said clearing-out signal to notify the operator to withdraw the plug.

My invention will be more readily understood by reference to the accompanying drawing, in which I have illustrated two telephone-lines extending from the subscribers' stations and connected each with its appropriate switches upon the multiple switchboard and provided each with two relays, one being differentially wound and extending to the central-office battery, which battery, as illustrated in the drawing, conveniently supplies current to the operator's apparatus. I have shown condensers in the cord-circuit in a usual way. Repeating-coils, as is well understood, might be substituted. It should be noted that one of the relays associated with the connecting-plug is provided with an extra contact leading from the tip of the plug through a testing device in order that it may be determined when a call for a line is made whether such line is in use by applying the tip of the plug to the ring of the jack and observing whether there is a click in the telephone, the click indicating that the line is busy. Such a busy test is well known in the art. In like manner

there is provided the usual listening and ringing key in association with the strands of the cord of the connecting-plug.

Station A is provided with the usual receiver, transmitter, induction-coil, gravity-switch, signal-bell, and condenser and is connected by wires 1 2 with the jacks *a b* and with relays *c d* (relay *c* being differentially wound) and the battery *f*. Circuit 3 leads through the armature-contacts of the relays and the line-signal *g*. The answering-plug *h* is provided with two contact-points, the tip being connected with strand 4 and the sleeve-contact with strand 5 of the cord of the answering-plug. The pair of relays *i k* should be of high resistance as compared with the coils of the line-relays *c d*. Subscriber's station B is provided with the usual apparatus and is connected by wires 6 7 with the spring-jacks *l m*, relays *n o*, and battery *f*. The circuit 8 from the battery *f* is connected through the contacts of relays *n o* and the line-signal *p*. The connecting-plug *q* is provided with two contacts, the tip being connected with the strand 9 and the sleeve being connected with the strand 10. The calling-key *r* and the listening-key *s* are arranged in the well-known way, each consisting of two springs or levers, which are by a cam-lever or in some other well-known way thrown upon their respective contacts when desired. The pair of relays *t u* are arranged with respect to their corresponding plug *q*, as are the relays *i k* to plug *h*, so that the supervisory or clearing-out signal *v* may be properly controlled. The relay *u* is provided with an extra armature, the back contact thereof leading to wire 11, which extends to the busy-test apparatus, which is of well-known construction and operation. The front contact of said extra armature, against which the armature is closed when the magnet of the relay *u* is excited, serves to complete the talking-circuit between strand 4 to the tip of the answering-plug and strand 9 to the tip of the connecting-plug.

I will now describe, with reference to the drawing, the manner of connecting and disconnecting two telephone-lines. The subscriber at station A on removing his receiver from its hook completes circuit from battery *f* through relays *d c*. Relay *c* being differentially wound remains inert, relay *d* becoming active and completing the circuit 3 through lamp *g*, which will glow. The operator answers the call by inserting plug *h* in jack *b*. This act causes increased current to flow through the winding of differential relay *c*, included in limb 1, while a partial shunt or short circuit is formed around the coil of said magnet in the circuit of limb 2. The relay thereupon becomes excited and attracts its armature, breaking the circuit of branch 3 and extinguishing the line-signal *g*. When

this action takes place, current from wire 12, connected with battery *f*, is directed by branch 13 through winding of relay *i* to the tip-strand 4 of the cord, and in the other direction by branch 14 through the winding of relay *k* to strand 5 of the cord connected with the sleeve of the plug, so that the pair of magnets *i k* will be excited and both their armatures attracted and the clearing-out signal *v'* will be put in position to be disclosed when the subscriber at station A hangs up his receiver upon its switch-hook.

I will now trace the circuits from the battery, assuming that plug *h* is inserted in the jack *b*. First, it will be apparent that the relay *d* will be still in the circuit of the two limbs 1 2 of the telephone-line and will be excited to attract its armature. The differential relay *c* which was neutral before plug *h* was inserted in jack *b* now becomes active, since current from battery *f* may be traced from wire 12 to wire 14, thence to wire 5, the sleeve of the plug, thence to the limb 1 of the telephone-line, and thence through the left coil of differential magnet *c* to the other pole of the battery, the current in said coil being thus increased. Tracing from wire 12 and wire 13 to limb 2 of the telephone-line it will be seen that the right winding of differential magnet *c* is shunted with respect to the battery. I will say in passing that the windings of magnet *c* are shown on the opposite ends of the core merely for convenience in illustration. The differential winding could be either twin wound superposed one upon the other, or as illustrated whichever might be most convenient, the superposed coils being the most common method for producing neutrality in the magnet by differential winding. The plug *h* being inserted in switch *b*, as we have assumed, and the receiver at station A being removed from the hook, both relays *i k* will be excited—that is to say, as previously partially described—the circuit from one pole of battery *f* may be traced to wire 12, wire 13 to strand 4 to the tip of the plug *h*, thence to limb 2, and thence through the transmitter and switch at station A to limb 1, and thence to the other pole of the battery. When the subscriber replaces the receiver on the switch, the connection for the battery between limbs 2 1 of the telephone-line will be broken at the switch, and thus the circuit of the battery through relay *i* will be broken, and said relay becoming neutral its armature will be retracted, bringing into circuit the disconnecting-signal *v'*, which will glow and serve as a signal to withdraw the plug *h*. It will be observed that when the receiver at station A is thus hung up the relay *k* remains in circuit and will be excited, the circuit, as previously traced in part, being from 12 to wire 14, thence through the winding of relay *k* to strand 5, thence to the sleeve of plug *h*,

thence to the ring of switch *b* to limb 1 of the telephone-line, and thence to the other pole of battery *f*.

The action of relays *t u* and their relations to the disconnecting-signal *v* and to the switch at station B are the same as described with respect to the apparatus at station A and do not need further elucidation.

As a matter of practice in the operation of a telephone-exchange it is usual to wait until both the signals *v v'* are disclosed before pulling out the plugs *g* and *h*. These signals, however, disclose to the operator the condition of the apparatus at each of the stations.

The battery *f* may be of, say, twenty-four volts pressure. The windings of the relays *i k* and *t u* may be as to each of about five hundred ohms. Each of the windings of the differential relay *c* may be of, say, fifty ohms, and the windings of the non-differential relay *d* may be of a hundred ohms. The resistances of the windings of the different relays and the voltage of the battery may be varied greatly. It is moreover evident that the use of two relays, as *c d*, one of them being wound differentially and permanently connected to the telephone-line combined with the battery and the line-signal, as herein described, may be utilized in association or combination with other cord-circuits and various other forms of supervising apparatus.

Having thus described my invention, I claim—

1. In a telephone-exchange system, the combination with the two limbs of a telephone-line extending from a substation to a central office, of two doubly-wound relays having one winding of each included permanently in each limb of the line, a source of current connected with the line at the central

office means at the substation for controlling the flow of current through all of said windings, means at the central office for directing an excess of current through those windings included in one limb of the line and for deducting part of the current through those windings included in the other limb when connection is made with the line, and a line-signal controlled jointly by the two relays.

2. The combination with a telephone-line extending in two conductors from a central source of current to a substation, a switch at the substation controlling the line-circuit, two line-relays each having two windings included permanently in said line conductors, respectively, the two coils of one of said relays being differentially wound, a local circuit containing a line-signal controlled jointly by said relays, a two-part spring-jack for the line at the central office, a corresponding plug and cord-circuit, two supervisory relays included in a bridge of the cord-circuit and controlling jointly a supervisory signal, said supervisory signal being displayed when one of said supervisory relays is excited and the other inert, and a connection from said source of current to said bridge at a point between said supervisory relays, whereby when connection is made with the line said differential relay is excited to withdraw the line-signal and the supervisory signal is brought in position to be displayed upon the termination of conversation.

In witness whereof I hereunto subscribe my name this 31st day of March, A. D. 1903.

JOHN G. ROBERTS.

Witnesss:

W. W. LEACH,
O. M. WERMICH.