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J. W. LATTIG & C. L. GOODRUM.

AUTOMATIC LISTENING APPARATUS FOR TELEPHONE OPERATORS' CORD CIRCUITS.

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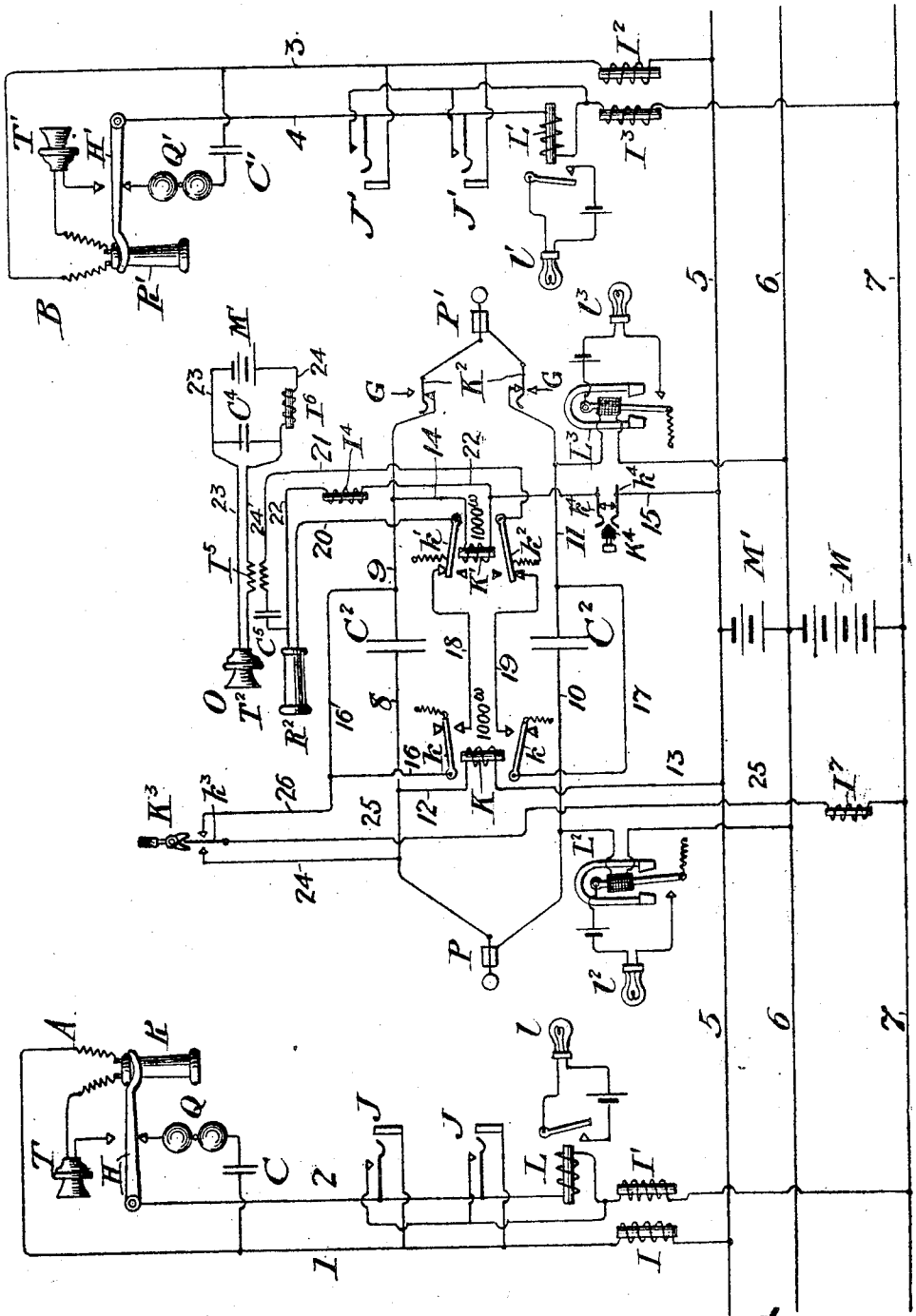

Witnesses:
O. W. Edelin.
Harry F. Brown

Inventors.
Jacob W. Lattig
Charles L. Goodrum
by Edward E. Clement, Atty.

UNITED STATES PATENT OFFICE.

JACOB W. LATTIG, OF WYNCOTE, AND CHARLES LANE GOODRUM, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNORS TO EASTERN TELEPHONE MANUFACTURING COMPANY, OF WEST CHESTER, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

AUTOMATIC LISTENING APPARATUS FOR TELEPHONE-OPERATORS' CORD-CIRCUITS.

No. 798,043. Specification of Letters Patent. Patented Aug. 22, 1905.

Application filed June 6, 1903. Serial No. 160,326.

To all whom it may concern:

Be it known that we, JACOB W. LATTIG, residing in Wyncote, in the county of Montgomery, and CHARLES LANE GOODRUM, residing in Philadelphia, Philadelphia county, State of Pennsylvania, citizens of the United States, have jointly invented a new and useful Automatic Listening Apparatus for Telephone-Operators' Cord-Circuits, of which the following is a specification.

Our invention relates to telephone-exchange systems, and has for its object the production of means automatically operable in the ordinary use and manipulation of the cords and plugs whereby the operator's telephone may be connected and disconnected at proper times and in the proper sequence. To this end we make use of relays connected with the cord-circuits in such fashion that when a call is answered and a connection thereby initiated the operator's circuit is completed to the particular cord-circuit employed, and when the connection is completed by the insertion of the calling-plug in the wanted-line jack the said circuit is again broken.

More specifically stated, our invention embraces a common battery at the central office and a pair of relays for each cord, one connected from the battery to the answering side of the cord and controlling normally open contacts in the operator's circuit and the other connected from the battery to the calling side of the cord and controlling normally closed contacts in the operator's circuit. Each relay is energized when its corresponding plug is inserted in a line-jack.

Our invention is illustrated in the accompanying drawing, wherein the figure is a diagram of a telephone-exchange system, showing two subscribers' lines and the central-office apparatus connected with one cord-circuit, all of which is supposed to be duplicated or multiplied according to the number of lines in the exchange system.

Referring to the drawing, A and B are two subscribers' stations having identical apparatus similarly connected throughout, the parts being designated by the same letters, distinguished from each other as to one line or the other by suitable exponents. At station A, T is the transmitter and R the receiver, which are bridged across the line by the switch-hook H when in use.

Q is the ringer or bell, and C a condenser connected therewith, these being bridged across the line while the hook is down.

1 2 are the line-wires, connected, respectively, from the subscriber's station to the bus-bars 5 and 7 of the main battery M M′ at the central office through suitable impedance-coils I I′. The corresponding line 3 4 from station B is similarly connected through coils I^2 I^3. Each line includes a signal-relay L or L′, controlling a local circuit which includes a source of current-supply and a lamp or other signal *l l* or *l*′. Each line is connected to multiple jacks J or J′, located on the switchboard and provided with contacts closed when a plug is inserted to short-circuit the respective line-relay L or L′

P and P′ are the answering and the calling plugs, respectively, of the cord-circuit 8 9 10 11, the two sides of which are separated in point of conductivity for continuous currents by the interposed condensers C^2 C^2. From the sleeve side of the cord conductors 10 and 11 there are connected two relays of the polar type to the intermediate bus-bar 6. These relays, lettered L^2 and L^3, are of the same description and operate in the same way as those described in United States Letters Patent No. 722,367, granted to us March 10, 1903, for a telephone system. Detailed description herein of the relays or of the operation of the system generally is therefore unnecessary, reference being made to the said patent for a full disclosure thereof. The operation only will be briefly stated here.

When subscriber A calls by removing his receiver from the hook, current flows through the line 1 2 from the main battery and energizes the line-relay, signalizing the call. The operator inserts the answering-plug in the answering-jack J, and thereby achieves three ends—connecting the cord conductors 8 and 10 to the line-wires 2 and 1, short-circuiting the line-relay to obliterate its signal, and connecting the supervisory relay L^2 in a circuit from the bus-bar 6 to the cord 10 through the sleeve-contact of plug and jack to line-wire 1, and so through the coil I to bus-bar 5 and battery-division M′. The current from this battery

is of suitable strength and direction to throw over the armature of the supervisory relay, thereby lighting its lamp if the calling subscriber should leave his hook down; but as long as he maintains his talking-circuit closed an overbalancing electromotive force will be impressed on the relay-bridge from cord to bus 6 due to the other division M of the battery, the armature being thus maintained in the normal position shown, to which it is biased, keeping its lamp dark. In making a call the calling-plug P′ is inserted in the jack J′, and as the line-circuit is presumably open at the substation the supervisory lamp lights; but the line-lamp remains dark, being short-circuited, as already stated. When the subscriber answers by taking down his receiver, the electromotive force at the terminals of the supervisory relay is reversed and the lamp becomes dark.

The above description relates to the system for which we have previously received a patent and with which we have found it convenient to illustrate our present invention. It will be observed that between the answering of the call and the completing of the connection there is a hiatus in which falls the manipulation of the operator's telephone connections and the test. It is with these that our present invention is principally concerned, and they will now be described.

K and K′ are two relays, the former connected from cord conductor 8 by wires 12 and 13 to the bus-bar 5, and the latter from the cord conductor 9 by wires 14 and 15 to the same bus-bar 5. The relay K controls two armatures *k k*, normally resting against back contacts under the influence of suitable retracting-springs, as shown. These armatures are connected by wires 16 and 17, respectively, to the cord conductors 9 and 11. When the magnet is energized, they are drawn up to make contact with the terminals of two wires 18 and 19, respectively, leading to the back contacts, against which normally rest two armatures k' and k^2, controlled by the magnet K′. These armatures k' and k^2 are connected by wires 20 and 21 to the operator's telephone set O.

The operator's set O includes the transmitter T^2 and the receiver R^2. The wire 21 passes from the armature k^2 up to the secondary winding of an induction-coil I^5 to the condenser C^5 and thence to the receiver R^2. The same side of the receiver is connected by a wire 22 through the coil I^4 and wire 15 to the sleeve side of the battery on bus-bar 5. The operator's transmitter is connected in the local circuit 23 24, which passes to the bus-bars of the main battery, designated for convenience as a separate battery M′. The primary winding of the coil I^5 is included in one side 24 of this local circuit, as is also the choke-coil I^6. Between this coil and the transmitter a condenser C^4 is bridged across the circuit to form a shunt-path for current variations due to the transmitter and to prevent their being propagated over the main bus-bars. The wire 22, it will be observed, connects the receiver on one side to the battery-bus 5 on the sleeve side of the battery—that is, on the same side as the sleeves of the jacks. This is the test-wire connection, and the coil I^4 is inserted for the purpose of producing a graduated click in the receiver when a line is found busy, the rush of current producing a very disagreeable effect if such provision were not made. At the same time the coil, which is of considerable resistance and impedance, prevents a disagreeable click being given in the receivers of two connected subscribers when their connected lines are tested for other connections, such a click being produced by the sudden abstraction of a portion of the current from the united lines as the test is made. In order to prevent disturbance of the operation of the other apparatus, the relays K and K′ are high wound, windings of about 1,000^{w} being most suitable in the system illustrated.

The operation of the operator's listening and testing apparatus will now be understood. Supposing A to have called and the answering-plug P to have been inserted, retiring line-signal *l* by short-circuiting the line-relay, and the supervisory signal to be in proper connection to perform its functions. Then another effect has also followed the insertion of the plug—viz., the closing of a path for current from the main battery through the relay K, as follows: bus 7 to coil I′, to shunt-springs in the jack, to tip of plug P, conductor 8, wire 12, relay-magnet K, wire 13, and so back to the battery-bus 5. Sufficient current passes through this circuit and through the magnet K to energize the latter operatively, the armatures being pulled up, connecting the wires 18 and 19 through *k* and *k* to wires 16 and 17, respectively, and so to cord conductors 9 and 11. As the plug P′ is idle up to this point in the operation, the relay K′ is quiescent, and the armatures k' k^2 remaining in retracted position the operator's telephone is bridged across the conductors 9 and 11 for purposes of conversation, with one side of the receiver connected to the bus 5 and the other side to the tip of the plug P′ by the path 20, k', 18, *k*, 16, 9, to tip—this for the purposes of testing. In making the test the operator touches the tip of the plug P′ to the sleeve of the wanted multiple jack, as usual. If the line is idle, the only battery connection it has to the sleeve side 3 is by way of the bus 5. This, however, is the same side the receiver connection is made to. Hence there is normally no difference of potential between the tip of the plug and the sleeve of the jack, and the test gives silence in the operator's receiver, indicating that the line may be taken possession of by full insertion of the plug. If the

line is in use, the conditions will be very different. If the line is calling and has not yet been answered, the circuit being closed at the subscriber's station, the potential of the sleeve of the jack, referred to the bus 5, is raised to the full strength of the batteries M and M', less the drop due to the line resistance. As the tip is applied to the sleeve under this condition, therefore, a click will be obtained, indicating that the line is busy, and it will be observed that the strength of this click can be very nicely graduated, notwithstanding it is due to the entire voltage of the battery, because the telephone is really working around the coil I^2 on the drop in potential, and this coil, as well as the coil I^4, can be adjusted once for all. Suppose the line is being called and has not yet answered. Another plug P' is then in a jack, and the bus 6 is connected to the jack-sleeves through the supervisory relay L^3 of the cord so in use. A corresponding difference of potential is thus again produced when the tip is applied, and the resulting click warns the operator to keep off. In case the line is in use, having called and been answered or been called and answered, a double connection to produce a difference of potential is existent, and the click results, as before. In case the line is found idle the operator inserts the plug in the wanted jack. As soon as she has done so, a circuit is closed through the relay-magnet K', as follows: battery-bus 7 to coil I^3, to shunt-springs in jack, to tip of plug, conductor 9, wire 14, magnet K', wire 15, and to bus 5 and battery. Magnet K' then becomes energized and pulls in its armatures k' and k^2, which break the connection between the wires 20 and 18 and 21 and 19, respectively, thereby cutting off the operator's set from the cord.

We have shown the relays K and K' with armatures forming part of the circuits controlled and their contacts as fixed solidly in place. It should be understood that we do not limit ourselves to the use of any particular type of relay, this form being diagrammatic merely and used for convenience. The type of relay most successfully used in telephone practice has series of German-silver springs with platinum points overlying each other and constituting all the contacts, closed and open and also movable, movement to produce makes and breaks, as desired, being caused by the armature lifting or depressing some or all of the springs, its functions being thus merely mechanical. This type of relay we usually employ in our system.

We have shown the ordinary ringing-key K^2 connected in the cord-circuit to separate conductors 9 and 11 from their connection with the calling-plug and connect the latter with the generator-terminals G G. As this forms no part of our invention, detailed description is unnecessary.

The action of the relays K and K' is ordinarily automatic; but occasions may arise in operation when one or the other relay should act without the insertion of a plug. Such an occasion for connection of the operator's set would be when a call is to be made without first having answered an incoming call, the answering-plug being idle. For this purpose it is necessary to have means of an auxiliary nature to energize relay K, and such means we have shown as a circuit-closer K^3, controlling a spring k^3, lying between contacts connected, respectively, to cord conductors 8 and 9 by way of wires 24 and 26 16, the spring being connected by wire 25, through coil I', to the battery-bus 7. The coil I^7 is similar in winding and resistance to coil I'. Hence by closing the spring k^3 on wire 24 the relay K gets current the same as if the plug P were inserted. The operator's telephone can thus be connected by manipulating key K^3 with plug P idle and any line tested and connection made therewith, ringing up the subscriber in the usual way. If now it is desired to continue the operator's telephone on that cord to converse with the called subscriber and without changing plugs, the relay K' must be deenergized, for the moment the plug P' was inserted it cut off the operator. For this purpose we add a key K^4, which breaks the circuit of relay K' at a point in the wire 15 by separating the springs k^4. This will leave the operator's set in circuit with the plug P' and the called subscriber as long as the key K^4 is held depressed.

It may be necessary to cut out the operator's telephone for a moment during the work of connecting before the calling-plug is inserted—for instance, if the calling subscriber has given the wrong number and wants a moment to look it up in the directory. In such case we provide means to energize the relay K' manually, consisting of the second contact on the right of the spring k^3 of the key K^3, already referred to. Thus by the movement of this key to the left the operator's telephone will be cut in if the answering-plug is idle. By moving it to the right the set will be cut out if the calling-plug is idle, and by depressing the key K^4 the set may be cut in again when both plugs are in jacks, thus permitting the operator to listen in on connected lines if necessary. All these keys and contacts are auxiliary and will be so claimed. They form part of our invention and are valuable in supplementing the automatic means.

Having thus described our invention, what we claim, and desire to secure by Letters Patent, is—

1. In a telephone-exchange system, subscribers' lines and connective terminals therefor, connective circuits and coöperating terminals therefor, an operator's telephone and a circuit therefor, normally open contacts and normally closed contacts in series in the op-

erator's telephone-circuit, a magnet actuated in initiating a connection between subscribers' lines to close the normally open contacts to connect the operator's telephone, and means actuated in completing the connection to open the normally closed contacts to disconnect the telephone, substantially as described.

2. In a telephone-exchange system, subscribers' lines and terminal jacks therefor, an operator's cord-circuits having answering and calling plugs in pairs, a source of energy, a relay associated with each plug of a pair, an operator's telephone set for listening and testing, means controlled by the answering-plug relay to connect the said set to the cord-circuit, means controlled by the calling-plug relay to disconnect the same, and circuit connections from the source of energy to the relays controlled in the use of their respective associated plugs, substantially as described.

3. In a telephone-exchange system, subscribers' lines and terminal jacks therefor, an operator's cord-circuits and answering and calling plugs therefor, an operator's telephone and connecting and disconnecting relays therefor associated with the respective plugs and adapted to connect and disconnect the operator's telephone in sequence to and from their respective cord-circuits, a source of current for said relays, circuits for said connecting-relays and circuit-closers therefor controlled by the operator for connecting her telephone, and a circuit automatically completed by the insertion of a calling-plug in a jack for disconnecting the telephone from its cord-circuit, substantially as described.

4. In a telephone-exchange system, subscribers' line-circuits and terminal jacks therefor, an operator's cord-circuit having an answering and a calling plug, an operator's telephone, a relay associated with each plug, circuit connections from the relays to contacts on the plugs, a source of current and coöperating contacts in the jacks, circuit connections from the operator's telephone to normally closed contacts under control of the calling-plug relay, and thence in series therewith through normally open contacts controlled by the answering-plug relay to the cord conductors, whereby the operator's set is connected to the cord when the answering-plug is inserted in a jack, and is disconnected therefrom when the calling-plug is inserted in a jack in the completion of connection, substantially as described.

5. In a telephone-exchange system, subscribers' line-circuits and terminal jacks therefor, an operator's cord-circuit having an answering and a calling plug, an operator's telephone, a relay associated with each plug, circuit connections from the relays to contacts on the plugs, a source of current and coöperating contacts in the jacks, circuit connections from the operator's telephone to normally closed contacts under control of the calling-plug relay, and thence in series therewith through normally open contacts controlled by the answering-plug relay to the cord conductors, together with auxiliary circuit connections from the relays to circuit-closers under control of the operator, whereby the connection and disconnection of her telephone may be effected either automatically in the use of the plugs, or manually when required, substantially as described.

It witness whereof we have hereunto signed our names in the presence of two subscribing witnesses.

JACOB W. LATTIG.
CHARLES LANE GOODRUM.

Witnesses:
M. S. LEWIS,
EDWARD E. CLEMENT.