No. 646,694. Patented Apr. 3, 1900.

W. D. GHARKY & E. E. CLEMENT.

TELEPHONE EXCHANGE SYSTEM.

(Application filed Aug. 20, 1898.)

(No Model.) 2 Sheets—Sheet 1.

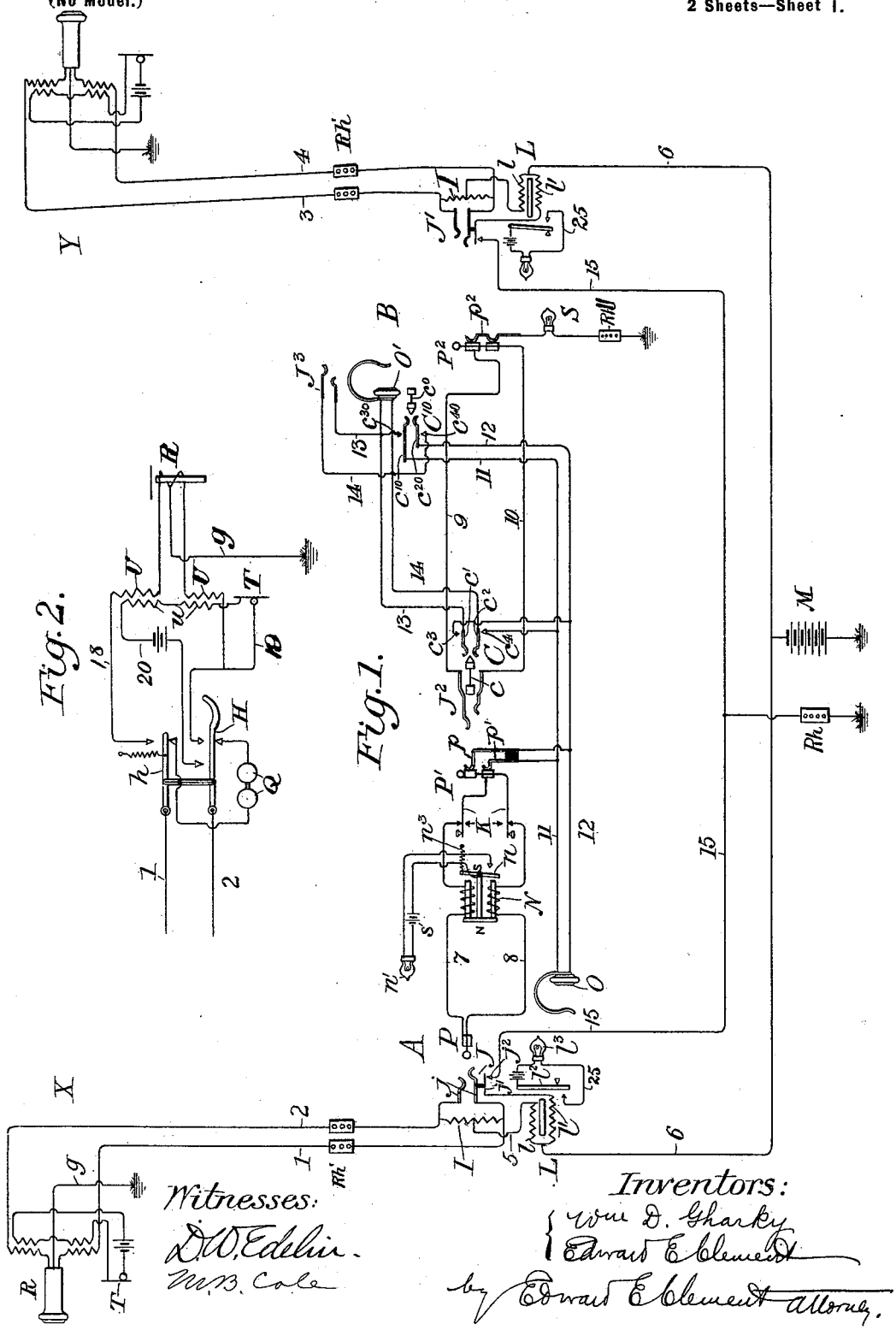

Fig. 1.

Fig. 2.

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Fig. 3.

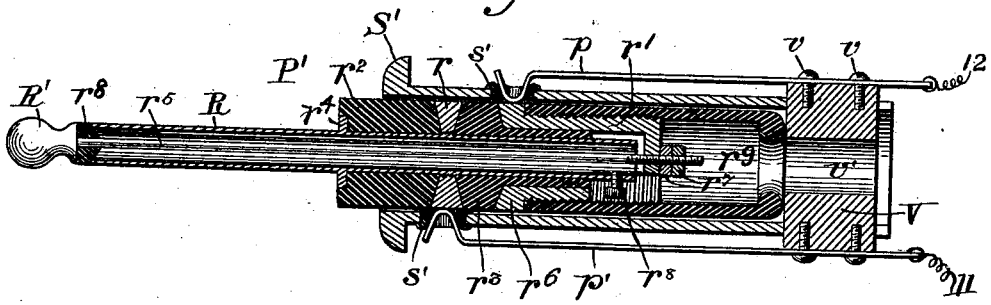


Fig. 4.

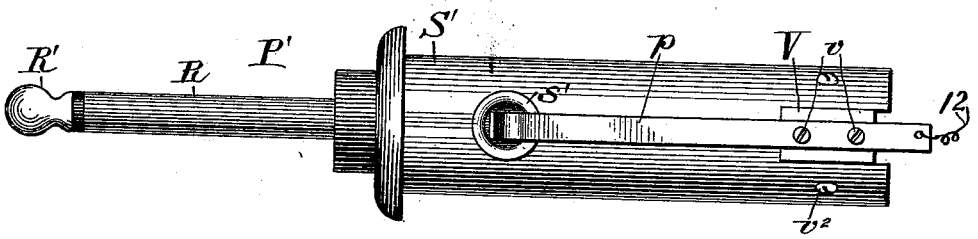
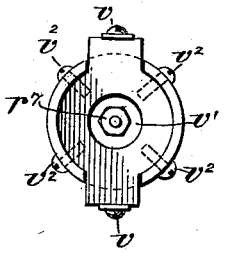


Fig. 5.



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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 646,694, dated April 3, 1900.

Application filed August 20, 1898. Serial No. 689,119. (No model.)

To all whom it may concern:

Be it known that we, WILLIAM D. GHARKY, residing in the city and county of Philadelphia, State of Pennsylvania, and EDWARD E. CLEMENT, residing in Washington, in the District of Columbia, citizens of the United States, have invented a new and useful Improvement in Telephone-Exchange Systems, of which the following is a specification.

Our invention relates to improvements in telephone-exchange systems in which subscribers' lines radiate from one or more common central offices, each line being provided at the subscriber's end with means for receiving or transmitting signals and a telephone set and at the central-office end with signal-receiving means and connective means, and each central office being provided with connecting means, with telephone sets, and with signal sending and receiving means, all capable of use with any of the lines.

The direct objects of the invention are the elimination of unnecessary apparatus, the simplification of all apparatus retained, the attainment of absolute privacy in conversations between subscribers, and an increase in the rapidity, as well as the certainty, of central-office operations. Many incidental advantages will appear from the detailed description, which need not be specifically mentioned.

In order to attain the objects above set out, we have provided certain means, which may be used in any system, but certain other means, relating particularly to central-office connections, which is particularly adapted for what is known as a "trunking" or "divided" central system. The first-mentioned apparatus we use in exchanges having but few subscribers. The second is intended for large systems having many subscribers. The following description will be based entirely on the second, for the reason that the first cooperates with it, and in fact forms a component part of it in large exchanges, and the operations are the same whether used in such coöperative relation or separately. The leading features then of a large exchange constructed in accordance with the invention are as follows: All signals are automatic from the first call for connection, which is sent by the act of taking down the subscriber's receiving-telephone for use, to the clearing-out signals, which are given by the replacement of the receiving-telephone upon its hook. The operators are divided into two sets, the duty of one set being to answer calls, while that of the other is to complete connections initiated by and according to instructions received from the first set. The work is thus simplified and expedited. The answering of a call, the passing of the number wanted, and the sending out of a ringing-current over the called line are all done in any particular instance by one and the same operator. Responsibility for omissions or delays is thus fixed. The operators are provided with supervisory signals always in service, which enable them to see at a glance the condition of a line at any time, whether the subscriber has called, whether he has been connected, whether he has answered or not, and whether one subscriber or both after conversing have hung up their receiving-telephones as a signal of conclusion. Perfect control of the work is thus attained. Finally, the operators depend upon their signals alone for information as to use or non-use of connected lines, having no means to connect their telephones directly or indirectly thereto after complete connection is once established. Absolute privacy is thus insured.

The general scheme of circuits and operation is as follows: All conversation is carried on over metallic circuits, using the wires throughout in series relation, while all signals are controlled over the same wires, but on separate circuits, known technically as "phantom-circuits," composed of the line and connecting wires in multiple relation with ground or separate wires for return. Both conversation and signaling are thus enabled to be simultaneously effected without mutual interference. The conversation or series circuits consist in any case of the line-wires and connecting-cords, with interposed trunk-lines where the subscribers happen to be connected to different switchboards. The supervisory-signal scheme is based on the principle of the Wheatstone bridge, any two line-

wires with their line-signal circuits and the interconnecting office-wires constituting a bridge, whereof two sides contain the line-signals, the other two sides contain the subscribers' instruments, the bridge contains the supervisory signal, and an external supply-circuit, consisting of the earth or a common return, contains a source of signaling-current. In this connection it should be stated that neither line-signals nor conversation depend upon the bridge for their effect.

Our invention is illustrated in the accompanying drawings, in which the same letters and numerals of reference indicate the same parts throughout.

Figure 1 is a diagram showing two subscribers' lines with their substation and central-station apparatus, together with one complete central-office outfit for their connection, including trunk and signal circuits. Fig. 2 is a similar diagram showing with more detail the arrangement of a preferred form of subscriber's apparatus, and Figs. 3, 4, and 5 are detail views of plugs and their seats.

Referring to the drawings, X and Y are two subscribers' stations, provided with receiving-telephones R, transmitters T, and line-wires 1 2 and 3 4, respectively, leading to different switchboards of the same or different central offices. We have shown them so connected because the interconnection of subscribers on the same board or section is accomplished with a portion of the same apparatus and by the same steps.

Bridged across the line-wires at the central office are impedance-coils I I, and connected to the ends of the wires are the springs $j\,j$ of the jacks J and J'. From the middle point of each impedance-coil a wire 5 is led to one end of winding l of an annunciator or relay magnet L, the other end of which is connected by wire 6 through the main battery M to ground. The magnet L is provided with another winding l', laid on oppositely and differentially with respect to the winding l and connected on one side to the wire 6 and on the other to a contact-spring j' in the spring-jack. This spring j' is so arranged that it is closed upon a contact-anvil j^2 whenever a plug is inserted in the jack, said contact-anvil j^2 being connected through wire 15 and resistance Rh to ground. The magnet L when energized operates a signal-lamp l^3 through the medium of an armature l^2, adapted to close a local circuit 25, containing the lamp and a suitable source of current. It is not necessary, however, that this signal should be a lamp or that the magnet L should act as a relay, for the armature l^2 may be so shaped as to serve as a signal itself in its movement.

The battery M and the resistance Rh are preferably common to all the lines on a section or in the exchange, and it will be observed that the former is never disconnected from the lines, being always ready to send out current over any line that is closed to ground at its other extremity. A constant test is thus maintained, as an accidental ground on either side of a line will manifest itself without delay at the central office.

At each answering-section of the switchboard—*i. e.*, before each answering operator, hereinafter spoken of as the "A" operator—and adapted to coöperate with the spring-jacks J and J' are pairs of plugs P P', each having two contacts connected with the corresponding contacts on its fellow by cord conductors 7 and 8. Interposed in each cord-circuit is an ordinary ringing-key K, adapted when actuated to disconnect plug P' from plug P and to connect it to a common circuit containing calling means, such as a generator, in a well-known manner. The plug P of each pair is of ordinary construction and needs no description. It ordinarily rests in a plain seat on the board-table, its cord conductor passing through a suitable orifice in the common way. Each plug P', however, is provided with external metallic rings or conducting portions $r\ r'$ on its body, which are electrically connected to its sleeve and tip contacts R R', respectively, and are adapted to make contact with springs p and p', carried in the plug-seat and insulated therefrom, as shown. These springs p and p' are permanently connected to the two sides 11 12 of the circuit of the operator's telephone O. By this arrangement it is apparent as long as plug P' remains in its seat the operator's telephone is connected to the cord-circuit 7 8, and hence if the plug P be inserted in a line-jack is thereby connected to line without any further act on the part of the operator.

The apparatus thus far described is sufficient for the connection and disconnection of lines on the same switchboard or section; but for connecting lines on different sections further means are provided. These consist of three principal appliances—viz., trunk or transfer circuits, operators' instruction-circuits therefor, and supervisory signals in the plug-cords.

The trunk-circuits are plain twin-wire circuits passing between the boards or board-sections, each terminating at one end in a spring-jack and at the other in a plug. The trunk-jacks J^2 are all placed in front of A operators, while the corresponding trunk-plugs are all placed in front of B operators. The terminal plugs P^2, as shown, are of the same construction as the plugs P' of the cord-circuits. The seats in which they normally rest are provided each with a single contact-spring, however, adapted to make connection with both plug-contacts. Connected to the spring p^2 of each trunk-plug seat is a wire leading to a signal S, (shown as an incandescent lamp,) and thence through a resistance Rh to ground. This is the trunk-signal, which indicates to the B operator that its trunk-line has been plugged in on by an A operator at another board.

Within each trunk-jack J^2 is provided a circuit-closer C, comprising a reciprocating

plunger c, adapted to be moved by a plug when the latter is inserted to its fullest extent in the jack, and springs c' c^2, adapted to be spread thereby to make contact with anvils c^3 c^4. These parts are so adjusted that the plug in its normal position in the jack leaves the circuit-closer untouched, a farther insertion than that required for contact with the jack-springs being necessary to operate the circuit-closer. This operation of the circuit-closer, moreover, is only temporary, the pressure of the springs c' and c^2 on the inclined surfaces or cam-faces of the plunger c ejecting the same into the position shown in the drawings when pressure is removed from the plug. This action of the springs c' and c^2 may be assisted, if necessary, by an ordinary helical retracting-spring around the stem of the plunger. The springs c' c^2 are connected, respectively, to the two sides 13 14 of the B operator's telephone-circuit, while the contact-anvils c^3 c^4 are similarly connected to the circuit 11 12 of the A operator. Thus the depression of the plunger c by an entered plug crosses these two circuits for the time.

Each B operator's circuit 13 14 has three terminal pieces of apparatus connected in parallel—viz., the telephone set O', the plunger-switch C^{10}, and a spring-jack J^3. The switch C^{10} is similar in its construction to the switch C and has the same function, that of crossing the B with an A operator's circuit. For this purpose each A operator's circuit is extended to all the B board-sections, or rather B operators, at each of which it has branch connections to the springs c^{10} c^{20}, which when spread by the plunger c^0 make contact with anvils c^{30} c^{40}. The jack J^3 is adapted to receive the terminal trunk-plugs on occasion and is technically denominated the "busy jack."

Since the ringing-keys which are placed in the cord-circuits 7 8 are exclusively under the control of A operators, it is necessary to provide some means whereby those operators will be enabled to know when to ring and when to stop—that is, when the B operator in any case has inserted the trunk-plug in the jack of the wanted subscriber and when such subscriber has answered. The means provided for this purpose comprise a polarized relay or annunciator magnet N and a signal controlled thereby. The windings of this magnet are included in both sides of the plug-cord 7 8, and it is operative only on the passage therethrough in parallel of current of a given direction—that is, the windings are differential as regards the two sides 7 8 of the cord in series. The magnet is shown with an armature n, adapted in one position to be idle, but in the other to close a local circuit containing a signal n'. Of course the armature n might well serve as the signal itself, however. A retracting-spring n^3 serves to keep the armature in its inoperative position when no current whatever is passing.

The subscribers' circuits (shown in Fig. 1) are lacking in detail, being diagraphically represented as they are while the talking set is connected. A fuller diagram is that in Fig. 3, wherein 1 2 are the line-wires, normally closed when the receiver is on the hook through the hook-lever H and parallel connected arm h to the circuit of the ringer Q. With the receiver off the hook the line-wires 1 2 are continued by way of hook-lever H and arm h to wires 18 19, the two sides of divided induction-coil U, receiver R, and wire g to ground, the receiver being thus inserted in the metallic circuit between the two halves of the induction-coil and having the middle point of its windings connected to ground. The local circuit 20, containing primary winding u of the induction-coil, transmitter T, and a suitable battery, is closed by hook H at the same time that the main circuit is thus completed.

The operation of the system will now be understood. Subscriber X desiring to converse with subscriber Y, removes his receiver R from the hook and places it to his ear. This puts his apparatus in the condition shown in Fig. 1. Current from battery M passes to ground, to the wire g, to the middle point of the receiver-windings, through the two halves of induction-coil U to and through line-wires 1 2 in parallel to the central office, through the two halves of the impedance-coil I to its middle point, through wire 5, the winding l of magnet L, and the wire 6 back to the battery. The magnet L is energized by this current and attracts its armature l^2, displaying the signal l^3. The A operator, perceiving the signal, inserts the plug P in the jack J, causing the springs j to make contact with the sleeve and tip of the plug, and thus connecting the cord-circuit and her telephone O to the line. At the same time the spreading of springs j causes the spring j' to close on the anvil j^2, when a circuit is completed from battery M through wire 6 to winding l' of magnet L, to the spring j' and anvil j^2, wire 15, and through resistance Rh to ground and back to battery. The current in coil l' neutralizes that in coil l as regards their effect on the core of the magnet L, whose armature l^2 is thereupon retracted and the signal l^3 retired. Having ascertained from subscriber X that he desires connection with subscriber Y and knowing the latter to be connected to another switchboard-section, the answering operator lifts plug P' from its seat, disconnecting her telephone by the act, and places said plug in the jack J^2 on a trunk-line leading to the section whereon Y's terminal jack is located, pressing it into said jack as far as it will go. The first effect of this insertion of plug P' into jack J^2 is to complete a circuit from battery M to ground, to resistance Rh' and signal S, to spring p^2, contact-rings on plug P^2 and the trunk-circuit 9 10 to the jack J^2 and plug P', through the cord-circuit 7 8, including the windings in parallel of magnet N, the plug P

and jack J, the two halves of the impedance-coil I, wire 5, winding *l*, and wire 6 back to the battery. This current lights the lamp S, which is a high-resistance lamp adapted to take the voltage required for the other signals, but does not energize magnet N. The second effect of insertion of plug P′ into jack J^2 is to cross the circuit 11 12 of A operator's set O with the circuit 13 14 of B operator's set O′ in the circuit-closer C. The A operator then repeats the number required, and the B operator lifts the plug P^2, whose signal is displayed, from its seat and inserts it in the proper jack. As she lifts the plug the signal is of course disconnected and retired. As soon as the plug is inserted in the required jack a new path from battery M is formed—viz., from battery to ground, to subscriber's station X, to wire *g*, and line-wires 1 2 to central jack J, plug P, cord-circuit 7 8, including windings of magnet N, plug P′, jack J^2, trunk-wires 9 10, plug P^2, jack J′, coil I, wire 6, and back to battery. It will be observed that this current flows through magnet N in the opposite direction from that of the signaling-current. The magnet is therefore energized in a proper way to turn its armature *n* and close the local circuit containing battery *s* and signal *n*′. The battery M as installed in systems of this character always has a low internal resistance, and as the line-wires 1 2 are used in parallel there is always a sufficient flow of current under the conditions thus stated to supply the branch circuit through conductors 7, 8, 9, and 10 no matter what the relative resistances may be. Being thus apprised by the signal *n*′ that plug P^2 is in the required jack, the A operator depresses the ringing-key K to send a calling-current forward over the trunk and called line. When subscriber Y answers by taking down his telephone from the hook, the signal *n*′ disappears. This is because a circuit is then completed to ground at station Y through wire *g* similar in every way to that at station X, and consequently battery M will send its current over the two lines in parallel, and none will pass through the cord and trunk line. This is a true Wheatstone-bridge effect, and in order that it may be attained in every case without fail the lines are necessarily all brought to the same or approximately the same resistance by the use of artificial resistances inserted, preferably, at the distributing-boards before they reach the switchboards proper. There is a second reason why the line-resistance must be equalized and that is for uniformity in working of the neutralizing-circuit 15. Either each individual branch of wire 15 must be separately balanced with its line, so as not to shunt it when cut in, or the lines must all be balanced, and the latter is the most satisfactory scheme. Line-balancing resistances are shown at R*h*′ in Fig. 1. When the two subscribers have finished their communication and have both replaced their receivers on the hooks, current no longer flows through the windings *l* of the magnets L and L. These magnets are therefore immediately energized by the local windings *l*′, and both display their signals as clearing-out signals. The hanging up of one of the receivers alone will produce no effect, except that if the called subscriber only should replace his instrument the magnet N will be energized to apprise the A operator of the fact. As long as either telephone is off the hook current will pass through both magnet-windings *l*.

In case the called subscriber does not answer the first ring the A operator, seeing the signal *n*′ active, will ring again. If he does not answer at all within a reasonable time, she withdraws plug P′ from the trunk-jack and restores it to its socket. This immediately places her again in connection with the calling subscriber, so that she can apprise him of the circumstances. At the same time, the plug P^2 being still in the jack J′, the winding *l*′ is immediately rendered active and the B operator gets a clearing-out signal without knowing, as it is not necessary she should know that the call has not been answered.

In case the connection proceeds up to the point of insertion of plug P^2 into jack J′ and the B operator discovers that the desired line is already busy, a plug being in that jack, she simply inserts the trunk-plug P^2 in her "busy jack" J^3 and speaking directly to the calling subscriber says "line busy." At the same time she can depress the plunger *c* of switch c^{10}, and the A operator hears the statement, thereupon disconnecting the calling-line.

In this system it will be observed there are no separate clearing-out signals and no bridges whatever of the office-circuits. The impedance-coils I I are bridged across the connected circuits; but they are wound to very high apparent resistance. The subscribers talk through the windings of magnet N; but these windings are of very low resistance and impedance individually, and, moreover, neutralize each other as to currents in the metallic circuit.

Figs. 3, 4, and 5 show a plug and plug-seat especially adapted for use in the system thus described. Each plug P′ comprises a tube R, of metal, provided with a shoulder r^4, integrally formed thereon a central spindle r^5, carrying a tip or head contact R′ and insulated from the tube R by the conical bushing r^8, a heel cup or thimble *r*′, surrounding but insulated from the tube R, and insulated contact-rings *r* and r^6, carried by and forming part of the tube and the thimble, respectively. In assembling the plug the insulating-sleeve r^2 is first slipped on the tube R from the rear end until it rests against the shoulder r^4, the ring *r* is screwed in place, the insulating-sleeve r^3 is slipped on, the thimble *r*′ put over it, and the spindle r^5 inserted and screwed firmly up in the thimble to bind the whole together. It will be observed that the thimble is centered on the tube over the insulating-sleeve r^3, and this centers the spindle r^5 with-

out further means. A rubber or fiber heel-cup r^9 is screwed over the thimble r', which is cut away at one side to expose the end of the tube R, the latter being there provided with a binding-screw r^8 for the cord conductor. The other cord connection with the spindle r^5 is made by means of binding-nuts r^7 directly on the end of the spindle. Of a size to receive the plug we provide a tubular seat S', having rubber-bushed side openings s' and a diametrical cut of some width across its lower end, while at its upper end it has a bead or flange to seat around the edges of the opening that receives it. Seated in the cut at the lower end of the tube S' is a perforated block V, of insulating material, with side pieces or wings projecting from opposite sides of the tube and carrying springs $p\,p'$, secured by screws v. These springs $p\,p'$ extend up along and parallel with the tube and at their upper ends are provided with bent contact portions adapted to enter the bushed perforations s' and make contact with the rings r and r^6, respectively, of the plug. The block V is secured within the tube S' by screws v^2, and its central perforation, as shown in Figs. 3 and 5, permits the passage of the conducting-cord from the plug. The rubber bushings prevent the accidental contact of the springs with the tube when the plug is withdrawn, which would short-circuit the springs.

We do not wish to be confined to particular details of construction herein set forth or to specific arrangements of the apparatus or circuits, much of which may be changed without departing from the spirit of the invention, but should be understood as including all minor changes within the scope and purview of our description.

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

1. In a telephone-exchange system, a subscriber's line, a spring-jack therefor, a line-annunciator having differential windings, and a source of current, said source being permanently connected to the line through one winding of the annunciator and adapted to energize it or not according to the condition of the line, in combination with a local circuit containing the second winding and means actuated by an operator in making connection with the line to close said local circuit and maintain the same closed as long as the connection continues, substantially as described.

2. In a telephone-exchange system, a subscriber's line, bearing a constantly-impressed electromotive force, means at the subscriber's station for determining the flow of current in the line, a doubly-wound annunciator, one of whose windings is connected permanently to line and the other in a normally-open local circuit, also bearing a constantly-impressed electromotive force, the two windings being equal and opposite in their magnetizing effect, and means actuated by the operator in making connection with the line to close said local circuit, and maintain it closed as long as the connection continues, whereby the subscriber may actuate the annunciator by causing an initial flow in the line, the operator may restore it by neutralizing the effects of said flow, and the subscriber may again actuate it by causing the flow in the line to cease, substantially as described.

3. In a telephone-exchange system, subscribers' lines, and combined calling and clearing-out annunciators therefor, each consisting of a doubly and differentially wound magnet and its armature, a constantly-active source of current, means under the control of a subscriber to direct current from said source through one winding of his annunciator, means under the control of an answering operator to direct current through the other winding, and further means under the control of the subscriber to cut off the current from one winding, leaving the other active, substantially as described.

4. In a telephone-exchange system a subscriber's line, and an annunciator and spring-jack therefor at the central office, the annunciator being provided with double windings laid on differentially, one winding connected to the line and the other in a local circuit, a constantly-active source of current, means at the subscriber's station, actuated in switching the telephone for use, to open and close circuit through said source and through the line-winding of the annunciator, and means connected with the spring-jack, and actuated by an operator in making connection therewith, to close the local circuit through a source of current while such connection continues, substantially as described.

5. In a telephone-exchange system two subscribers' lines, each permanently connected through a line-annunciator to a source of current, and a common return-conductor separate from the lines, extending from the source of current to the subscribers' stations, central-office-connecting means bridged across the lines and forming a metallic-circuit path for conversation-currents, a supervisory signal included directly in the said connecting means, and switches at the subscribers' stations for determining the flow of current in the respective lines, substantially as described.

6. In a telephone-exchange system, a subscriber's line permanently connected at one switchboard-section through a line-annunciator winding to a source of current, and provided with a terminal jack; a trunk-line extending to another switchboard-section and connected to a signal at its farther end, and means to connect said line-jack to the trunk-line, the arrangement being such that when the line is so connected current will flow from the line through the trunk-line and cause the exhibition of the signal, substantially as described.

7. In a telephone-exchange system a subscriber's line having a terminal jack, a pair of

plugs and a metallic-circuit-connecting cord consisting of two conductors, the second plug of the pair having a tip and a sleeve connected respectively to the two conductors of the cord, a pair of rings carried on the body of the plug and insulated from each other, one joined to the tip-contact, and the other to the sleeve, together with a plug-seat carrying a block of insulation with a pair of springs thereon connected respectively to the opposite sides of an operator's circuit, the springs being of different lengths, so as to make contact respectively with the two rings on the plug when the latter is in the seat, whereby an operator's circuit is directly connected with a subscriber's circuit by the mere act of inserting an answering-plug, substantially as described.

8. In a switch-plug for telephone systems the tube constituting a sleeve-contact, the central spindle terminating in a tip-contact, the cone of insulation underlying the tip and fitting within the end of the tube, the insulating-jacket on the tube, and the surrounding cup centered thereon, cut away to expose the end of the tube, and receiving and centering the end of the spindle, substantially as described.

9. In switching apparatus the plug consisting of a tubular body, an insulated headed spindle therein, a rear cup surrounding the body but insulated therefrom and receiving the end of the spindle, and exposed conducting portions on said body and cup; in combination with a recessed seat, and insulated contact-springs therein adapted to rest on said conducting portions of the plug when it is in the seat, substantially as described.

10. In switching apparatus the plug-seat consisting of a tubular shell, a block of insulation secured to the lower end thereof and perforated to permit the passage of the plug-cord, bushed orifices in the sides of the shell at different distances from the block, and contact-springs secured to the block and extending through the orifices within the shell, substantially as described.

11. In a telephone-exchange system the combination of subscribers' lines connected to a common source of current at the central office, and arranged to permit the current to flow over each pair of wires in parallel when the circuit is closed at the subscriber's station, a central-office circuit for connecting one pair with another for conversation, and a supervisory-signal magnet included therein having its windings oppositely connected in the two sides thereof, said connecting-circuit forming a bridge of the connected lines, whereby if only one subscriber has his circuit closed the operator will be apprised thereof, substantially as described.

12. In a telephone-exchange system, subscribers' lines connected through a common source of current at a central office to ground or a common return, and provided with switches at the subscribers' stations to complete the ground or common-return circuit, connecting cord-circuits and trunk-lines, each trunk-line provided with a terminal signal device, connected on one side to said common-return conductor and each cord-circuit containing a polarized supervisory-signal magnet, whereby, first, when a line is connected through a cord-circuit to a trunk-line the signal of the latter will be displayed but the polarized supervisory-signal magnet will not respond, second, when the trunk-line is connected to a second line current will flow back from said line in a reversed direction through the cord-circuit to energize the supervisory-signal magnet, and third, when the called subscriber connects his line to ground or common return current will cease to flow in the cord-circuit and the supervisory-signal magnet will become inert, substantially as described.

13. In a telephone-exchange system, a Wheatstone bridge of which each of two connected subscribers' lines, from the substation to the spring-jack, forms a side; each subscriber's-line connection from the spring-jack to a central battery, through a line drop-annunciator, forms another side; said battery and a common-return conductor, or ground, connecting it to all the subscribers' stations and to switch-contacts therein; the office-connective circuit or operator's cord-circuits, forming the bridge-conductor, from jack to jack of the connected lines; a supervisory signal included in said office-connective or cord circuit; and means whereby either subscriber may change the switch-contacts at his station to thereby change the condition of his side of the Wheatstone bridge, whereby current from the central battery will flow through the bridge conductors and energize the supervisory signal, substantially as described.

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