

No. 646,695.

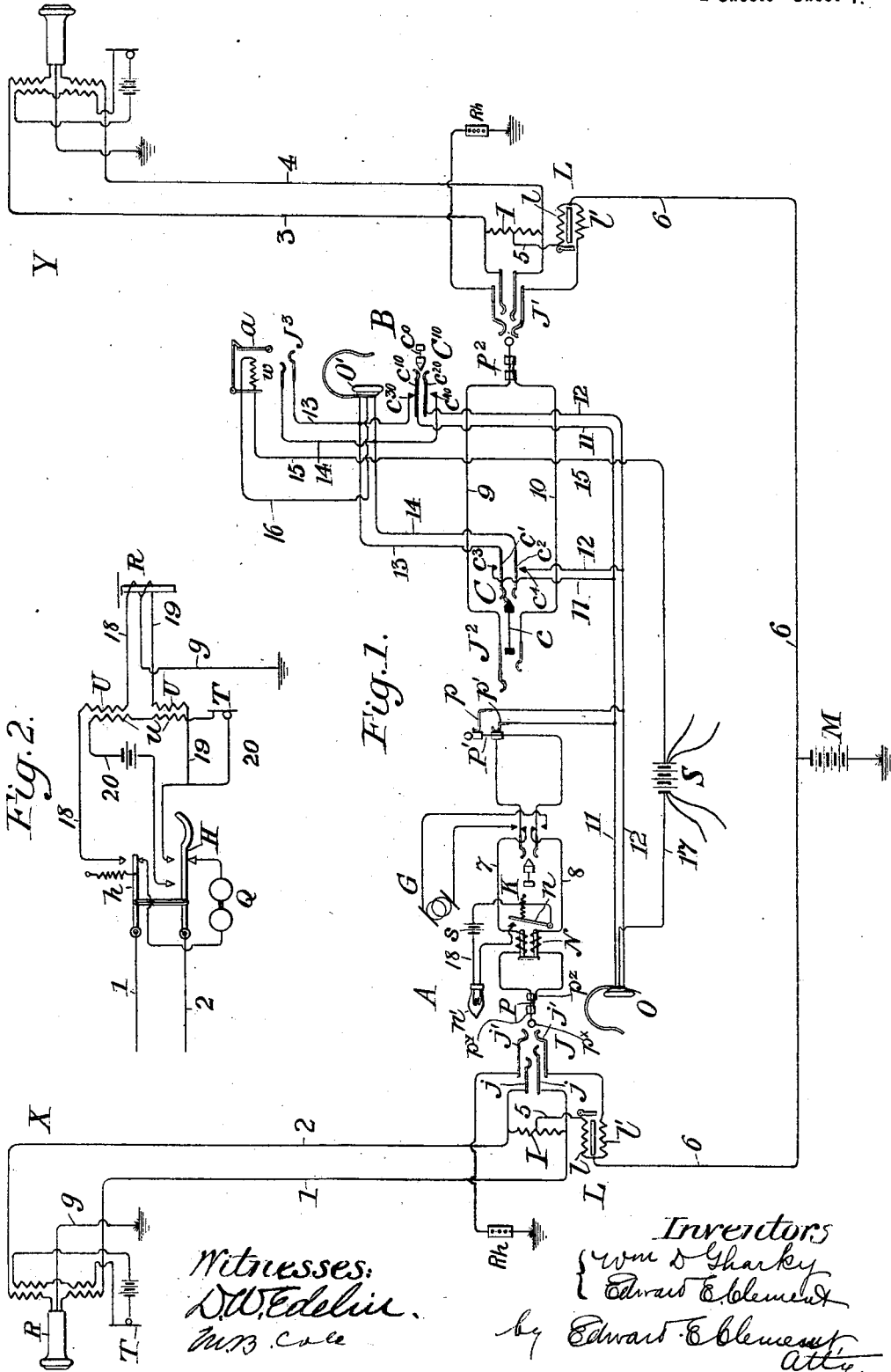
Patented Apr. 3, 1900.

W. D. GHARKY & E. E. CLEMENT.
TELEPHONE EXCHANGE SYSTEM.

(Application filed Aug. 20, 1898.)

2 Sheets—Sheet 1.

(No Model.)



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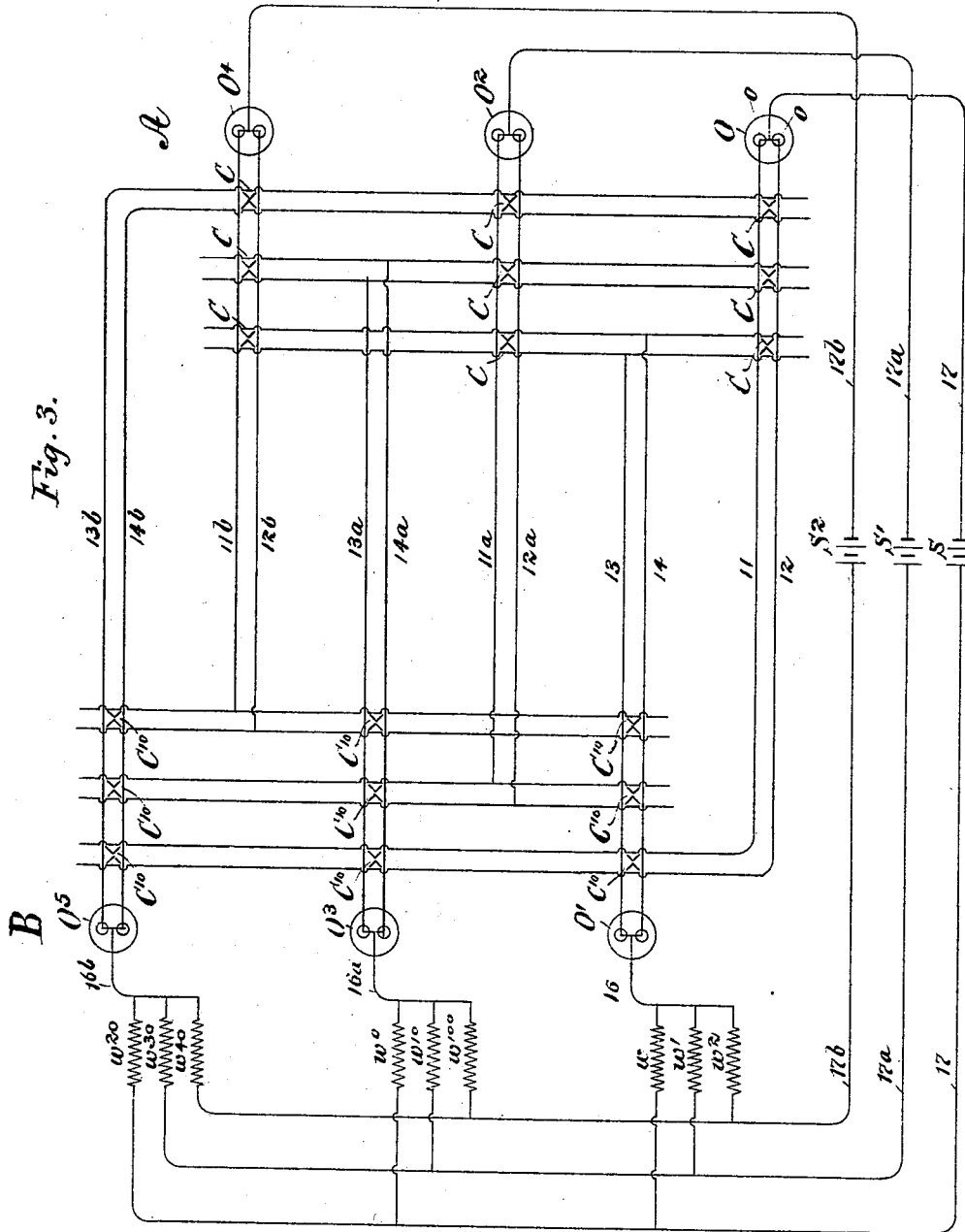
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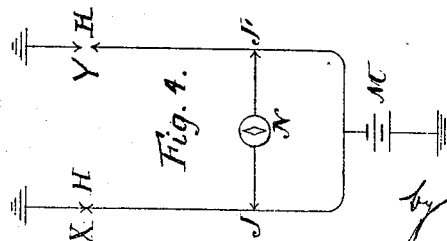
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(No Model.)

2 Sheets—Sheet 2.



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UNITED STATES PATENT OFFICE.

WILLIAM D. GHARKY, OF PHILADELPHIA, PENNSYLVANIA, AND EDWARD E. CLEMENT, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNORS TO THE SUN ELECTRIC MANUFACTURING COMPANY, OF NEW JERSEY.

TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 646,695, dated April 3, 1900.

Application filed August 20, 1898. Serial No. 689,120. (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 the city of Washington, District of Columbia, citizens of the United States, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a specification.

Our invention relates to systems for telephonic interconnection wherein a central office or offices is or are provided, subscribers' lines radiating therefrom to substations, where they are provided with telephonic and signaling apparatus.

The invention relates particularly to such systems of this character as are known as "divided" central or trunking systems, and it constitutes an improvement upon the particular system described and claimed in our joint application for patent, Serial No. 689,119, filed August 20, 1898. According to the invention set forth in said application conversation is carried on over metallic or series circuit, while signaling is simultaneously permitted to be carried on over multiplied or phantom circuits. The various steps in connecting and disconnecting subscribers are performed by two (2) sets of operators called, respectively, for convenience, "A" and "B" operators. Each A operator is provided with terminal plugs and communicating cords therefor which she uses in the ordinary way for interconnecting subscribers upon her own section. Each B operator, on the other hand, devotes her entire time and attention to finishing connections which have been trunked by the answering A operators at their sections—that is to say, the B operators attend to the completion of trunk-calls and to those only, while the A operators attend to all other business. In order to permit the A operators to keep track of the condition of the lines, certain supervisory signaling means are provided. In the application aforesaid said means consist in a polarized relay. In order to apprise the B operators of connections initiated on the trunk-lines of the A operators, trunk-signals have been used. These trunk-signals receive the current from the main

source through the calling-jack and the answering-plug circuit. In order to prevent this current from operating the supervisory signal before referred to, the expedient of polarization was adopted. The principal change in the construction thus described, which constitutes the improvement to be covered in the present application, is the abolition of individual trunk-signals and the consequent permissible reduction of the polarized supervisory relay to a simple ordinary low-wound relay. In place of the individual trunk-signals we use in the present system individual operator's signals, each of which is common to a number of trunk-terminals. These are arranged to be operated whenever the operators' conversation-circuits are crossed without any especial act or thought on the part of either operator.

Our invention is fully illustrated in the accompanying drawings, wherein like letters and figures of reference refer to the same parts throughout.

In said drawings, Figure 1 is a diagrammatic view of the circuit connections of two subscribers whose line-terminals are located upon different switchboard-sections. Fig. 2 is a detailed view of the circuit at each subscriber's station. Fig. 3 is a diagram of the circuits of a number of operators, showing their signals. Fig. 4 is a diagram illustrating the use of a Wheatstone bridge in the signaling-circuits.

Referring to Fig. 1, X and Y are two subscribers' stations, each provided with a complete telephone set comprising the usual transmitter and receiver. From the middle point of the windings of the receiver A wire *g* is led to the ground and the receiver-windings are interposed between the divided halves of the secondary winding of the subscriber's induction-coil.

The instruments, as shown in Fig. 1, are supposed to be in position for use and the details of their circuits are not shown; but upon reference to Fig. 2 it will be seen that the line-wires 1 and 2 during the non-use of the instrument and while the receiver is hanging upon the switch-hook are bridged by the circuit of the bell or ringer Q and discon-

ected from the conversation-circuit. When the receiver is removed from the hook, however, the levers *H* and *h* rise under the influence of a suitable spring and after breaking the bell-circuit make a circuit over the line-wires 1 and 2 through the local connections 18 and 19, the secondary *U* of the induction-coil and the receiver, the middle point of whose windings is connected to ground through the wire *g*, and at the same time the local transmitter-circuit 20, including the transmitter and the primary *u* of the induction-coil, together with a suitable battery, is closed.

The line-wires 1 2 and 3 4 terminate in jack-springs *j j* upon the central-office switchboard-sections. Each pair of line-wires is bridged prior to its connection with the jack-springs by an impedance-coil *I*, from the middle point of which a wire *δ* is led to one winding *l* of the line-annunciator *L*, and thence by the wire *6* to the main battery *M* and to ground. The annunciator *L* is provided with a differential winding *l'*, one end of which is connected to the wire *6* and the other to the spring *j'*, which is adapted to be connected by a collar upon the connecting-plug with a twin spring *j'*, from which a wire leads through resistance *R/h* to ground. All of the apparatus thus described is substantially the same as that in our prior application above referred to.

Each *A* operator is provided with pairs of plugs *P P'*, plug *P* having a tip and sleeve *p^x* and *p^y*, which are connected, respectively, to the sleeve and tip of plug *P'*, although this order of connection is not essential, being reversible, if desired. The plug *P* also has a collar *p^z*, which is insulated from the tip and sleeve and whose function is to connect the springs *j'* when the plug is in the jack. The plugs *P* and *P'* are connected by the cord conductors 7 8. A relay *N* is provided for each pair of plugs, its windings being connected in parallel in the two sides 7 and 8 of the plug-cord circuit. By this arrangement the relay will only be energized by currents passing there-through in multiple. The armature *n* of this relay is adapted when attracted to close a local circuit 18, containing a suitable battery *s* and a signal, shown as an incandescent lamp *n'*. An ordinary ringing-key is also provided for each cord-circuit, which upon its actuation connects the circuit of a generator with the plug *P'*. The said plug *P'* rests in a seat which is provided with contact-springs *p p'*, adapted to touch the sleeve and tip contacts of the plug or external rings thereon, respectively, connected thereto, and to thereby continue the two sides of the plug-cord circuit 7 8 to the *A* operator's listening-circuit 11 12.

The plugs *P P'*, with their associated apparatus, suffice for the connection of subscribers whose line-terminals are near together; but where, as shown in Fig. 1, connection is necessary between subscribers upon different switchboard-sections trunk-lines 9 10 are

used, each trunk-line terminating at one end in a jack *J²* and at the other end in a plug *P²*. All the jacks *J²* of a given group of trunk-lines which interconnect any one board with another are grouped together before the *A* operator at the first board, while their plugs *P²* are grouped together before the *B* operator at the other board. The listening-circuit 11 12 of the *A* operator terminating in her telephone set *O* is branched to all these trunk-lines and also to all the other switchboard-sections. Conversely, the listening-circuit 13 14 of each *B* operator terminating in her telephone *O'* is branched to the jacks *J²* of all the trunk-lines leading to her board. Within each trunk-jack *J²* a circuit-closer *C* is provided having a plunger *c*, adapted to be depressed under certain conditions by a plug inserted in the jack, to thereby spread apart springs *c' c²*, forming the terminals of the *B* operator's circuit 13 14 and cause them to make contact with anvils *c³ c⁴*, constituting terminals of the *A* operator's circuit 11 12. Before each *B* operator and in proximity to her trunk-terminals a similar switch *c⁰* is provided, having a plunger *c⁰*, which upon depression spreads apart springs *c¹⁰* and *c²⁰*, which form terminals of the *A* operator's circuit 11 12, causing them to make contact with anvils *c³⁰ c⁴⁰*, connected with the two sides 13 14 of the *B* operator's circuit. In proximity to the trunk-plugs *P²* and connected to the *B* operator's circuit is also provided a jack *J³*.

In order that signaling may be carried on between the operators, the following means are provided: A wire 17 is led from the middle point of the windings of the *A* operator's telephone *O* through the battery *S* and to all the other switchboard-sections. From the middle point of the windings of each *B* operator's telephone *O'* a wire 16 is led out. Before each *B* operator an annunciator is located provided with a shutter *a* and having its winding *w* connected on one side to wire 16 and on the other to wire 17. Only one of these annunciators is shown herein; but it will be understood that the wire 16 of each *B* operator serves as a common connection for all the wires 17 of the *A* operators at different boards, and, conversely, each wire 17 of an *A* operator is cross connected through various annunciator-windings *w* with the respective wires 16.

The operation of our system thus described is as follows: Subscriber *X* desiring to converse with subscriber *Y* removes his telephone-receiver *R* from the hook *H*, whereupon the latter and its connected lever rise under the influence of the spring and complete the talking-circuit shown in Fig. 2. Current will then flow from the battery *M* through the wire 6, the winding *l*, wire 5, the two halves of the coil *I* and the line-wires 1 2 in parallel to the subscriber's station and there through the wires 18 19, the two halves of the secondary *U* and the two halves of the

receiver-winding, the wire *g*, and ground back to the battery. The annunciator *L* thereupon displays its signal and the A operator at that board perceiving the signal inserts the plug *P* in the jack *J* corresponding thereto. Inasmuch as the plug *P'* remains in its seat a talking-circuit is immediately completed without any further act on the part of the operator from the subscriber's instrument to her set *O*. Having ascertained the connection desired and finding it to be with the subscriber *Y*, who is located on another board, the A operator removes the plug *P'* from its seat and inserts it in the jack *J*² of the trunk-line leading to the desired board. In so doing the A operator presses the plug *P'* into the jack farther than is required simply to make connection with the jack-springs, the tip of the plug thereby depressing the plunger and spreading the springs *c'* and *c*² into contact with the anvils *c*³ and *c*⁴. A complete metallic circuit is thus established between the A and B operators' sets *O* and *O'*. Incidentally the signaling-circuit through the annunciator *A* before the B operator and corresponding to the A operator is completed as follows: from the battery *S* through wire 17, through the split windings of the telephone *O*, through the wires 11 12 in parallel, anvils *c*³ *c*⁴, springs *c'* *c*², wires 13 14 in parallel, split windings of telephone *O'*, wire 16, winding *w*, wire 15, and back to the battery. The A operator is thus enabled to instruct the B operator directly as to the number of the subscriber wanted, and while in such instructions she gives the number of the trunk-line and of the subscriber wanted the annunciator *A* performs the function of directing the B operator's attention immediately to the proper group of trunk-plugs, and in case the B operator should happen to be temporarily engaged furnishes a continued indication that she has been called by the A operator, to whose board said trunk-lines are extended. Upon receiving her instructions the B operator inserts the plug *p*² in the jack *J'* of the subscriber *Y*. Current will then immediately flow from battery *N* through wire 6, winding *l*, wire 5, impedance-coil *I*, and jack *J'* of the called subscriber, through plug *P*², trunk-wires 9 10, jack *J*², plug *P'*, cord connection 7 8, the two halves of the winding of relay-magnet *N*, plug *P*, jack *J*, line-wires 1 2, and to ground through the wire *g* of the calling subscriber. This current energizes the magnet *N*, which thereupon attracts its armature *n*, closing circuit 18 and displaying the signal *n'*. This apprises the A operator of the insertion of the plug *p*², and immediately upon perceiving the signal *n'* she depresses the calling-key *K*, which connects the generator through the plug *P'* and the trunk-line to the called subscriber's line to ring his bell. The signal *n'* remains displayed until the said subscriber *Y* answers the call by removing his telephone-receiver from the hook, whereupon the current from the battery *M*, which had previously

flowed back through the connecting-circuit to the calling-subscriber's station, is diverted through the line-wires 3 4 to ground at the station *Y*. Current no longer passing through the connecting-circuit, the magnet *N* releases its armature and the signal *n'* is retired, thus apprising the A operator of the fact that the subscriber *Y* has answered the call.

Referring to Fig. 3, which is a diagram of the instruction-circuits of three A girls and three B girls with their signals, the A girls' positions are shown at *O*, *O*³, and *O*⁴, the symbols which are so lettered being supposed to represent, diagrammatically, operators' head-phones with the caps removed to show the coils *o* and *o'*. From each A girl's position to each B girl's position (the latter shown at *O'*, *O*³, and *O*⁵) extends an instruction-circuit. That from girl *O* is numbered 11 12, and, as clearly shown, it passes to the B girls' positions, crossing all their circuits, which are numbered 13 14, 13^a 14^a, and 13^b 14^b. The circuit from the position *O*³ is lettered 11^a 12^a and that from position *O*⁴ is 11^b 12^b, each of these likewise crossing all the B girls' circuits at the left of the figure, but all being normally disconnected. Conversely to the above the circuits 13 14, 13^a 14^a, and 13^b 14^b pass from the head-phones *O'*, *O*³, and *O*⁵ to the A girls' positions, where each of them is carried across or past all the A girls' circuits. At the place of intersection of the circuits 11 12 and 13 14 at the right-hand side of the figure we have shown a pair of bent lines, which are intended to represent a switch which may be turned to connect wire 11 with wire 13 and wire 12 with wire 14. In reality these switches, which are lettered *C*, are made as shown in Fig. 1, where a plunger *c* acts upon springs *c'* and *c*² to cross the operators' circuits. These switches are all located at the trunk-jacks on the A sections, but the trunk-lines are omitted from Fig. 3 and the switches reduced to their simplest elements in order to prevent confusion. Obviously when any switch *C* is actuated the operator *O*, *O*³, &c., has crossed her circuit with that of the corresponding B operator, according to which switch is used. From a point midway of the windings of the telephone *O* the wire 17 is led out and passes to the B operator's positions, where it forms a common return for the annunciator-coils *w*, *w*⁰, and *w*²⁰, located, respectively, opposite the B girls, whose head-phones are indicated at *O'*, *O*³, and *O*⁵. Similarly a wire 17^a passes from the middle point of the windings of operator's telephone *O*² and forms a common return for the three coils *w'*, *w*¹⁰, and *w*³⁰, while the wire 17^b passes from a telephone *O*⁴ to form a common return for the windings *w*², *w*¹⁰⁰, and *w*⁴⁰. Thus there is an annunciator-coil opposite each B girl for each A girl. From the middle point of the windings of telephone *O'* the wire 16 is led out to form a common return for the three coils *w*, *w'*, and *w*². From the telephone *O*³ a similar wire 16^a is connected to three coils *w*⁰, *w*¹⁰, and

w^{100} , while from telephone O^5 the wire 16^b forms a common return for the coils w^{20} , w^{30} , and w^{40} .

Now suppose the operator at O is using a trunk-line to actuate the left-hand switch C at her position. She thereby connects the wires $11\ 12$ with the wires $13\ 14$, and not only are the telephones O and O' connected on the metallic circuit, but the following circuit is completed: from battery S by wire 17 to telephone O , and thence by wires $11\ 12$ in parallel to switch C , thence by wires $13\ 14$ in parallel to telephone O' by wire 16 to the annunciator w , and by wire 17 back to the battery. The annunciator thereupon displays its signal, telling the first B girl that the first A girl is calling her. By manipulating the other two switches C opposite the telephone O the first A girl can send current from the batteries S' and S^2 at will through the annunciators w^0 and w^{20} . Similarly the girl O^2 can work any one of the annunciators w' , w^{10} , and w^{30} , according to which operator's circuit she connects herself with.

The switches C^{10} enable the B operators to connect their circuits with those of the A operators for further instructions, &c.

Fig. 4 shows in the simplest possible way the distribution of current upon which depends the operation mentioned. In this figure X and Y are the subscribers' stations, having switches H each adapted to ground the line. The cord-circuit, including a trunk-line when a connection has been completed, is shown extending from J to J' , and the supervisory signal is indicated by a galvanometer N . Supposing X to have called, current is flowing from battery M through the left-hand line $1\ 2$ and to ground at station X , and thence back to battery. The operators have made the connection from J to J' and the subscriber Y has not yet answered—i. e., he has not yet worked his switch to ground the line. Current from battery M will now find two paths, one from the battery direct to station X and ground via the point J , and the other by way of point J' across through the galvanometer N to point J , and then out to station X and ground. The internal resistance of the battery being small, enough current flows through the branch containing the signal to operate the same. When subscriber Y answers the call by grounding his line, it must be obvious that a true Wheatstone bridge is produced. The galvanometer N is in the bridge-wire, and as long as the resistances of lines $1\ 2$ and $3\ 4$ are approximately the same there will be no current in the bridge when both lines are complete. If either subscriber should hang up his telephone, and thereby remove the ground from his line, we evidently have a break (or an infinite resistance) in one side of the bridge, and whichever side it is the bridge-wire with galvanometer N will receive current. In applying this to the diagram Fig. 1 it must be borne in mind that for signaling purposes the

component wires of the metallic circuit $1\ 2$ and $3\ 4$ are one. The cord and trunk circuits are also single conductors, so that for signaling purposes the conditions are exactly as shown in Fig. 4. One advantage of this bridge construction is that whenever both subscribers have finished a conversation and hung up their receivers the magnet N will not respond, but both line-signals will show for clearing out.

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

1. In a telephone-exchange system, operators' metallic instruction-circuits for conversation normally disconnected, a separate circuit containing battery and a signal extending between the operators, said circuit composed in part of the different instruction-circuits, whereby when an operator connects her instruction-circuit with another a corresponding signal is thereby given to the other operator, substantially as described.

2. In a telephone-exchange system a series of metallic instruction-circuits adapted to be crossed at will to permit communication between operators, a series of signaling-circuits cross-connecting the operators in such a manner that each instruction-circuit forms a common return for all the signaling-circuits leading to any operator, together with suitable signals and batteries in said circuits, substantially as described.

3. In a telephone-exchange system operators' metallic instruction-circuits adapted to be crossed together at will, and each containing one operator's telephone, signaling-circuits, each containing battery and connected to an operator's telephone at one end and branched to a number of other operators' telephones, together with a signal in each branch, whereby the crossing of one operator's instruction-circuit with another will operate the signal indicative of the first operator in front of the other operator, substantially as described.

4. In a telephone-exchange system, operators divided into two sets, conversation-circuits between each operator of one set and all the operators of the other set, a signaling-circuit associated with and completed through the circuit of each operator of the first set, and branched through annunciators distributed before the operators of the second set to their circuits, whereby when the circuit of an operator of the first set is crossed with that of one of the other set, the appropriate signal before the second operator is automatically displayed, substantially as described.

In testimony whereof we have hereunto set our hands, this 15th day of August, A. D. 1898, in the presence of two witnesses.

WM. D. GHARKY.
EDWARD E. CLEMENT.

Witnesses:

ROBERT OSBORNE, Jr.,
EMERSON CONRAD.