(No Model.) 2 Sheets—Sheet 1.

A. DE KHOTINSKY.

TELEPHONE SIGNAL AND SIGNALING CIRCUIT.

No. 560,617. Patented May 19, 1896.

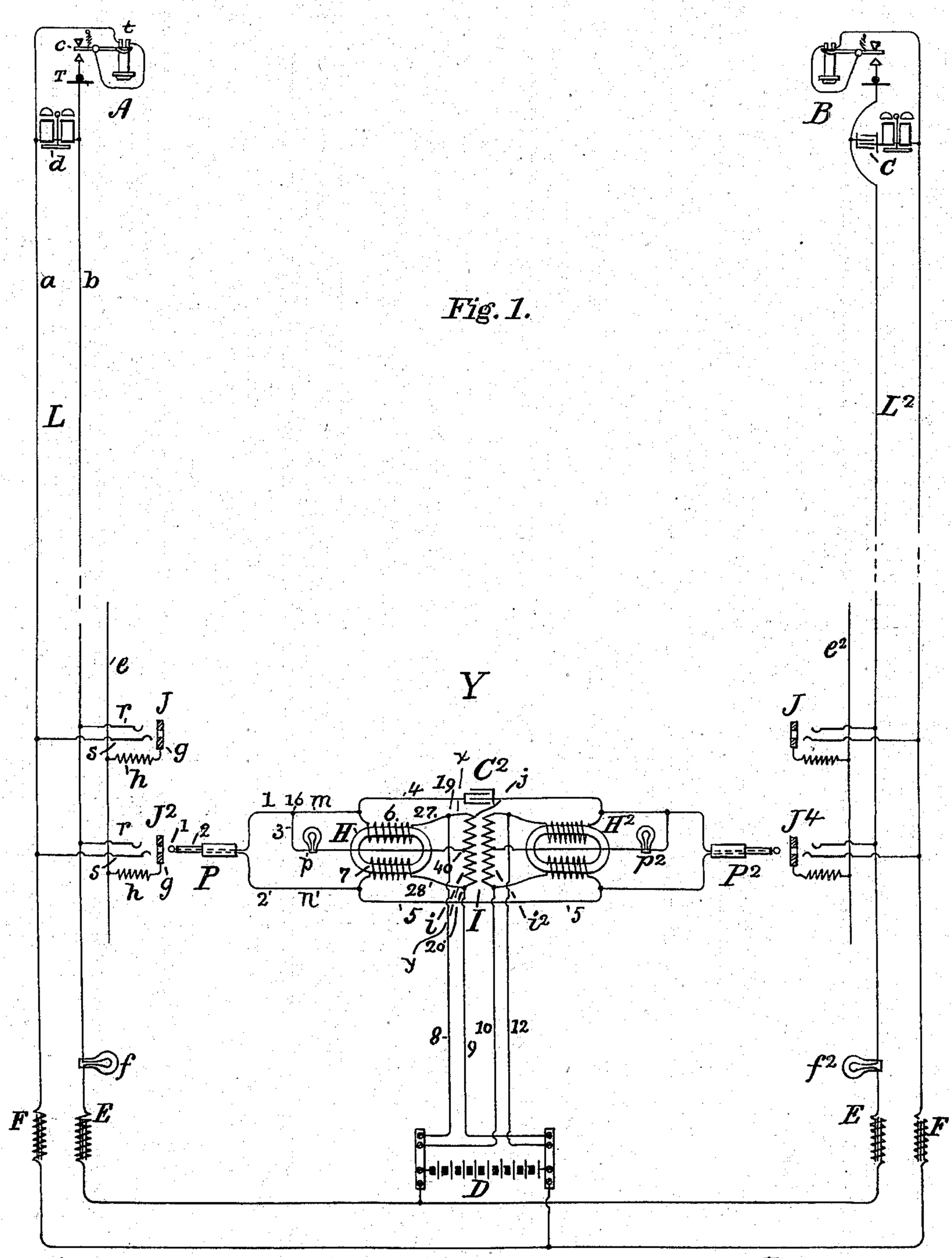

Fig. 1.

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Fig. 2.

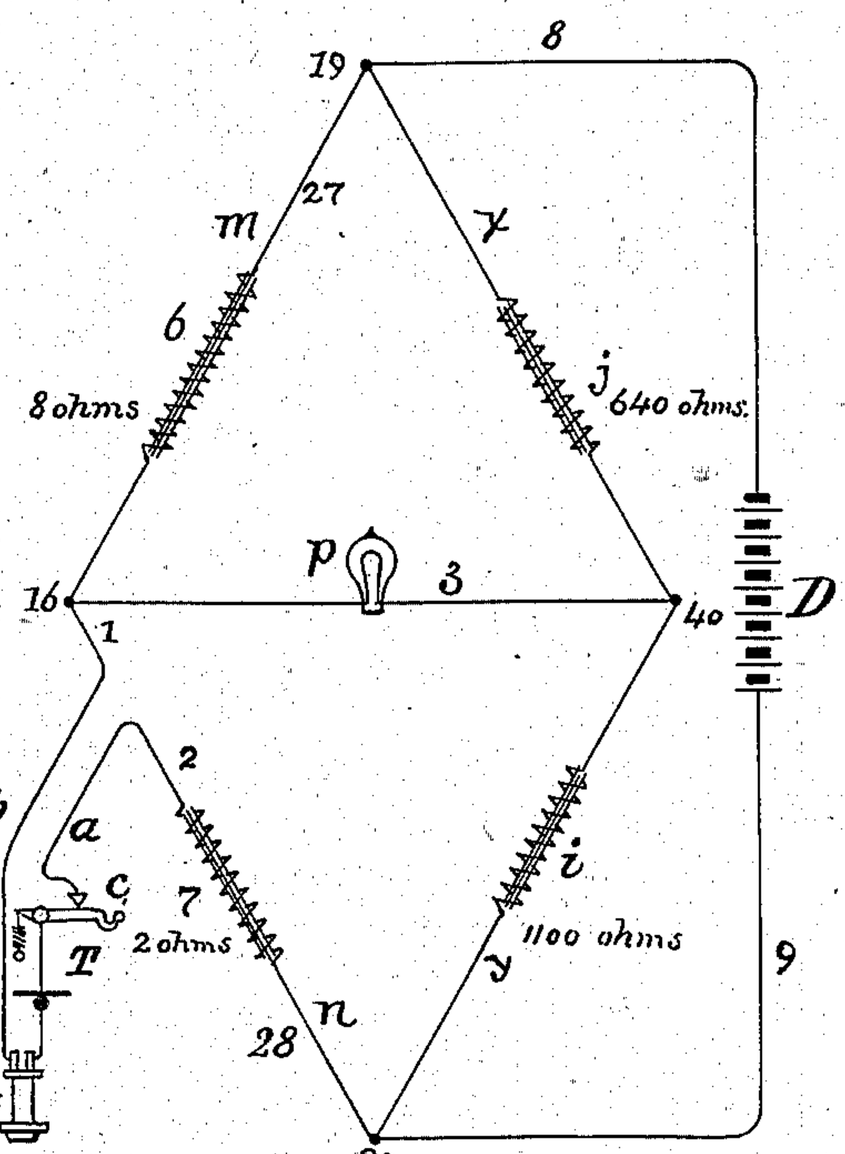
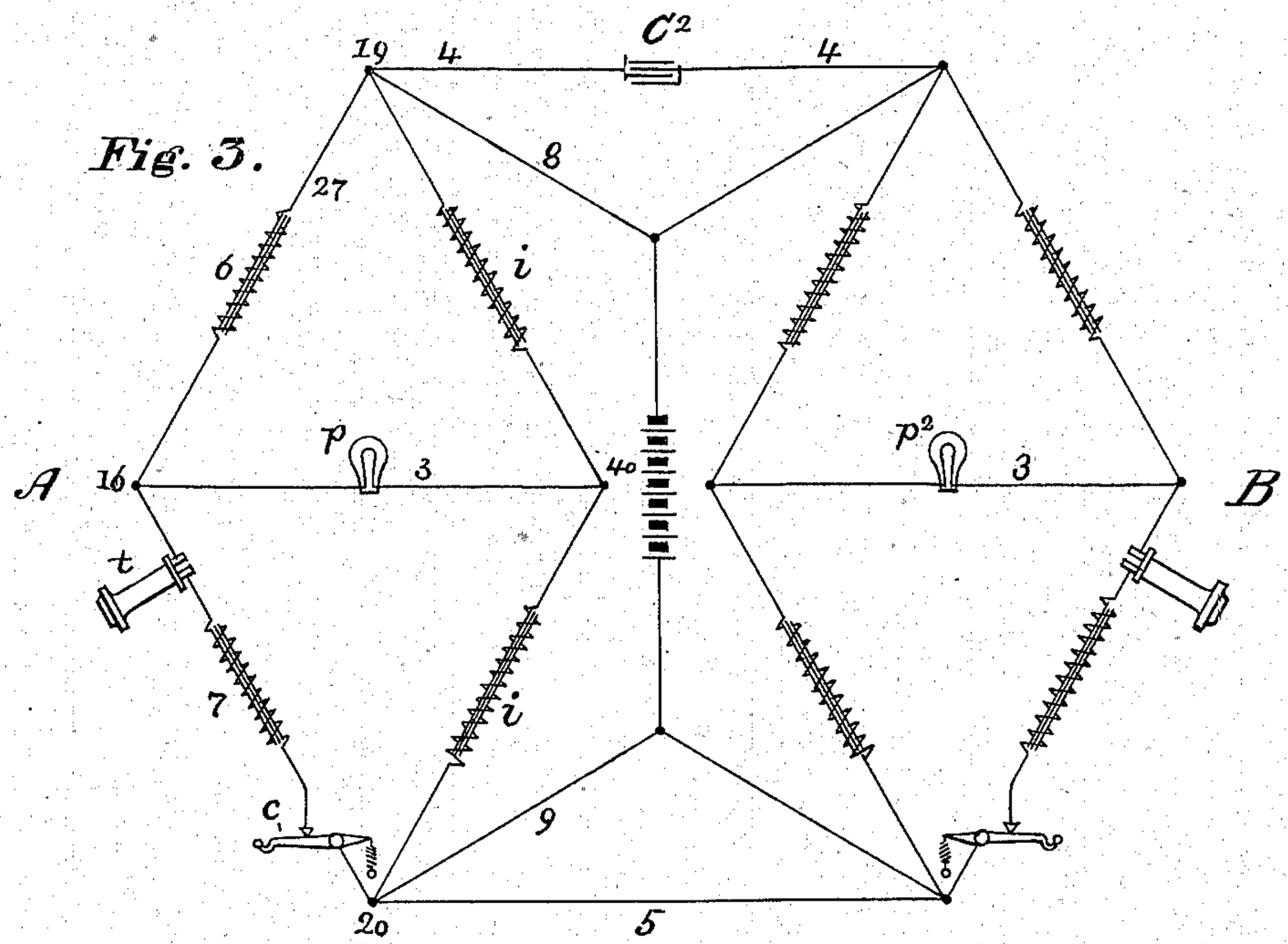


Fig. 3.



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UNITED STATES PATENT OFFICE.

ACHILLES DE KHOTINSKY, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO THE AMERICAN BELL TELEPHONE COMPANY, OF SAME PLACE.

TELEPHONE SIGNAL AND SIGNALING-CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 560,617, dated May 19, 1896.

Application filed March 13, 1896. Serial No. 583,080. (No model.)

To all whom it may concern:

Be it known that I, ACHILLES DE KHOTINSKY, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain Improvements in Telephone Signals and Signaling-Circuits, of which the following is a specification.

This invention concerns telephone-exchange systems working with centralized or common transmitter and signal current generators, and more particularly relates to the employment of glow-lamps for call and disconnecting signals and to the circuit arrangement and mode of operation of the latter.

It is not, of course, new to maintain a battery at the central station connected with or common to a number of circuits for signaling purposes, or to use a similar battery similarly arranged and connected with any main circuit or with any pair of united circuits while conversation is going on, to serve as a source of transmitter-current supply; nor is it new to employ lamps as call or disconnecting signals; but my invention contemplates the use of the same battery for call-signals, for conversation, and for the operation of disconnecting-signals, and provides that the call-signal lamp shall be illuminated to call the attention of the operator when the substation-circuit is closed or its resistance suitably varied at the substation, that the said lamp shall be extinguished when the operator inserts an answering-plug in a socket of the calling-line, that by the act of inserting the plug the disconnecting-signal lamp is brought into operative relation with the battery and the substation apparatus, but does not exhibit any signal until the desired conversation is completed, and that when such period arrives the said lamp shall become illuminated in response to such reverse change of the circuit continuity or resistance at the substation as is brought about in restoring the apparatus to its normal conditions.

All necessary substation changes can be effectuated by the removal of the receiving-telephone from the hook or yoke switch which serves as its support when not being used and by replacing it upon such support, and, adopting this expedient, by my invention the call-signal lamp glows and indicates a call when the telephone is initially lifted for conversation, the said lamp is deprived of its operating-current and the signal disappears when the answering-plug enters the line-socket, and the disconnecting-signal lamp glows to indicate the end of the communication when the subscriber once more operates his switch, reversely, however, by replacing his telephone on the hook.

It will be readily understood that the substation call-bell is normally in circuit and is usually of resistance sufficiently high to keep the current maintained on the line by the calling-battery so low that it cannot cause the call-signal lamp to glow, and when so arranged the action of the telephone-switch is to connect the telephones in parallel to the said bell, and thus greatly reduce the resistance of the circuit and increase the current to the strength required for the operation of the lamp; but if, as is sometimes the case, it be desired to keep the line-circuit normally open, so that no current flows in it when at rest, this can easily be done by interposing a condenser in the bell-circuit, and in that case the operation of the substation-switch is to actually close the circuit and change the call-current from zero to the strength required.

The characteristic feature of the invention is that the subscriber's circuit, including its circuit-changing switch and other substation apparatus and the central-station disconnecting-signal lamp, are while the operator's plug and cord circuit is connected with the line associated with a Wheatstone balance or bridge system, the said circuit being in one of the arms or branches and the disconnecting-signal lamp in the bridge or cross-wire of the said system. It is evident that if during such connection the two sides of the bridge are balanced there will be no current through the bridge and no illumination of the lamp, and the several necessary fixed resistances and impedances of the system are so proportioned to the resistance of the substation-circuit that the disconnecting-signal lamp shall remain dark (the system being practically balanced) as long as the subscriber's telephone remains absent from its hook-switch, and that the said system shall become unbalanced and the lamp thereby be made to glow and to give the

signal when the telephone is restored to its support. The operation of this device is greatly facilitated by the fact that the disconnecting-signal glow-lamp does not become luminous if a current as great as one-half of its working current passes through it. An operative balance is thus very easily attained for the purpose of signaling. And it is also evident that the change in the resistance of the line-circuit brought about by the action of the substation-switch on the replacement of the telephone is fully competent to so unbalance the system that a current of sufficient strength to make the disconnecting-signal lamp glow shall circulate through the bridge in which it is placed. This fact is of considerable consequence, since obviously as lines are of different resistances a perfect balance comprehending an actual zero of current in the bridge could, with the same connecting-cords and fixed resistances and impedances, seldom be obtained.

My invention also comprises the association of the subscriber's circuit and switch and a main-circuit call-signal lamp with the said disconnecting-signal lamp and the Wheatstone balance, of which it forms a part, and likewise the employment, in connection with two such subscriber's circuits united to form a through line of communication, of two disconnecting-signal lamps, one for each circuit, and two Wheatstone-bridge systems, the lamp of each circuit being placed in the cross-wire of its own bridge system, so that each lamp will respond exclusively to the circuit-changer at the substation of its own circuit, and in this arrangement the battery may be connected in a third cross-wire common to both systems.

In the operation of the invention it is preferable to make the resistance of the disconnecting-signal lamps considerably higher than that of the call-signal lamp, and suitable magnitudes for these and for the several fixed resistances of the balance have been determined for average conditions, from practical workings, and are hereinafter stated. Such change as may under a wide change of conditions of the substation-line become necessary can readily be deduced by those skilled in the art from the laws on which the Wheatstone balance is based. The insertion of a plug in the socket of a line does not sever the call-signal lamp from the said line, but establishes a shunt around the lamp of resistance low enough to withdraw a major portion of the current therefrom, and thereby extinguish the lamp.

In the drawings which accompany this specification, Figure 1 is a diagrammatic representation of two substation-circuits and an operator's looping-cords and plugs associated with a centralized or common transmitter and signal current generator illustrative of and embodying my invention. Fig. 2 is a diagram illustrating the disposition of one substation-circuit with one-half of the operator's cord-circuit and its clearing-out signal in a Wheatstone balance or bridge system, and Fig. 3 illustrates two connected substation-circuits each with its disconnecting-signal in a Wheatstone balance or bridge system.

The apparatus at the substations may consist of a high-resistance bell d, permanently bridged between the line conductors a and b, transmitting-telephone T, receiving-telephone t, and hook-switch c. When the telephone is hung upon the hook-switch, owing to the high resistance of the bell d the circuit is practically open. If, however, it is desired to keep the line-circuit normally open, a condenser, as C, may be connected in the bell branch.

The line conductors a b of the substation-circuits extending to the central station Y are there connected with the poles of the battery D, which is thereby included in the circuit, which contains also electromagnetic resistance or impedance coils F and E and a glow-lamp f, which serves as a call-signal.

The impedances are arranged in the normal circuit for the double purpose of reducing the strength of the calling-current which flows through the circuit when the latter is closed at the substation, so that the said current will not be too powerful for the lamp f, and of opposing the passage of voice-currents when the circuit is connected for conversation. The resistance of each in this instance may be one hundred and ten ohms, and they may, if desired, be wound over the same core. They may, however, be readily modified in a manner well understood to suit varying conditions. The resistance of the call-signal lamp under the same conditions may be twelve ohms, or thereabout.

The two substation-circuits L L^2 are represented upon the several sections of the multiple switchboard by plug-sockets J J^2, each containing branch terminal contact-springs r s and being provided with the usual busy-test ring, the several test-rings of each circuit being connected through considerable resistances—say three hundred ohms—with their test-wire e.

When either plug of any pair of cords is thrust into a line-socket, a Wheatstone balance or bridge system is established by means of suitable circuit connections and resistance and retardation coils associated with the connecting-cord attached to the said plug, a glow-lamp being contained in the cross-wire or bridge and the subscriber's circuit and substation apparatus in one of the branches of the said bridge system.

Fig. 2 shows the theoretical arrangement of the system, and since its several appliances, conductors, and junctions are marked with the same reference letters and numerals as those which designate the same parts in the actual arrangement depicted in Fig. 1 there is no difficulty in tracing them in the latter.

D is the battery furnishing current for the substation-transmitters and for ringing off. i and j are resistances in or constituting two

arms of the balance; 6, a retardation-coil or impedance in the third arm or branch; 7, an impedance in series with the substation circuit and apparatus collectively constituting the fourth arm or branch, and *p* the glow-lamp in the bridge serving as the disconnecting-signal.

The appliances *i* and *j* in the branches on either side of the junction 40 of the Wheatstone balance are shown as being simple resistances; but it is obvious that in systems where the two cords of a pair have their conductors united inductively by a repeating induction-coil the said resistances *i* and *j* may be replaced by the two windings of the said repeating-coil, and that in any case retardation-coils may, if desired, be employed. Main wires 8 and 9 lead from the battery D to the points 19 and 20. At these points the battery-circuit divides and between them has two main paths. One of these leads through the two branches *x* and *y* of the system and may be traced as follows: point 19, resistance *j*, point 40, and resistance *i* to the point 20. The other includes the two other branches *m n* of the balance and is traceable from point 19 through wire 27, retardation-coil winding 6, point 16, wire 1, substation-circuit conductors *b* and *a*, and the substation-telephones, wire 2, retardation-coil winding 7, and wire 28 to the point 20. The bridge or cross-wire 3, containing the disconnecting-signal glow-lamp, is connected between the points 16 and 40.

The windings 6 and 7 of the retardation-coil H may or may not, as shown, be wound on the same iron core, and the resistances *i* and *j* may also, if desired, be closely associated.

Practical demonstrations of the system have yielded satisfactory results when the resistances *i* and *j* have been made, respectively, eleven hundred and six hundred and forty ohms, the retardation-coil windings 6 and 7 eight and two ohms, respectively, and the bridge glow-lamp two hundred and twenty ohms; but it is manifest that these may under varying lengths of circuit and operative conditions require modification, which, however, in view of the well-known principles underlying the Wheatstone-bridge system, can readily be made.

Fig. 3 represents the two substation-circuits connected by the operator's plugs and cords, each having a Wheatstone bridge for its own disconnecting-signal, so that each such signal may be made responsive to the operation of its own substation-switch. This figure is simply a duplication of what is shown in Fig. 2, with, however, the addition of the two conductors 4 and 5, associated, as shown in Fig. 1, with the cord conductors to furnish an easy and unobstructed path for the voice-currents in the through conversation-circuit. One of the said auxiliary conductors 4 contains a condenser C^2 to prevent any short-circuiting of the current of the battery D.

In Fig. 1, although I have shown the extensions through the impedances F and E and the call-signal lamp *f* as being in permanent connection with the circuit, whether a plug is or is not in a socket, it is evident that if desired the said extension may be arranged on the well-known plan which provides that the insertion of the plug in its socket will dissever the call-signal portion from the substation portion of the circuit, and it is also evident that such change can be made without interfering with the Wheatstone-bridge arrangement of the disconnecting-signal.

In the operation of my invention when a subscriber wishes to call the central station the telephone *t* is removed from the hook-switch *c*, which rises and closes the circuit, and current from the generator D causes the lamp line-signal *f* to glow in a well-known manner. The insertion of the answering-plug P into the socket J^2 establishes a shunt-circuit through the plug-and-cord conductors around the lamp line-signal *f* and the impedances F and E, the effect of which is to withdraw the major part of the battery-current therefrom and to extinguish the signal. The line-spring *r* makes contact with the tip of the plug, and the line-spring *s* makes contact with the sleeve of the plug, and at the same time the said sleeve connects with the test-ring *g*. When the operator has ascertained by testing in any usual manner that the substation (say B) is not busy, the plug P^2 is inserted in the socket of the jack J^4. By the insertion of either plug in the socket the disconnecting-signal lamp is brought into operative relation with the battery D and also with the substation apparatus, and into such a balance with the other elements which make up the system—*i. e.*, the line and instrument resistance, the two helices of the coil H, and the resistances *i* and *j*—that no operative current passes through the bridge 3, and the lamp *p* consequently does not become illuminated, for though, as hereinafter stated, the balance may not be absolute while the subscriber's telephone *t* remains absent from the automatic switch-hook *c*, the current passing through the bridge is then of minimum strength, and, being too weak to light the lamp, we may consider that an operative balance is attained; but when the telephone is restored to its support such operative balance is destroyed, and a sufficiency of current being now diverted through the bridge the lamp is caused to glow and a signal to disconnect is thus obtained, which again disappears as soon as the plug is withdrawn from its socket.

Having thus described my invention, its construction, arrangement, and operation, I claim—

1. The combination of a main telephone-circuit extending between a central station and a substation, the telephone-switch or circuit-changer at the substation, and switch connections and an associated disconnecting-signal at the central station; with a Wheat-

stone balance or bridge system, the said disconnecting-signal being in the bridge or cross-wire, and the telephone substation-circuit and circuit-changer being connected in one of the resistance-arms of the said balance or system.

2. The combination with a substation telephone-circuit, a main battery included therein, an automatic telephone-switch controlling the resistance of said circuit at the substation, a connecting switch-cord or like connection at the central station, and a glow-lamp disconnecting-signal associated therewith; of a Wheatstone balance or bridge system having the said glow-lamp connected in its bridge or cross-wire, balancing resistances or impedances connected with the cord conductors included in its several resistance-arms, and the substation-circuit and automatic switch contained in one of the said arms; whereby the resistance of the said arm, and the current through the bridge are made to depend on the position of the said switch substantially as specified.

3. The combination in a telephone-exchange, with a main circuit extending between a central and a sub station, a switch actuated by the removal and replacement of the telephone at the latter station controlling the continuity or resistance of the circuit, and a main battery and glow-lamp call-signal both at the said central station connected in the said circuit; of switch cord conductors at the central station adapted by plug-and-socket connections to unite any two circuits on the reception of a call-signal, and arranged as a Wheatstone balance or bridge system of which the substation-circuit when switched forms a part; the said system having a disconnecting-signal lamp, and the main battery, in its two bridges or cross-wires respectively, and the substation-circuit, the resistance of the substation instruments, and the controlling-switch thereof, in one of its arms or branches, so that an operative current may flow through the bridge and disconnecting-signal lamp or not, according as the telephone at the substation is absent from, or placed upon its switch-support.

4. The combination of two telephone substation-circuits connected at a central station by switch-conductors, constituting a link connection, to form a through or compound circuit, and an automatic telephone-switch at each substation controlling the continuity or resistance of its own circuit; with two Wheatstone balance or bridge systems, one for each substation-circuit, interposed in the said switch-conductors, glow-lamp disconnecting-signals one for each circuit, included each in the bridge or cross-wire of the bridge system of its own circuit, a main battery in a third bridge or cross-wire common to both bridge systems, each substation-circuit, its instruments, and its automatic switch being connected in one of the branches of its own bridge system, to serve as a variable resistance therefor; whereby each disconnecting-signal lamp is made responsive solely to the operation of its own substation-switch; substantially as specified herein.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 6th day of March, 1896.

ACHILLES DE KHOTINSKY.

Witnesses:
GEO. WILLIS PIERCE,
JOSEPH A. GATELY.