

H. G. WEBSTER.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED FEB. 23, 1906.

930,519.

Patented Aug. 10, 1909.

2 SHEETS—SHEET 1.

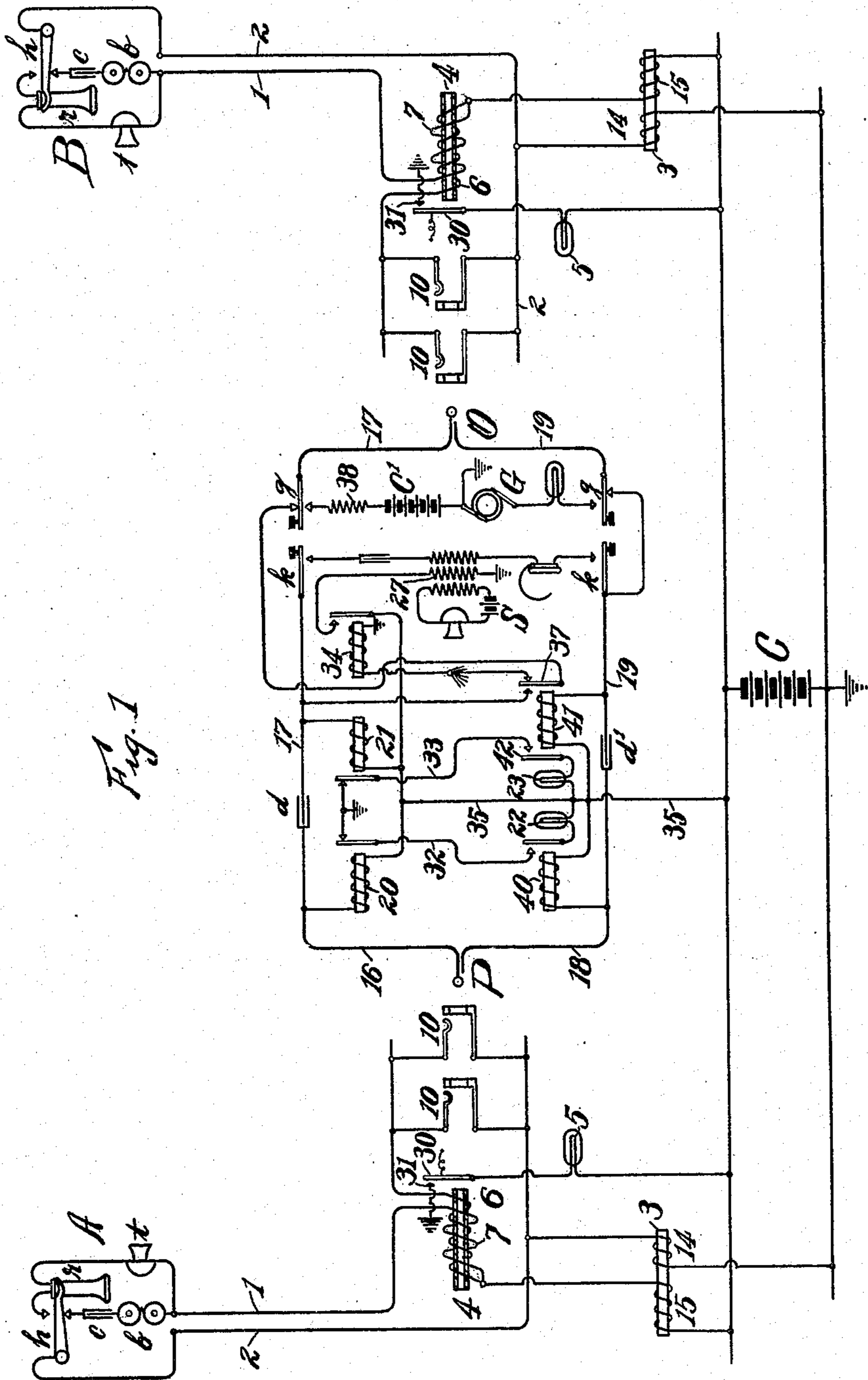


Fig. 1

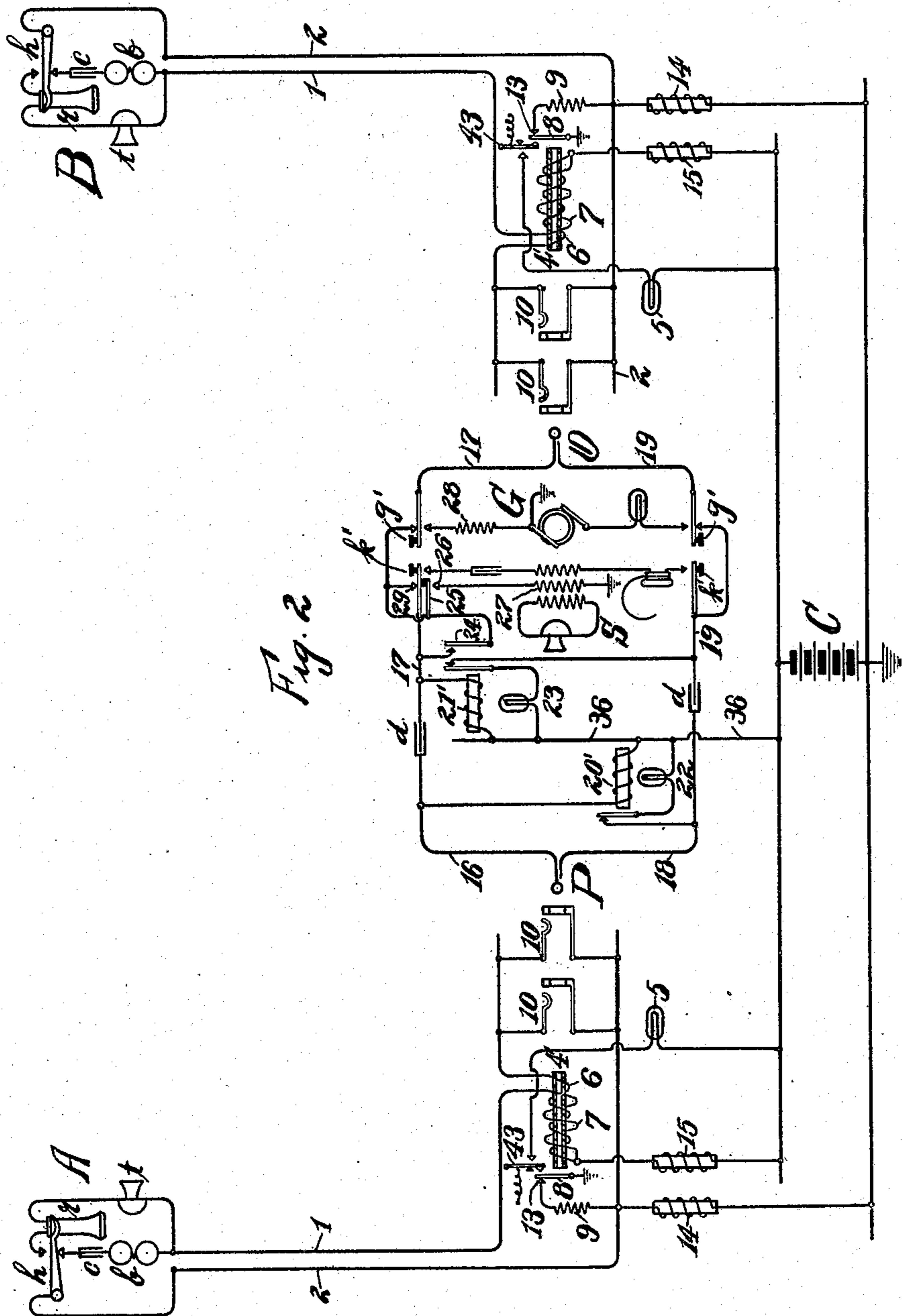
Witnesses
G. E. Muller.
H. C. Olmstead

Inventor
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By Thomas H. Ferguson
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UNITED STATES PATENT OFFICE.

HARRY G. WEBSTER, OF CHICAGO, ILLINOIS, ASSIGNOR TO MILO G. KELLOGG, OF CHICAGO, ILLINOIS.

TELEPHONE-EXCHANGE SYSTEM.

No. 930,519.

Specification of Letters Patent.

Patented Aug. 10, 1909.

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To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, a citizen of the United States, and resident of Chicago, county of Cook, and State of Illinois, have invented a certain new and useful Improvement in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description.

My invention relates to telephone exchange systems employing a central battery for signaling, and particularly to that type adapted for central battery transmission in which the switching terminals or spring jacks of the lines are constructed each with only two contact pieces, connected with the two line limbs respectively; the connecting plugs being correspondingly provided each with only two contacts, these forming the terminals of link conductors by which the lines are temporarily switched together.

The principal object of my invention is to provide improved means for controlling the display of the subscriber's calling signal, and a second object is to provide improved means for controlling the circuits of the supervisory signals.

Other objects and advantages of my invention will be apparent to those skilled in the art from the following description.

In accordance with my invention, I associate with the line circuit a signal controlling electro-magnet normally under the control of the subscriber, whereby a call may be initiated at the central office. The magnet core is provided with a non-magnetic metallic shell or shield, and has two windings differentially connected, one of said windings being included in that portion of a line limb extending to the substation and the other winding being included in that portion of the same line limb extending to the spring jacks. The two windings are connected at their intermediate point to the central source of current, said connection including an impedance or resistance. The two windings are preferably "concentric" windings; that is, wound one outside of the other upon the magnet core, and that winding connected toward the substation has a lesser number of turns than the other winding. The magnet is preferably in the form of a relay magnet controlling the circuit of an incandescent lamp signal, although I am not limited to such construction, as it will be obvious that it might be a magnet controlling directly a

mechanical signal or target. The magnet is so designed that when circuit is closed through the first mentioned winding by the removal of the telephone at the substation, it will be sufficiently energized to cause the display of its signal. Cord connecting apparatus is provided, adapted upon the insertion of the connecting plug to complete a circuit from the central battery through the last mentioned winding of the magnet in opposition to that through the first mentioned winding and the armature adjustment and relative number of turns are such that the current through this opposing winding will sufficiently weaken or reverse the energization of the magnet to allow its armature to be retracted and efface the calling signal as long as the plug remains in the jack. The two windings are serially included in one side of the talking circuit but being wound over a non-magnetic shell as well as differentially connected and preferably of relatively low resistance, do not interfere with transmission nor unduly unbalance the talking circuit.

I will describe my invention more fully by reference to the accompanying drawings forming a part of this specification, in which—

Figure 1 illustrates two complete line circuits together with appropriate cord connecting apparatus all organized in accordance with the preferred form of my invention, and Fig. 2 illustrates a modification of the line circuit arrangement of Fig. 1 and an alternative cord connecting structure adapted for use therewith.

Referring first to Fig. 1, the subscriber's apparatus is represented as consisting of a telephone hook switch *h*, signal bell *b*, condenser *c*, transmitter *t*, and receiver *r*, the bell and condenser being in normal bridge of the two line limbs and the receiver and transmitter being in a normally open circuit which is closed upon the elevation of the hook switch. Although I have shown but one arrangement, it will be understood by those skilled in the art that various other arrangements of the subscriber's apparatus may be used, and I do not confine myself to the particular arrangement illustrated.

Under normal conditions, the receiver being upon its switch-hook, the condenser *c* prevents a normal flow of current from the battery *C* at the central office over the tele-

phone line limbs. When, however, the subscriber removes his telephone from its hook, thus establishing a relatively low resistance path for current through the transmitter *t* and receiver *r*, the signal controlling relay 4 at the central office will be energized by the flow of current from the battery C through winding 15 of impedance coil 3, winding 7 of relay 4, limb 1 of the telephone line, through the substation, back to the central office over limb 2 and thence through winding 14 of impedance coil 3 to the return or ground side of the battery C. This current will energize relay 4, causing the attraction of its armature, thus closing a circuit for signal lamp 5. Upon observing the calling signal, the operator will insert the left hand or answering plug P of the cord circuit into a spring jack 10 of the line, corresponding to the calling signal, thus causing the tip and sleeve contact pieces of the plug to engage respectively with the corresponding contact pieces of the spring jack. The tip contact pieces of the plug and spring jack complete a circuit for the flow of current from battery C, which may be traced as follows:—from the active terminal of battery C, through conductor 35, relay 20, strand 16, spring jack 10, winding 6 of relay 4 and thence through winding 7 and the line limbs to the return side of the battery over the circuit previously traced. It will be seen that the current through winding 6 of relay 4 now opposes that through winding 7 and the energization of relay 4 is thus sufficiently reduced to allow the retraction of its armature 30 and the extinguishment of lamp 5. Supervisory relay 20 is at this time energized. The engagement of the sleeve contact pieces of the plug and spring jack has meanwhile established a circuit which may be traced from the active terminal of the battery C through conductor 35, the winding of relay 40, strand 18, plug and jack contacts and thence through winding 14 of impedance 3 to the return side of the battery. This circuit causes the energization of relay 40 and by the attraction of its armature, lamp 22 is connected to conductor 32 which now stands open at the armature of relay 20. Were the hook switch at substation A now depressed by the replacing of the receiver *r*, the consequent interruption of the circuit of the line limbs would cause the de-energization of relay 20 and allow its armature to be retracted closing the circuit of lamp 22 and causing its illumination.

Upon securing from the subscriber the number of the line desired, in this case at substation B, the operator tests in the usual way by applying the tip of her calling plug O to the sleeve of a multiple jack 10 of the desired line. The tip being normally at the same potential as the jack sleeve contacts, no effect is produced if the line is idle. If, how-

ever, the line be connected for conversation at some other spring jack, a flow of current will result when the test is made, which may be traced from the active terminal of battery C through conductor 35 and relay 40 or 41 of that cord which is already connected with the line, thence through its strand 18 or 19 to the sleeve of the multiple jack at which connection exists, over limb 2 to the jack at which the test is made, thence through the normally closed contacts of the relay 41, and the winding of relay 34 to the return side of the battery. The relay 34 is a test relay of relatively high resistance and its energization by a current flowing over the path just traced causes the attraction of its armature, thus including the winding 27 of the operator's induction coil in circuit with the battery C giving the customary click which indicates that the line is busy. Finding the line idle, the operator inserts the calling plug O and actuates her ringing key *g*, in the usual manner. Current now flows from generator G through strand 19, limb 2, the substation condenser *c* and bell *b*, limb 1, windings 7 and 6 of relay 4, and thence through strand 17 and resistance 38 to the return side of the generator through the battery C' or the circuits connected with this battery. The current through relay 4 at this time is of opposite direction in its two windings, and while some portion of the current will be diverted from winding 6 to the path through winding 15 of impedance 3, the relay will not be sufficiently energized to cause the attraction or vibration of its armature. The non-magnetic shell upon the relay core provides additional means for preventing the actuation of the relay armature at this time. Upon the restoration of the ringing key, a circuit for relay 41 is completed similar to that previously traced for relay 40. The consequent attraction of armature 47 of this relay disconnects the high resistance test relay 34 from the tip strand and completes the circuit of this strand 17 to relay 21 and condenser *d*. Likewise the attraction of armature 42 of relay 41 completes a circuit to cause the illumination of the supervisory lamp 23 which may be traced from the active terminal of battery C through conductor 35, lamp 23, armature 42, conductor 33, and the contacts of relay 21, (which is at this time de-energized) to the return side of the battery. When the subscriber answers, the elevation of his hook switch *h* allows current to flow from conductor 35 through relay 21, strand 17, and winding 6 of relay 4; and uniting with current flowing through winding 15, thence through winding 7, limb 1, receiver *r*, transmitter *t*, and to the return side of the battery through limb 2 and winding 14 of impedance 3. The armature of relay 21 is thus attracted, opening the circuit of lamp 23 and the current which now flows through the

windings of relay 4 being opposed in direction in the two windings is insufficient to cause the attraction of its armature. The line lamp 5 consequently remains dark. The two subscribers are now inductively united for conversation by means of strand 16—17 which includes condenser d and strand 18—19, which includes the condenser d' . When either subscriber hangs up, the consequent interruption of current through relay 20 or 21 allows its armature to drop back, thus causing the illumination of lamp 22 or 23. When both lamps are thus lighted, the operator understands that conversation is finished and removes the connection.

Fig. 2 differs from Fig. 1 in that the supervisory signals associated with the link conductor have their circuits completed over a portion of the talking circuit of the cord and line and the line relay 4 has its windings and contacts so arranged that when the relay is partially energized, its armature will assume an intermediate position. Referring to the drawing it will be seen that the insertion of a plug O into a jack of a line not in use will result in the establishment of a circuit from battery C through conductor 36, lamp 23, strand 19, limb 2 and to the return side of the battery through resistance 9 and impedance 14, the resistance 9 being relatively low as compared with that of the impedance coil. The current flowing over this path will be sufficient to cause the illumination of lamp 23 as long as relay 21' remains deenergized. When the subscriber closes circuit at the substation, current will flow from conductor 36 through relay 21', strand 17, windings 6 and 7 and to the return side of the battery through limbs 1 and 2, and the resistance 9 in multiple with impedance 14; and a relatively small current will also flow to line from battery C through the impedance 15 to the point intermediate of the windings 6 and 7. The first mentioned current will energize relay 21', thus interrupting the circuit of lamp 23 and will partially energize relay 4' through the unequal opposing effect of its two windings. This will cause its armature 8 to be attracted to its intermediate position against the spring stop 43, thus removing the low resistance connection to earth of limb 2, through resistance 9, this now being the condition required for conversation.

When a subscriber initiates a call, the current flowing through winding 7 being at this time unopposed, the relay 4' is energized to its greater extent causing the complete attraction of its armature 8 to close the circuit of the line lamp 5, and upon the insertion of the answering plug the opposing current through winding 6 reduces the energization of the relay to its partial value, allowing the armature to return to its intermediate position and extinguishing the lamp. Referring

to the busy test it will be seen that upon the initial actuation of the listening key k' in answering a call, the testing tip of the plug O is connected through a portion of strand 17 and spring 25 of the listening key, to the test winding 27 of the operator's set S, and that the lower terminal of this winding is connected to the return side of the battery as is the sleeve of the multiple jacks. Under normal conditions, therefore, no click will result when testing in the usual way. If, however, the line circuit tested be in use, the potential of the sleeve or test terminal of the multiple jacks of the line tested will be raised above that of the return side of the battery either by current flowing through a lamp 22 or 23 and strand 18 or 19 of the busy cord circuit or through relay 20' or 21', strand 16 or 17 and the limbs of the busy line, thus causing a click to be given in the operator's set when such busy line is tested. When the plug is inserted, the restoration of the listening key disconnects the test winding 27 and reestablishes the normal circuit of strand 17 at contact 29. When the subscriber answers, the energization of relay 21' and consequent attraction of armature 24 closes a circuit around the break controlled by the listening key at contact 29, thus preventing a subsequent interruption to the talking circuit should the operator actuate her key while the subscribers are in conversation. The resistance 28 is so proportioned with relation to the resistance of impedance 15 and winding 6 that when the ringing key g' is actuated to call a subscriber, the relay 4' will be partially energized, thus removing the connection through the low resistance 9 and preventing the display of the line lamp 5 at this time. The structure of Fig. 2 operates in other respects as that of Fig. 1, and needs no further description.

Assuming the battery C to have a potential of 40 volts, I find that good results can be secured by making the ratio of turns in windings 7 and 6 of relay 4 or 4' as three is to five, and that winding 14 may have a resistance of two hundred ohms, winding 15 a resistance of five hundred ohms, relay 20 or 20' a resistance of two hundred ohms and relay 40 a resistance of five hundred ohms, for subscribers' lines of average length; but I do not limit myself to these specific resistances or turns. The armature adjustment of relay 4 or 4' is preferably one in which there is a relatively wide air gap between the core and the armature and in which the armature has a relatively small range of motion.

It will be understood that the battery C or C' may be one and the same and that the various grounds indicated may be connections to the grounded side of the battery or the office return.

It will be apparent that various modifications may be made in the structures illus-

trated without departing from the spirit and scope of my invention, and that my invention may be embodied in numerous other organizations than those shown. I, therefore, do not wish to be limited to the specific disclosure, but aim to cover by the terms of the appended claims all such modifications and embodiments.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. A telephone exchange system comprising a telephone line terminating at an exchange, a signal controlling electro-magnet having two opposing windings serially included in the line, a source of current and a resistance in bridge of said line from a point intermediate of said windings, means under the control of a subscriber for closing a circuit through one winding to energize said magnet sufficiently to cause the display of its signal, means for including the other winding in series with said first mentioned winding, and in shunt of said resistance whereby said energization is reduced to an amount insufficient to cause such display, and a second signal controlling electro-magnet associated with the line by the closing of said shunt circuit.

2. A telephone exchange system comprising a telephone line terminating at an exchange, a signal controlling electro-magnet having two opposing windings serially included in the line, a source of current and a resistance in bridge of said line from a point intermediate of said windings, means under the control of a subscriber for closing a circuit through one winding to energize said magnet sufficiently to cause the display of its signal, means for including the other winding in series with said first mentioned winding, and in shunt of said resistance whereby said energization is reduced to an amount insufficient to cause such display, and a signal controlling electro-magnet included in said shunt circuit and responsive to said first mentioned means.

3. A telephone exchange system comprising a telephone line terminating at an exchange, a signal controlling electro-magnet having two opposing windings serially included in the line, a source of current and a resistance in bridge of said line from a point intermediate of said windings, means under the control of a subscriber for closing a circuit through one winding to energize said magnet sufficiently to cause the display of its signal, means for including the other winding in series with said first mentioned winding and in shunt of said resistance, whereby said energization is reduced to an amount insufficient to cause such display, a second signal, and means for utilizing the current in the shunt circuit in the control of said second signal.

4. A telephone system comprising a tele-

phone line extending between two stations, means for establishing a conversational circuit over said line, a signal controlling relay having two energizing windings included in one limb of the talking circuit thus established and having contacts adapted to occupy three operative positions, means under the control of one station for actuating said relay by completing a circuit through both of its windings to cause its contacts to occupy one of said positions, and means under the control of the other station for actuating said relay to cause it to occupy another of said positions.

5. A telephone system comprising a telephone line extending from a substation to an exchange, a link-circuit for making connection to said line, means for holding conversation over said line and link-circuit, a signal controlling relay having two energizing windings included in one limb of the talking circuit thus established and having contacts adapted to occupy three operative positions, means under the control of the subscriber for actuating said relay to cause its contacts to occupy one of said operative positions, and means under the control of the operator for actuating said relay by completing a circuit through both of its windings to cause its contacts to occupy another of said positions.

6. A telephone system comprising a telephone line extending from a substation to an exchange, a link-circuit for making connection to said line, a signal controlling relay having two energizing windings included serially in one limb of said line and having contacts adapted to occupy three operative positions, a source of current bridged between the line limbs at a point intermediate of said windings, means under the control of the subscriber for completing a circuit through one of said relay windings to cause said relay contacts to occupy one of said operative positions, and means under the control of the operator for completing a circuit for said relay to cause said contacts to occupy another of said positions.

7. A telephone system comprising a telephone line extending from a substation to an exchange, a link-circuit for making connection to said line, means for holding conversation over said line and link-circuit, a signal controlling relay having two energizing windings included in one limb of the talking circuit thus established and having contacts adapted to occupy three operative positions, a source of current connected in bridge from a point intermediate of said windings to the opposite limb and having its pole adjacent to said latter line limb grounded, a resistance included in a branch extending from said latter line limb through normal contacts of said relay, and supervisory apparatus included in branches extending from the live pole of said battery to the opposite link-circuit strands.

8. A telephone system comprising a telephone line extending from a substation to an exchange, a link-circuit for making connection to said line, means for holding conversation over said line and link-circuit, a signal controlling relay having two energizing windings included serially in one limb of said line, a source of current connected in bridge from a point intermediate of said windings to the opposite line limb and having its pole adjacent to said latter line limb grounded, and supervisory apparatus included in branches extending from the live pole of said source to the strands of said link-circuit.

9. A telephone system comprising a telephone line extending in two line limbs between two stations, a connection terminal for said line having contacts for each of said limbs, a two-strand link-circuit and connecting plug for establishing connection with said line limbs through said connection terminal contacts, a signal controlling relay having two energizing windings included in one limb of said telephone line and having contacts adapted to occupy three operative positions, means under the control of one station for actuating said relay to cause its contacts to occupy one of said positions, and means under the control of the other station for actuating said relay by closing a circuit through both of its windings and one set of plug and jack contacts to cause it to occupy another of its positions.

10. A telephone system comprising a telephone line extending in two limbs from a substation to an exchange, a connection terminal for said line having contacts for each of said limbs, a two strand link-circuit and connecting plug for establishing connection with said line limbs through said connection terminal contacts, means for holding conversation over said line and link-circuit, a signal controlling relay having two energizing windings included in one limb of the talking circuit thus established and having contacts adapted to occupy three operative positions, means under the control of the subscriber for actuating said relay to cause its contacts to occupy one of said operative positions, and means under the control of the operator for actuating said relay by closing a circuit through both of its windings and one set of plug and jack contacts to cause the contacts of said relay to occupy another of said positions.

11. A telephone system comprising a telephone line extending between two stations, a signal controlling relay individual to said line and having two windings serially connected in one limb of said line, means for normally closing a circuit from one of said stations through one only of said relay windings to alter the operative condition of said relay, and means jointly controlled at said

stations for causing a flow of current in series through both windings to further alter the operative condition of said relay.

12. A telephone system comprising a telephone line connecting a substation with the exchange, a signal controlling relay for said line having a pair of windings serially included in circuit with one limb of said line, cooperating switching means at the substation and the exchange jointly controlling a flow of current in series through said relay to alter the operative condition thereof, and means normally responsive to said switching means at the substation to close a circuit through one only of said relay windings to produce a different operative condition of said relay.

13. A telephone system comprising a telephone line extending from a substation to the exchange, a connection terminal at the exchange, a line relay having two windings connected in series in one limb of said telephone line at a point intermediate of a contact of said connection terminal and the substation, a signal, means controlled at the substation for causing a flow of current through one winding of said relay to display said signal, and operator's connection means for connection with said terminal adapted to cooperate with said first-mentioned means to establish a current flow in series through said windings and said line limb to efface said signal.

14. A telephone system including a telephone line extending from a substation to the exchange, a line relay for said line with a signal controlled thereby, said line relay having two windings connected in series in one limb of said telephone line, means controlled at the substation for causing a flow of current through one of said windings only to display said signal, an operator's link-circuit and a source of current connected therewith arranged for connection with the limb of said telephone line including said windings in series to cause a flow of current through both said windings to efface said signal.

15. A telephone system including a telephone line, a signal actuating relay therefor, two windings for said relay connected in one limb of said line, means for normally causing a flow of current over said line limb through one only of said windings to operate said relay, and means for causing a flow of current over said line limb in series through both windings to change the operative condition of said relay.

In witness whereof, I hereunto subscribe my name, this 19th day of Feby. 1906.

HARRY G. WEBSTER.

Witnesses:

G. E. MUELLER,

H. C. OLMSTEAD.