H. G. WEBSTER.

TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED AUG. 4, 1904.

930,512.

Patented Aug. 10, 1909.

2 SHEETS—SHEET 1.

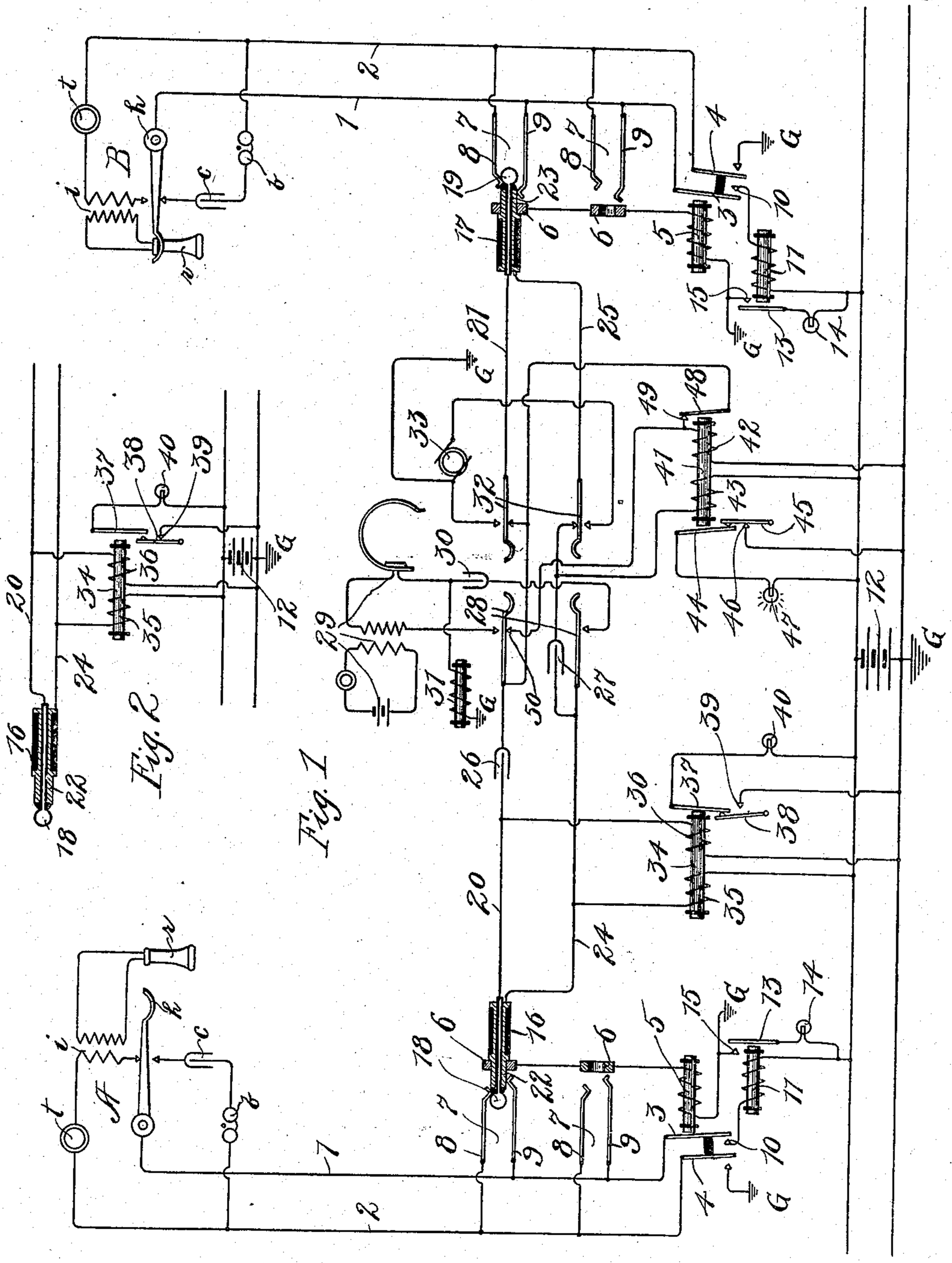

Fig. 2

Fig. 1

Witnesses:

Leonard W. Norander.

Charles J. Schmidt,

Inventor

Harry G. Webster

ANDREW. B. GRAHAM CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

H. G. WEBSTER.

TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED AUG. 4, 1904.

930,512.

Patented Aug. 10, 1909.

2 SHEETS—SHEET 2.

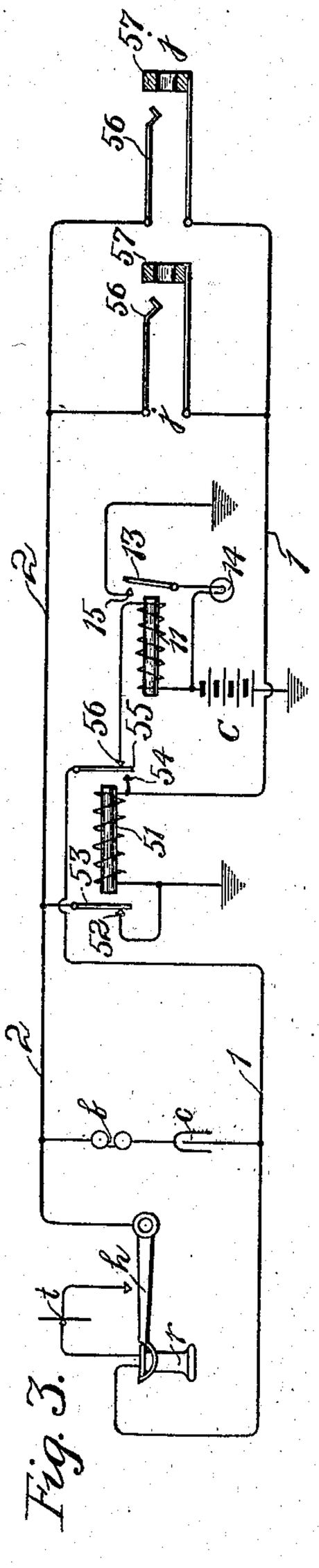

Fig. 3.

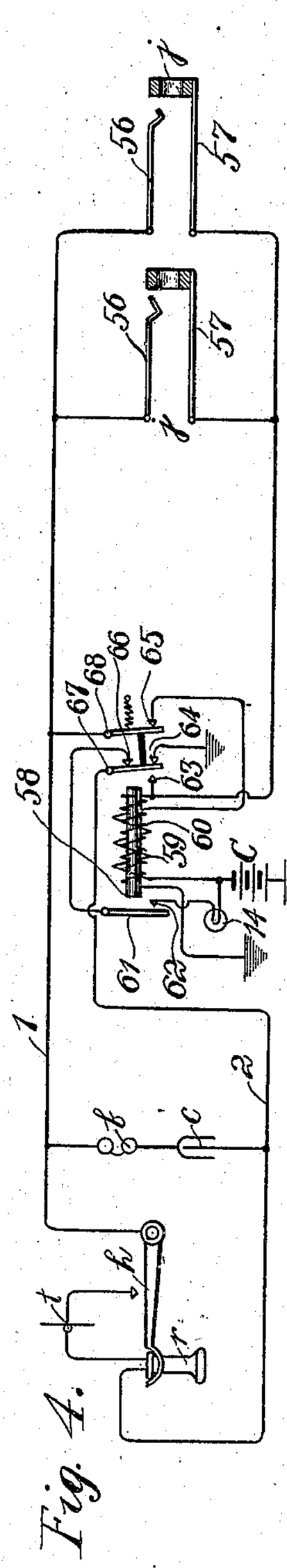

Fig. 4.

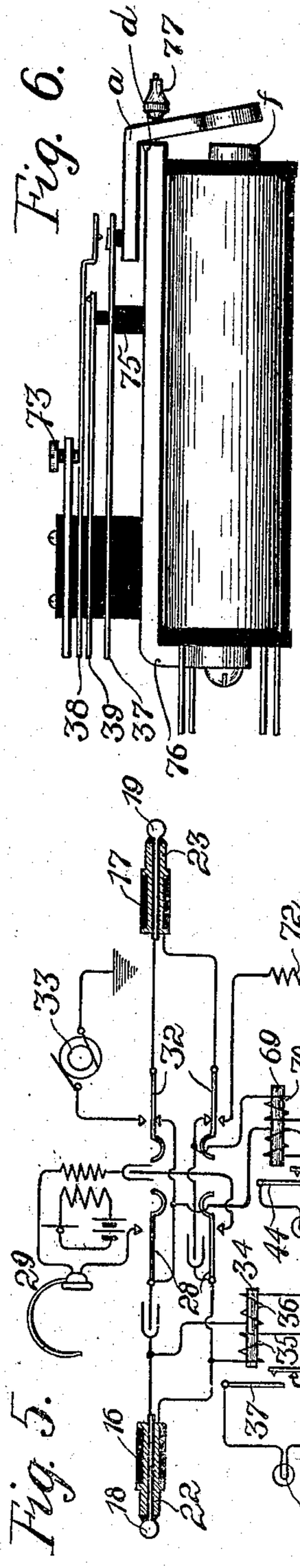

Fig. 6.

Fig. 5.

Witnesses:

Leonard W. Novander.

Arthur H. Boettcher,

Inventor

Harry G. Webster

ANDREW. B. GRAHAM CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

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

TELEPHONE-EXCHANGE SYSTEM.

No. 930,512. Specification of Letters Patent. Patented Aug. 10, 1909.

Application filed August 4, 1904. Serial No. 219,413.

To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, a citizen of the United States, and a resident of Chicago, Cook county, and State of Illinois, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to central battery systems in which subscribers' lines extend from sub-stations to an exchange, and are there associated with cord connecting apparatus, the said connecting apparatus including a supervisory signal or signals, which are controlled through the manipulations of the operator, and the actuation of the subscriber's hook switch jointly. Systems of this character have been devised in which the supervisory signal is a small incandescent lamp, its circuit being controlled by a differentially wound relay having its two windings included in the two talking strands of the cord circuit. In such systems it is necessary that the line wire leading from one side of the central battery be normally connected to ground through a contact associated with the subscriber's hook switch, the ground connection being automatically broken when the telephone is taken for conversation. In other systems which have gone into use, the use of a ground at the subscriber's station is avoided by using two relays, one for each of the talking strands of the cord circuit. In such systems the supervisory signal is in a local circuit controlled by the joint action of the two relays.

The object of my invention is to provide means by which the ground at the subscriber's station is rendered unnecessary, and to simplify the cord connecting apparatus. This is accomplished by associating with the cord circuit a relay having contacts which have two operative positions (besides the normal one) controlling the local circuit of the supervisory signal. Relays of this type are characterized by having two armatures with spring tension adjustment, or having two armatures one being of greater magnetic permeability than the other, or having a single armature arranged to assume two operative positions, (as distinguished from its normal position) determined by the degree of energization of the relay magnet, and I do not wish to limit myself to any particular construction in such a relay.

In the accompanying drawings illustrating a preferred form of my invention I have shown diagrammatically,—in Figure 1, two complete line circuits of the three wire type in association with cord connecting apparatus utilizing the special relay, and indicating the two operative positions of the relay contacts. Fig. 2 indicates the normal position of the relay contacts. Fig. 3 is a diagram of a well known two wire line circuit using a line relay and a cut-off relay. Fig. 4 is that of a two wire line circuit in which the line and cut-off relays are replaced by a single relay, and Fig. 5 shows diagrammatically cord connecting apparatus adapted for association with either line circuit, thus illustrating two modifications of my invention. Fig. 6 illustrates the mechanical arrangement of one type of cord relay which may be used in my invention.

Similar characters refer to corresponding parts in the various drawings.

Referring to Fig. 1 the subscribers' stations A and B are provided with the usual apparatus adapted preferably for use with a central source of current supply and comprising a transmitter *t*, an induction coil *i* and receiver *r* in a circuit which stands normally open at the hook switch *h*; the bell *b* and condenser *c* being in circuit with the line when the hook switch is depressed. Under normal conditions limbs 1 and 2 of the line extend to the central office and are there connected to the jacks 7—7; limb 1 being also carried through contacts 3—10 of the cut-off relay 5, and the winding of relay 11, to the active side of the central battery 12; and limb 2 is carried through contact 4 of the cut-off relay to the ground or return side of battery 12. The winding of the cut-off relay 5 is of comparatively high resistance and is interposed between the test pieces or thimbles 6—6 of the jacks, and the ground G; and the thimbles 6—6 are so arranged that upon the insertion of a plug into a line jack an electrical connection is established between the thimbles 6 and sleeve springs 9 of the jacks associated with the line. The cord connecting apparatus includes an answering plug 16 and a calling plug 17, the plug tips 18—19 being united by strands 20 and 21 and condenser 26; and the plug sleeves 22—23 by strands 24—25

and condenser 27; and the usual listening-in key 28, ringing key 32, calling generator 33 and operator's set 29 are provided. A supervisory relay 34 is associated with the answering plug and controls the circuit of the supervisory signal lamp 40; and the supervisory relay 41 is associated with the calling plug 17 and controls the circuit of supervisory lamp 47 as well as certain connections concerned in the busy test, which will be explained later. The supervisory relay 34 is so adjusted that when energized to a limited extent contact 37 will engage contact 38, but will not bring it out of engagement with contact 39, the normal position of this relay being indicated in Fig. 2. Relay 41 is so arranged and adjusted that when energized to a limited extent contact 44 will engage contact 45, but contact 45 will still remain in engagement with contact 46. Contacts 48—49 of this relay will also be brought into engagement when the relay is partially energized. When either relay is energized to a greater extent the contacts 38—39 or 45—46 will be separated by the further movement of the armature contact 37 or 44 respectively.

Subscriber A in calling moves his receiver from its hook switch completing a circuit of relay 11 and lighting the lamp 14 in the usual manner. Upon the insertion of the answering plug 16, current flows from battery 12 through winding 35 of relay 34 and thence through the winding of cut-off relay 5, causing the actuation of relay 5 and thereby disconnecting line relay 11, extinguishing the lamp 14, and removing the normal ground of the line at contact 4. At the same time current is supplied to the subscriber's instrument through windings 35—36 of relay 34, causing the complete actuation of the relay 34 and leaving the lamp 40 unlighted, as shown in the drawing. After ascertaining the line desired for connection (in this case that of subscriber B) the operator tests in the usual manner by touching the tip 19 to thimble 6. Contacts 48—49 of the calling supervisory relay 41 stand normally open in order that a test of a busy line may not produce an excessive click in the receivers of the connected subscribers. In case the line tested is busy, current will flow from the thimble of the line tested through tip 19, strand 21, the operator's receiver and induction coil winding and impedance coil 31 to the ground or office return, producing a click in the receiver, in the well known manner. In case the line is idle the operator hearing no click inserts her plug into the jack and rings the subscriber, the current from generator 33 serving to energize relay 5 at this time. Upon the restoration of the ringing key a circuit is completed from battery 12 through winding 43, strand 25, plug sleeve 23, thimble 6 and relay 5, causing the continued energization of relay 5. On account, however, of the comparatively high resistance of this circuit and of the arrangement and adjustment of relay 41 the current which now flows through winding 43 is only sufficient to partially energize relay 41, bringing its contacts into the relation indicated in the drawing. The engagement of contacts 48 and 49 serves to short circuit contacts 50 of the listening-in key 28, so that in case the operator listens in on the connection after ringing, the winding 42 will not be disconnected as it is during the making of a busy test. The engagement of contacts 44—45 completes the circuit of lamp 47 causing its illumination. When subscriber B removes his receiver in answering, the circuit thus completed is of comparatively low resistance and includes both windings of relay 41; the relay is thus completely energized and the circuit of lamp 47 opened at contacts 45—46. When a subscriber replaces his receiver after conversation, current ceases to flow through line limbs 1—2 and relay winding 36 or 42 and the contacts return to their intermediate position, completing the circuit of the associated supervisory signal as shown in the case of relay 41. Both lamps when lighted constitute a signal for disconnection and upon the removal of both plugs all parts assume their normal condition.

In Fig. 3 is illustrated a line circuit differing from that of Fig. 1 in that the bell *b* and condenser *c* are in a permanent bridge of the line at the sub-station, and the jacks *j j* at the exchange have but two contact pieces. The thimbles 57—57 of the jacks serve normally as testing terminals for the line, but when the line is switched for conversation they also constitute connection terminals for the sleeve side of the line.

Fig. 5 indicates a modification of the cord circuit of Fig. 1 adapted for use with the line circuit of Fig. 3 and when associated with this line circuit presents a modification of my invention, the operation of the structure thus indicated being as follows: The subscriber calls in the usual manner by removing his receiver and thus closing a circuit of battery C through line relay 11 lighting the calling signal lamp 14. On the insertion of answering plug 16 the relay 51 is energized by a current from battery C′ flowing through winding 35 of relay 34, plug and jack contact 22—57 and the winding of relay 51 to the return side of the battery. This energizes relay 51 causing the contacts 52—53 and 55—56 to become separated, thus removing the normal connections of the line with relay 11 and battery C. The actuation of the relay 51 causes contacts 54—55 to engage, thus completing a second circuit from contact 57 of the jack through limbs 1 and 2 of the line and winding 36 of relay 34,

causing the complete energization of relay 34 and preventing the illumination of lamp 40, as was described with regard to Fig. 1. The calling supervisory relay 69 is similar to relay 34, differing in this respect from the calling supervisory relay 41 of Fig. 1. The operator tests, plugs in and rings in the usual manner. During the actuation of the ringing key, relay 51 is energized by current from battery C^2 flowing through the resistance 72. The circuit of the ringing generator 33 is from the ground or battery return, through plug and jack contact 19—56, line limbs 2—1, relay contacts 55—54, plug and jack contacts 57—23, resistance 72 and thence through the common circuits of battery C^2 to ground. Upon the restoration of the ringing key relay 51 is energized by current through winding 70 of relay 69, but as in the system of Fig. 1 this current being relatively weak as compared with that which flows when the circuit of the line limbs is closed at the sub-station, the relay 69 is only energized to a limited extent, causing only the engagement of contacts 44—45, thus closing the circuit of lamp 47, causing its illumination. When the subscriber answers an increased current now flows through winding 70 and through winding 71 of relay 69, causing a greater energization which serves to separate contacts 45—46, extinguishing the lamp. When either subscriber hangs up, the low resistance circuit through the line limbs and winding 36 or 71 being broken the relay is then energized to a limited extent only and its contacts assume the intermediate position, causing the illumination of the lamp 40 or 47 associated therewith. Both lamps when lighted constitute the signal for disconnection, and upon the removal of the plugs all apparatus assumes the normal condition shown in the drawing.

When the cord circuit of Fig. 5 is associated with the line circuit illustrated in Fig. 4 the operation of the cord circuit apparatus is substantially the same as when associated with Fig. 3. The line circuit, however, is one in which a single relay 58 is associated with the line instead of the two separate relays 51 and 11 of Fig. 3. This relay 58 has an energizing winding 59 of comparatively low efficiency, and when the circuit of battery C is closed therethrough (as when the subscriber removes his receiver from the switch hook) the circuit being completed through contacts 65—68, limbs 1—2 and contacts 67—64 to the return side of the battery, the relay is only energized to a limited extent and only actuates contact 61, bringing it into engagement with contact 62, thus completing a circuit of battery C through lamp 14, which includes contacts 66—67—64, causing the illumination of the lamp. Winding 60 of this relay is of comparatively high efficiency and resistance. When a connecting plug as 16 is inserted, a circuit thus being completed from battery C′ through winding 35 of relay 34, plug and jack contacts 22—57 and winding 60 to ground, relay 58 is then energized to a greater extent and causes the separation of contacts 67—66—64, thus opening the circuit of lamp 14 and removing the normal ground from line limb 2, and also causes the separation of contacts 65—68, thus disconnecting winding 59 from line limb 1. The greater energization of the relay also brings into engagement contacts 63—67, thus completing a direct connection from jack contact 57 to limb 2 of the line. If the sub-station circuit is open at this time relay 34 is energized to a limited extent only, completing the circuit of lamp 40 through contacts 37—38—39, causing its illumination. When the circuit is closed at the sub-station the increased flow of current through winding 35 of relay 34 and also through winding 36, causes the greater energization of the relay 34 to separate contact 38—39, thus extinguishing the lamp. When plugging in to call a subscriber the circuit completed through winding 70 of relay 69 and winding 60 of relay 58, being of comparatively high resistance, relay 69 is only partially energized, while relay 58 is completely actuated as previously described. The test is secured in the usual manner, plug tip 19 and jack contact 57 being of the same potential as long as no connection exists with a jack of the line tested. While ringing, the relay 58 is completely actuated by current of battery C^2 flowing through resistance 72 and winding 60.

Fig. 6 indicates the mechanical arrangement of one type of relay corresponding to that indicated as relay 34 or relay 69. The armature *a* resting upon the knife edge *d* is held in place by the pin and nut 77, and is shown in its normal position. The piece 76 is a continuation of the relay core. The springs 37—38—39 correspond to the similarly numbered contacts of relay 34; spring 37 normally rests upon the shoulder of the insulating piece 75; when the relay is partially energized the armature *a* is sufficiently attracted to the pole piece *f* to bring spring 37 into engagement with the contact of spring 38, but the tension of spring 38 is so adjusted by screw 73 or by other obvious means that this limited energization of the relay magnet is not sufficient to cause a further movement of its armature. When the relay is energized to a greater extent as by an increased flow of current through its winding or by current through an additional winding, the final movement of the armature takes place, thereby raising spring 38 out of engagement with the contact of spring 39.

While I have indicated in Figs. 1 and 5 two windings for the cord relay it is obvious that winding 35, 43 or 70 may be of suffi-

cient energizing capacity to cause the required increase in energization of its respective magnet when the corresponding line circuit is closed and that the presence of the supplementary windings 36, 42 and 71 upon the same cores as windings 35, 43 and 70 respectively, is not essential to the operation of my invention; the requirement being merely that the windings, which are included on said cores, shall be sufficient to secure the intermediate and final positions of the armatures or contacts associated therewith.

To recapitulate I have indicated in the various drawings structures in which the insertion of a plug into the jack of an idle line causes the supervisory relay associated therewith to be energized to a limited extent to complete the circuit of its supervisory signal, and in which the completion of the circuit through the line limbs causes a greater energization of the supervisory relay to again efface the signal.

Where the term, "operative earth connection", is used in the following claims, it is to be understood as meaning a ground or third conductor connection, required for the proper operation of the supervisory signal.

While I have indicated in Figs. 3, 4 and 5 separate batteries C—C′—C² it will be obvious to those skilled in the art that these may be one and the same battery; also that the various grounds shown indicate the return side of the central office battery or batteries.

Wherever in the following claims I have referred to "the non use" of a line, it is to be understood that I am referring to that condition in which the telephone of the associated line is not in use, rather than to the condition of a connection being established with said line at the central office.

Wherever in the following claims I refer to "the use" of a line, it is to be understood that I am referring to the conversational circuit being established.

It will be understood that although I have illustrated a cord circuit directly uniting two subscribers' circuits without any intermediate or trunk connecting link, yet my invention is not limited to such a direct connection between subscribers in a single switchboard or in the same central office.

Wherever in the following claims I refer to a telephone line, it will be understood that said term is not limited to a line extending from a subscriber's station and terminating at a central office.

It will also be obvious to those skilled in the art that my invention is not confined in its application to switch board systems of the character illustrated in the drawings, but that it may be applied to and utilized in other telephone exchange systems and in signaling systems in general, and I therefore do not limit myself to the precise structures or circuit arrangements illustrated in the accompanying drawings but

I claim:

1. A telephone exchange system including telephone lines extending to a central office, call signals associated with said lines and adapted to be operated by current over said lines, line conductors for extending said telephone lines to the switchboard, link circuits at said switchboard for uniting said lines for conversation, spring jacks for said lines, each provided with three contact pieces, two connected with their associated line conductors and the third connected with a third conductor normally disconnected from said line conductors, connecting plugs each provided with two contact pieces, adapted, when inserted into a spring jack, to connect one of said line conductors with one strand of its associated link circuit, and to connect the other line conductor with the other strand of its link circuit and with said third conductor, a source of current associated with said link circuit and having its two poles connected respectively with the two strands of said link circuit to furnish current over the metallic circuit of said line, a relay magnet winding included in a relatively high resistance connection extending between said third conductor and a return conductor maintained at a potential different from that pole of the source of current connected with said third conductor when a link circuit is connected with the line conductors, whereby said relay magnet will be energized to destroy the substation control of its associated line signal, a supervisory signal, and a unitary supervisory magnet for exercising sole control over said supervisory signal.

2. A telephone exchange system including telephone lines extending to a central office, call signals associated with said lines and adapted to be operated by current over said lines, line conductors for extending said telephone lines to the switchboard, link circuits at said switchboard for uniting said lines for conversation, spring jacks for said lines, each provided with three contact pieces, two connected with their associated line conductors and the third connected with a third conductor normally disconnected from said line conductors, connecting plugs each provided with two contact pieces, adapted, when inserted into a spring jack, to connect one of said line conductors with one strand of its associated link circuit, and to connect the other line conductor with the other strand of its link circuit and with said third conductor, a source of current associated with said link circuit and having its two poles connected respectively with the two strands of said link circuit to furnish current over the metallic circuit of said line, a relatively high resistance relay magnet

connected between said third conductor and a return conductor maintained at a potential different from that pole of the source of current connected with said third conductor when a link circuit is connected with the line conductors, whereby said relay magnet will be energized to destroy the substation control of its associated line signal, a supervisory signal, and a unitary supervisory magnet for exercising sole control over said supervisory signal.

3. A telephone exchange system including telephone lines extending to a central office, call signals associated with said lines and adapted to be operated by current over said lines, line conductors for extending said telephone lines to the switchboard, link circuits at said switchboard for uniting said lines for conversation, spring jacks for said lines, each provided with three contact pieces, two connected with their associated line conductors and the third connected with a third conductor normally disconnected from said line conductors, connecting plugs each provided with two contact pieces, adapted, when inserted into a spring jack, to connect one of said line conductors with one strand of its associated link circuit and to connect the other line conductor with the other strand of its link circuit and with said third conductor, a source of current associated with said link circuit and having its two poles connected respectively with the two strands of said link circuit to furnish current over the metallic circuit of said line, a relay magnet winding included in a relatively high resistance connection extending between said third conductor and a return conductor maintained at a potential different from that pole of the source of current connected with said third conductor when a link circuit is connected with the line conductors, whereby said relay magnet will be energized to destroy the substation control of its associated line signal, a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug whereby when said testing contact piece of the plug is engaged with said third contact piece of a spring jack of a line, a flow of current will result through said test circuit if another plug be inserted into another spring jack of the same line, and whereby, if no connection exists with said line, no test indication will result, a supervisory signal, and a unitary supervisory magnet for exercising sole control over said supervisory signal.

4. A telephone exchange system including telephone lines extending to a central office, call signals associated with said lines and adapted to be operated by current over said lines, line conductors for extending said telephone lines to the switchboard, link circuits at said switchboard for uniting said lines for conversation, spring jacks for said lines, each provided with three contact pieces, two connected with their associated line conductors and the third connected with a third conductor normally disconnected from said line conductors, connecting plugs each provided with two contact pieces, adapted, when inserted into a spring jack, to connect one of said line conductors with one strand of its associated link circuit, and to connect the other line conductor with the other strand of its link circuit and with said third conductor, a source of current associated with said link circuit and having its two poles connected respectively with the two strands of said link circuit to furnish current over the metallic circuit of said line, a relatively high resistance relay magnet connected between said third conductor and a return conductor maintained at a potential different from that pole of the source of current connected with said third conductor when a link circuit is connected with the line conductors, whereby said relay magnet will be energized to destroy the substation control of its associated line signal, a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug whereby, when said testing contact piece of the plug is engaged with said third contact piece of a spring jack of a line, a flow of current will result through said test circuit if another plug be inserted into another spring jack of the same line, and whereby, if no connection exists with said line, no test indication will result, a supervisory signal, and a unitary supervisory magnet for exercising sole control over said supervisory signal.

5. A telephone exchange system including telephone lines extending to a central office, call signals associated with said lines and adapted to be operated by current over said lines, line conductors for extending said telephone lines to the switchboard, link circuits at said switchboard for uniting said lines for conversation, spring jacks for said lines, each provided with three contact pieces, two connected with their associated line conductors and the third connected with a third conductor normally disconnected from said line conductors, connecting plugs each provided with two contact pieces, adapted, when inserted into a spring jack, to connect one of said line conductors with one strand of its associated link circuit, and to connect the other line conductor with the other strand of its link circuit and with said third conductor, a source of current associated with said link circuit and having its two poles connected respectively with the two strands of said link circuit to furnish current over the metallic circuit of said line, a relay magnet winding included in a relatively high resistance connection extending

between said third conductor and a return conductor maintained at a potential different from that pole of the source of current connected with said third conductor when a link circuit is connected with the line conductors, whereby said relay magnet will be energized to destroy the substation control of its associated line signal, a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug whereby, when said testing contact piece of the plug is engaged with said third contact piece of a spring jack of a line, a flow of current will result through said test circuit if another plug be inserted into another spring jack of the same line, and whereby, if no connection exists with said line, no test indication will result, a winding of a signal controlling electromagnet associated with said link circuit and adapted to be included in circuit with said source of current and with said relatively high resistance connection when said link circuit is connected with the line, whereby said signal controlling electromagnet is caused to display its signal and a second winding on said electromagnet under the control of the substation switch for causing the effacement of said signal by causing a flow of current over the line circuit and through said second winding.

6. A telephone exchange system including telephone lines extending to a central office, call signals associated with said lines and adapted to be operated by current over said lines, line conductors for extending said telephone lines to the switchboard, link circuits at said switchboard for uniting said lines for conversation, spring jacks for said lines, each provided with three contact pieces, two connected with their associated line conductors and the third connected with a third conductor normally disconnected from said line conductors, connecting plugs each provided with two contact pieces, adapted, when inserted into a spring jack, to connect one of said line conductors with one strand of its associated link circuit, and to connect the other line conductor with the other strand of its link circuit and with said third conductor, a source of current associated with said link circuit and having its two poles connected respectively with the two strands of said link circuit to furnish current over the metallic circuit of said line, a relatively high resistance relay magnet connected between said third conductor and a return conductor maintained at a potential different from that pole of the source of current connected with said third conductor when a link circuit is connected with the line conductors, whereby said relay magnet will be energized to destroy the substation control of its associated line signal, a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug, whereby, when said testing contact piece of the plug is engaged with said third contact piece of a spring jack of a line, a flow of current will result through said test circuit if another plug be inserted into another spring jack of the same line, and whereby, if no connection exists with said line, no test indication will result, a winding of a signal controlling electromagnet associated with said link circuit and adapted to be included in circuit with said source of current and with said relatively high resistance relay magnet when said link circuit is connected with the line, whereby said signal controlling electromagnet is caused to display its signal, and a second winding on said electromagnet under the control of the substation switch for causing the effacement of said signal by causing a flow of current over the line circuit and through said second winding.

7. A telephone exchange system including telephone lines extending to a central office, call signals associated with said lines and adapted to be operated by current over said lines, line conductors for extending said telephone lines to the switchboard, link circuits at said switchboard for uniting said lines for conversation, spring jacks for said lines, each provided with three contact pieces, two connected with their associated line conductors and the third connected with a third conductor normally disconnected from said line conductors, connecting plugs each provided with two contact pieces, adapted, when inserted into a spring jack, to connect one of said line conductors with one strand of its associated link circuit, and to connect the other line conductor with the other strand of its link circuit and with said third conductor, a source of current associated with said link circuit and having its two poles connected respectively with the two strands of said link circuit to furnish current over the metallic circuit of said line, a relay magnet winding included in a relatively high resistance connection extending between said third conductor and a return conductor maintained at a potential different from that pole of the source of current connected with said third conductor when a link circuit is connected with the line conductors, whereby said relay magnet will be energized to destroy the substation control of its associated line signal, a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug, whereby, when said testing contact piece of the plug is engaged with said third contact piece of a spring jack of a line, a flow of current will result through said test circuit if another plug be inserted into another spring jack of the same line, and whereby,

if no connection exists with said line, no test indication will result, a relay winding associated with said link circuit and adapted to be included in circuit with said source of current and with said relatively high resistance connection when said link circuit is connected with a line, a signal associated with said relay winding and caused to operate by the energization of said relay winding over said circuit and a second winding on said relay for causing the effacement of said signal by a flow of current over the line circuit under the control of the substation switch.

8. A telephone exchange system including telephone lines extending to a central office, call signals associated with said lines and adapted to be operated by current over said lines, line conductors for extending said telephone lines to the switchboard, link circuits at said switchboard for uniting said lines for conversation, spring jacks for said lines, each provided with three contact pieces, two connected with their associated line conductors and the third connected with a third conductor normally disconnected from said line conductors, connecting plugs each provided with two contact pieces, adapted, when inserted into a spring jack, to connect one of said line conductors with one strand of its associated link circuit, and to connect the other line conductor with the other strand of its link circuit and with said third conductor, a source of current associated with said link circuit and having its two poles connected respectively with the two strands of said link circuit to furnish current over the metallic circuit of said line, a relatively high resistance relay magnet connected between said third conductor and a return conductor maintained at a potential different from that pole of the source of current connected with said third conductor when a link circuit is connected with the line conductors, whereby said relay magnet will be energized to destroy the substation control of its associated line signal, a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug, whereby, when said testing contact piece of the plug is engaged with said third contact piece of a spring jack of a line, a flow of current will result through said test circuit if another plug be inserted into another spring jack of the same line, and whereby, if no connection exists with said line, no test indication will result, a relay winding associated with said link circuit and adapted to be included in circuit with said source of current and with said relatively high resistance relay magnet when said link circuit is connected with a line, a signal associated with said relay winding and caused to operate by the energization of said relay winding over said circuit and a second winding on said relay for causing the effacement of said signal by a flow of current over the line circuit under the control of the substation switch.

9. A telephone exchange system comprising a two-limb telephone line, a jack for said line having two talking contacts corresponding to the line limbs and a third contact normally disconnected from the other two contacts, a coöperating plug having two contacts, one to engage a talking contact of said jack and the other to engage the other two jack contacts whenever said plug is in position in said jack, a link-circuit having talking strands terminating in said plug contacts, a line relay, means normally controlled over said line to actuate said line relay, means for disconnecting said line relay from the line to destroy said control by the completion of a circuit through one of said plug contacts, one of said talking strands and the third contact of said jack, a supervisory signal, and a unitary supervisory relay for solely controlling said supervisory signal, associated with said link-circuit.

10. A telephone exchange system comprising a telephone line extending in two limbs from a substation to the exchange, a line signal at the exchange, a line relay and a source of current normally in circuit with said line, means at the substation for closing said circuit to display said line signal, a jack for said line having two talking contacts corresponding to the line limbs and a third contact normally disconnected from the other two contacts, a cut-off relay for destroying the normal control of said line signal, a connection from said third contact of said jack through said cut-off relay to one pole of said source of current, a coöperating plug having two contacts, one to engage a talking contact of said jack and the other to engage the other two jack contacts whenever said plug is in position in said jack, a link-circuit having two talking strands terminating in said plug contacts, a connection from that plug contact which is adapted to engage the third jack contact, to that pole of said source of current opposite that to which said cut-off relay is connected, a supervisory signal, and a unitary supervisory relay for solely controlling said supervisory signal, associated with said link-circuit.

11. A telephone exchange system comprising a telephone line extending in two limbs from a substation to the exchange, a source of current, a line signal, a line relay normally connected between one limb of said line and one pole of said source, a normal connection between the other limb of said line and the other pole of said source, means at the substation for conductively uniting said limbs normally to actuate said line relay to display said line signal, a jack for

said line having tip and sleeve talking contacts and an extra sleeve contact normally disconnected from the other two contacts, a cut-off relay for destroying the normal substation control of said line signal, a connection from said extra sleeve contact of said jack through said cut-off relay to one pole of said source of current, a coöperating plug having a tip contact for engaging the tip contact of said jack and a sleeve contact for engaging the two sleeve contacts of said jack whenever said plug is in position in said jack, a link-circuit having two talking strands terminating in said plug contacts, a supervisory signal, and a unitary supervisory relay for solely controlling said supervisory signal having a winding connected between the sleeve side of said link-circuit and that pole of the source of current opposite to that to which said cut-off relay is connected.

12. A telephone exchange system comprising a telephone line extending in two limbs from a substation to the exchange, a source of current, a line signal, a line relay normally connected between one limb of said line and one pole of said source, a normal connection between the other limb of said line and the other pole of said source, means at the substation for conductively uniting said limbs normally to actuate said line relay to display said line signal, a jack for said line having tip and sleeve talking contacts and an extra sleeve contact normally disconnected from the other two contacts, a cut-off relay for destroying the normal substation control of said line signal, a connection from said extra sleeve contact of said jack through said cut-off relay to one pole of said source of current, a coöperating plug having a tip contact for engaging the tip contact of said jack and a sleeve contact for engaging the two sleeve contacts of said jack whenever said plug is in position in said jack, a link-circuit having two talking strands terminating in said plug contacts, a supervisory signal, and a unitary supervisory relay for solely controlling said supervisory signal having a winding connected between the sleeve side of said link-circuit and that pole of the source of current opposite to that in which said cut-off relay is connected and a winding connected between the tip side of said link-circuit and that pole of said source to which said cut-off relay is connected.

13. A telephone exchange system comprising a telephone line extending in two limbs from a substation to the exchange, a source of current, a line signal, a line relay normally connected between one limb of said line and one pole of said source, a normal connection between the other limb of said line and another pole of said source, means at the substation for conductively uniting said limbs normally to actuate said line relay to display said line signal, a jack for said line having two talking contacts and an extra contact normally disconnected from the other two contacts, a cut-off relay for destroying the normal substation control of said line signal, a connection from said extra contact of said jack through said cut-off relay to one pole of said source of current, a coöperating plug having a contact for engaging one talking contact of said jack, and a second contact for engaging the two other contacts of said jack whenever said plug is in position in said jack, a link-circuit having two talking strands terminating in said plug contacts, a supervisory signal, and a unitary supervisory relay for solely controlling said supervisory signal having a winding connected between the said second contact of said plug and that pole of the source of current opposite to that to which said cut-off relay is connected.

14. A telephone exchange system comprising a telephone line extending in two limbs from a substation to the exchange, a source of current, a line signal, a line relay normally connected between one limb of said line and one pole of said source, a normal connection between the other limb of said line and the other pole of said source, means at the substation for conductively uniting said limbs normally to actuate said line relay to display said line signal, a jack for said line having two talking contacts and an extra contact normally disconnected from the other two contacts, a cut-off relay for destroying the normal substation control of said line signal, a connection from said extra contact of said jack through said cut-off relay to one pole of said source of current, a coöperating plug having a contact for engaging one talking contact of said jack, and a second contact for engaging the two other contacts of said jack whenever said plug is in position in said jack, a link-circuit having two talking strands terminating in said plug contacts, a supervisory signal, and a unitary supervisory relay for solely controlling said supervisory signal having a winding connected between the said second contact of said plug and that pole of the source of current opposite to that to which said cut-off relay is connected and a winding connected between said first-mentioned contact of said plug and that pole of said source to which said cut-off relay is connected.

In witness whereof, I hereunto subscribe my name this 2nd day of August, A. D. 1904.

HARRY G. WEBSTER.

Witnesses:
FLORENCE WICKLIN,
LUELLA MERRITT.

Correction in Letters Patent No. 930,512.

It is hereby certified that in Letters Patent No. 930,512, granted August 10, 1909, upon the application of Harry G. Webster, of Chicago, Illinois, for an improvement in "Telephone-Exchange Systems," an error appears in the printed specification requiring correction, as follows: In line 52, page 8, the word "in" should read *to;* and that the said Letters Patent should be read with this correction therein, that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of October, A. D., 1909.

[SEAL.]

C. C. BILLINGS,

Acting Commissioner of Patents.