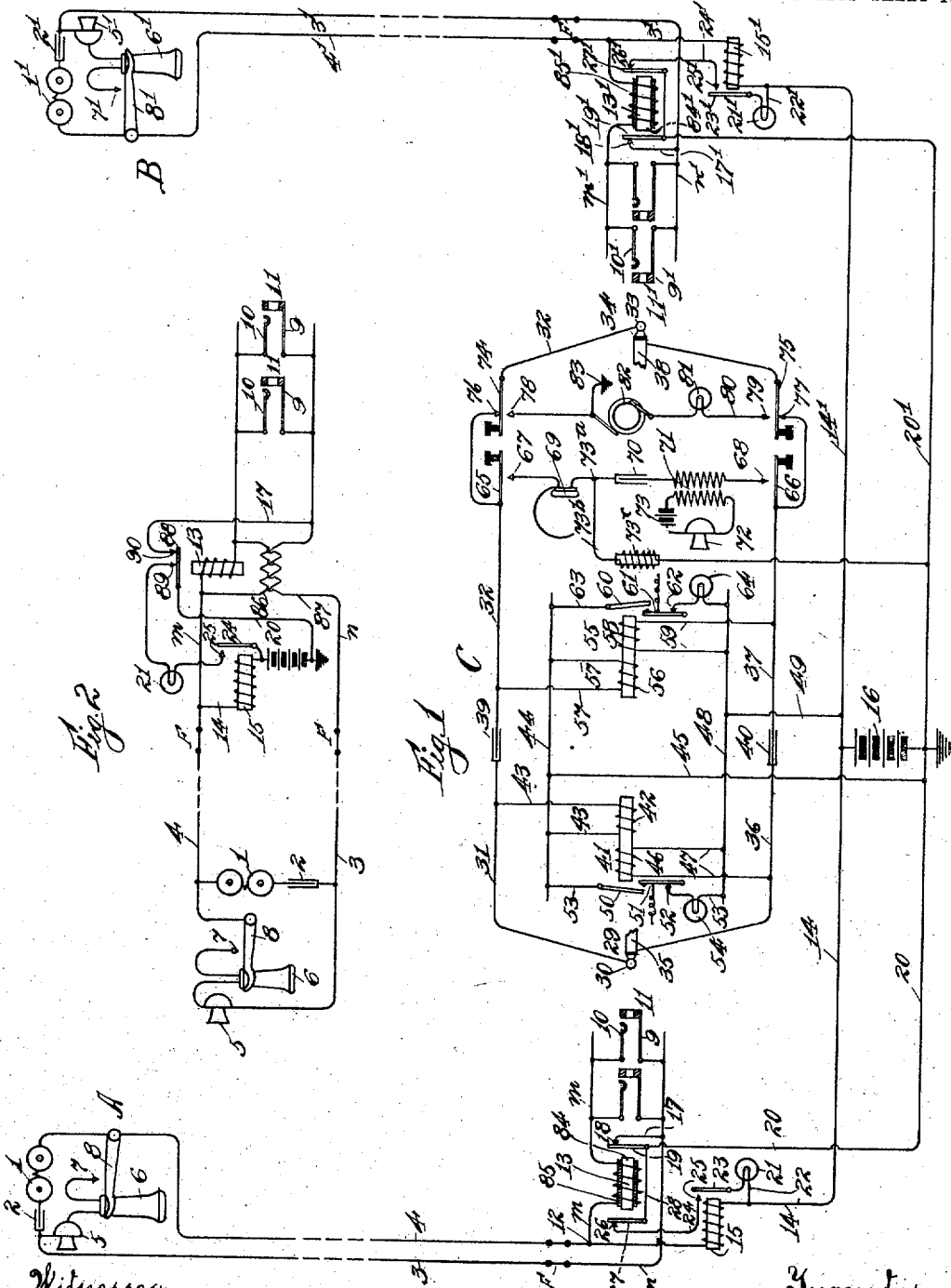


H. G. WEBSTER.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED JAN. 13, 1906.

930,517.

Patented Aug. 10, 1909.

2 SHEETS—SHEET 1.



Witnesses:
G. E. Mueller
A. H. Lyon

Inventor
HARRY G. WEBSTER
by Thomas H. Ferguson
Attorney

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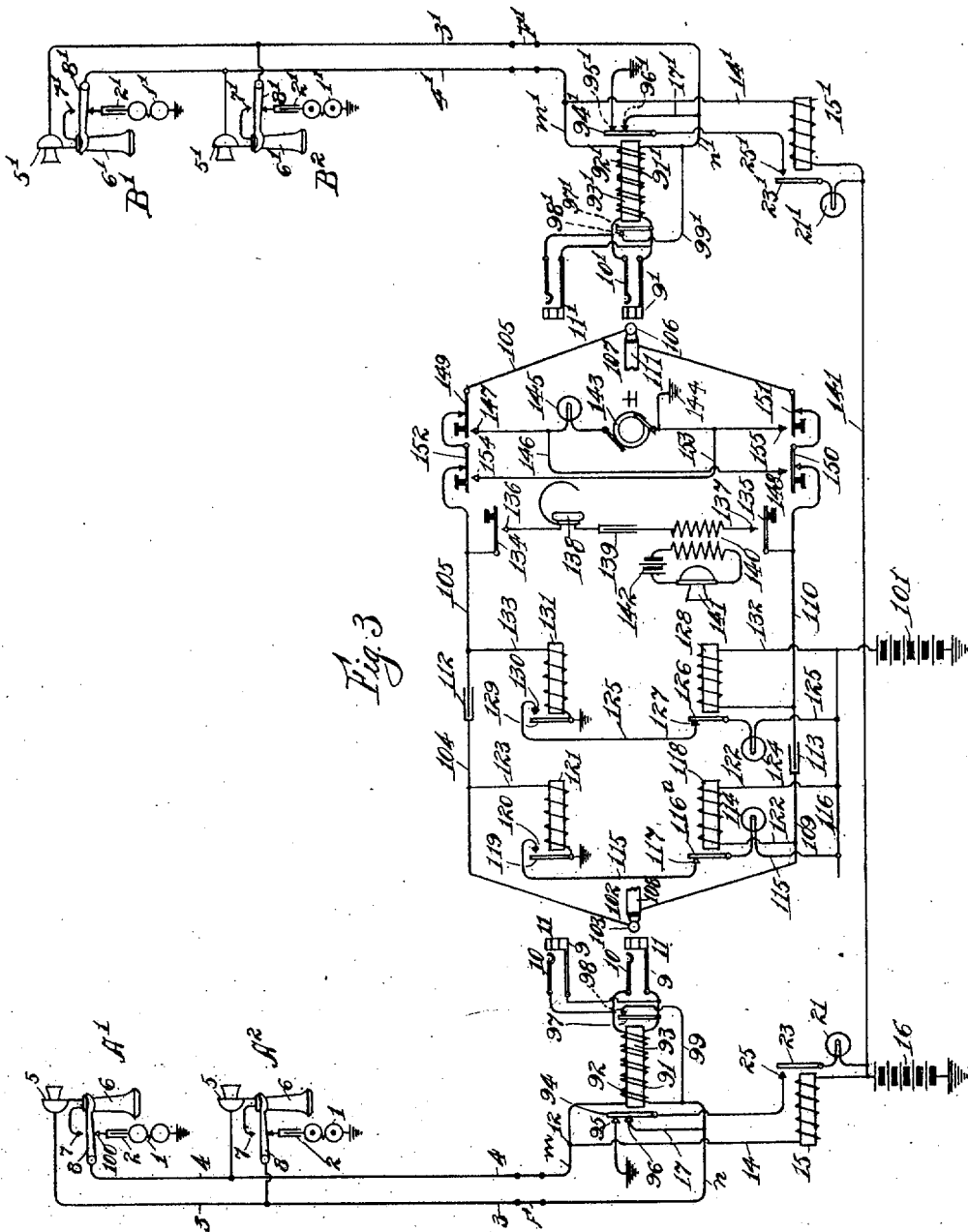


Fig. 3

Witnesses
S. E. Mueller.
A. H. Dyeon

Inventor
HARRY G. WEBSTER
by Thomas H. Ferguson
Attorney

UNITED STATES PATENT OFFICE.

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

TELEPHONE-EXCHANGE SYSTEM.

No. 930,517.

Specification of Letters Patent.

Patented Aug. 10, 1909.

Application filed January 13, 1906. Serial No. 295,985.

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 new and useful Improvements in Telephone-Exchange Systems, of which the following is a specification.

The present invention relates to telephone systems generally, and more particularly to systems, known as "two wire" telephone systems, in which the two wires of each telephone line may be extended through the multiple switchboard to the two wires of a connected telephone line with the accompanying advantages of common battery at the central office, a suitable busy test and the usual line and supervisory signals. In systems of this type, it is desirable to keep the talking circuit free from separable contacts, to employ simple apparatus and to obtain a positive action of the parts through a wide range of conditions met in installing the system. It is also of advantage to have the transmission current supplied in bridge of the cord circuit, to have normally a direct earth connection on that line limb associated with the testing terminal, and to have the line limbs free from low resistance earth connections at the exchange when calling a subscriber.

The object of the present invention is to provide a novel organization of circuits and apparatus for accomplishing these ends.

The various features of novelty, with their accompanying advantages, will more fully appear upon reference to the following detailed description, the accompanying drawing and the appended claims.

In the drawing, three different forms of the invention are illustrated.

Figure 1 illustrates diagrammatically a "two wire" system constructed in accordance with the present invention, showing a copper shell about the core of the cut-off relay for rendering the same non-inductive; Fig. 2 illustrates a portion of a similar system in which the cut-off relay is rendered non-inductive through the agency of a non-inductive shunt about its winding; and Fig. 3 illustrates diagrammatically another "two wire" system in which a different cord circuit, together with an independent source for supplying transmission current, is employed, and in which the cut-off relay is rendered

non-inductive by the use of "twin" windings included in the telephone line limbs.

Referring to Fig. 1, A and B designate substations which are connected to the central office C by suitable telephone lines. The equipment at substation A, which may be of any preferred type, is here shown as comprising a call-bell 1 in series with a condenser 2, in permanent bridge of the telephone line limbs 3—4. A second normally open bridge, including the transmitter 5 and the receiver 6, is closed at the contact 7 by the switch-hook 8 whenever the receiver is removed therefrom. At the central office, the line limbs 3 and 4 are connected to the distributing-frame F, from which they are continued by the extension conductors *m*, *n* to the contacts 9 and 10 of the usual jacks 11. In the extension conductor *m*, is included the winding of a controlling relay 13 which is preferably a cut-off relay. The extension conductor *m* is permanently connected at the point 12 by a branch 14, including the winding of a line relay 15, to the live pole of the battery 16. The extension conductor *n* is connected, by a conductor 17, to a fixed contact 18 of the cut-off relay, which cooperates with the movable contact 19 to complete a circuit through a conductor 20 to the negative pole of the battery 16. A bridge is completed through the call-signal lamp 21 between the conductors 14 and 20 by way of the conductor 22, leading from the conductor 14 to the movable contact 23 of the line relay 15, the conductor 24, connecting the fixed contacts 25 and 26 of the line and cut-off relays respectively, and the movable contact 27 of the cut-off relay which is connected by a conductor 28 to the movable contact 19.

The equipment and the connections thus far described with reference to substation A are practically duplicated in connection with substation B, and the corresponding parts are indicated by similar primed characters.

The interconnecting means at the central office comprises the answering plug 29, whose tip contact 30 is connected, by means of the strands 31 and 32, to the tip contact 33 of the calling plug 34, and whose sleeve contact 35 is connected by strands 36—37 to the sleeve contact 38 of the calling plug. The usual condensers 39 and 40 are interposed between the strands 31—32 and 36—37. In this instance, I have illustrated "double act-

ing" relays for controlling the operation of the supervisory signals. The relay 41, which is associated with the answering end of the cord circuit, has one winding 42 included in a branch 43 between the strand 31 and a conductor 44, which is permanently connected by a conductor 45 to the grounded side of the battery. The other winding 46 is included in a branch 47 between the other strand 36 and a conductor 48, which is permanently connected by a conductor 49 to the live pole of the battery 16. The relay contacts 50, 51 and 52 control a branch 53 between the conductors 44 and 48, which includes the signal lamp 54. This branch is normally open at the contacts 50 and 51 and may be closed by the engagement of these contacts, due to a certain energization of the relay magnet, and again broken between the contacts 51 and 52 by a further energization of the relay magnet. A second supervisory relay 55 comprises the winding 56 included in a branch 57 between the strand 32 and the conductor 44, and the winding 58 included in a branch 59 between the conductor 48 and the strand 37. Its contacts 60, 61 and 62 control a bridge 63 between the conductors 44 and 48, to cause the display and effacement of the supervisory lamp 64 in the same manner as that heretofore described in connection with the relay 41. The windings of the supervisory relays are of relatively low resistance as compared with that of the line relay 15; for instance, the former may have a resistance of one hundred ohms each, and the latter five hundred ohms. However, I do not wish to limit myself to these specific resistances. The usual listening-key 65—66 is employed to close a bridge, between the contacts 67 and 68, which includes the operator's receiver 69, a condenser 70 and the secondary winding of an induction coil 71. The operator's transmitter 72 is included in a local circuit with the primary of the induction coil 71 and a battery 73. The bridge is connected at the point 73^a to the grounded side of the battery by a conductor 73^b through an impedance 73^c. The ringing-key 74—75 normally engages the contacts 76 and 77 to maintain the continuity of the strands 32 and 37, but may be depressed into engagement with the contacts 78 and 79 to close a bridge 80 through the lamp 81 and the calling generator 82 which, preferably, has one of its poles grounded at 83.

In the operation of the system, a party at substation A, desiring to converse with a party at substation B, removes his receiver 6 so as to close the bridge including his transmitter 5 and receiver 6, contact 7 and switch-hook 8. Since the opposite poles of the battery 16 are normally connected, through the extension conductors m , n , to the line limbs 3 and 4, the closing of the bridge at the sub-

station will complete a circuit through the winding of the line relay 15, thereby energizing it sufficiently to bring its contacts 23 and 25 into engagement and complete the bridge through the signal lamp 21 to cause its display, as a signal to the operator that a connection is desired. Upon observing this signal, the operator will insert the answering plug 29 into the answering jack of the line 3—4 and depress the listening-key 65—66 to connect her receiver 69 in circuit with the substation to learn the wishes of the calling party. The insertion of the plug 29 into the jack will complete a circuit through the winding of the cut-off relay 13 as follows: from the live pole of the battery 16, through the conductor 14, extension conductor m including the winding of the cut-off relay 13, jack contact 10, tip contact 30, strand 31, branch 43 including the winding 42 of the supervisory relay 41, conductors 44 and 45 to the grounded side of the battery. The closing of this circuit will energize the cut-off relay sufficiently to attract its contacts 19 and 27 to disconnect the line limb 3 and its extension conductor n from ground and to break the bridge including the call signal lamp 21, thus extinguishing it and removing its control from the party at the substation. At the time the plug 29 is first inserted in the jack, a circuit will be completed from the active pole of the battery 16 through the conductors 49 and 48, the branch 47 including the winding 46 of the supervisory relay 41, strand 36, sleeve contact 35, jack contact 9, conductor 17, cut-off relay contacts 18—19 and conductor 20 to the grounded side of the battery. This circuit will be only momentary, since the energization of the cut-off relay will break it at the contacts 18—19. When this occurs, the circuit will be completed from the jack contact 9 to the grounded side of the battery, by way of the extension conductor n , line limb 3, the transmitter and receiver bridge at the substation, line limb 4, extension conductor m , jack contact 10, tip 30, strand 31, conductor 43 including the winding 42 of the supervisory relay 41 and conductors 44 and 45. These circuits through the windings of the supervisory relay 41 will energize it sufficiently to draw the contact 51 out of engagement with the contact 52 and thereby maintain the signal lamp 54 dark. Upon learning that the calling party desires a connection with substation B, the operator will touch the tip 33 of the calling plug 34 to one of the jack contacts 9 to determine whether the line is busy or idle. If the line is busy, there will be a potential at the jack contact 9 above that of ground, and as soon as the tip contact is touched against it, a flow of current will result over the strand 32, contacts 65—67 of the listening-key, which is depressed at this time, through the operator's receiver 69 and

to ground through the branch 73^b. This will cause a "click" in the operator's receiver, which will indicate to her the busy condition of the line. If the line is found to be idle, the operator will insert the plug 34 into one of the jacks 11', thereby closing a circuit through the winding of the cut-off relay 13' to cause it to attract its movable contacts 19' and 27' to remove the control of the call-signal 21' from the subscriber at substation B and to disconnect the line limb 3' and its extension conductor *n*' from ground in the manner previously described in connection with the cut-off relay 13, associated with the line 3—4. The insertion of this plug, by completing the circuit through the winding of the cut-off relay 13', which includes the winding 56 of the supervisory relay 55, causes the latter to be sufficiently energized to bring the contacts 60—61 into engagement, thereby completing the circuit through the supervisory lamp 64 and causing its display. At this time, the circuit from the live pole of the battery, through the winding 58, the sleeve strand of the cord circuit, the line limb 3', the substation bridge, the line limb 4', the tip strand 32, and the winding 56 of the supervisory relay to the negative pole of the battery 16, will not be completed. As soon, however, as the answering party removes his receiver 6', the bridge through the substation will be closed and this circuit thereby completed, to cause the further energization of the relay 55 to draw its contact 61 out of engagement with its contact 62 and thus break the bridge including the supervisory lamp 64. Thus, during conversation, the supervisory lamps 54 and 64 will remain dark, due to the greater energization of their controlling relays 41 and 55; but as soon as either party hangs up his receiver, the associated relay will be deenergized sufficiently to cause its lamp to light. The lighting of both lamps 54 and 64 will serve as a signal to the operator to disconnect the parties.

In this form of the invention, the cut-off relays have a single energizing winding which is included in the talking circuit when the lines are connected for conversation. Since impedance would seriously interfere with the transmission of speech, I have provided the cores 84 and 84' of these relays with copper shells 85 and 85' to render them non-inductive. Obviously, other means for accomplishing this result might equally well be employed. For example, in Fig. 2 I have shown the relay 13 provided with a non-inductive shunt 86. In this particular instance, the winding of this shunt, which is connected to the extension conductor *m* at opposite sides of the winding of the relay 13, has associated with it a second winding 87 which is included in the extension conductor *n* for the purpose of balancing the telephone line for conversational purposes. In this instance, the relay

13 is provided with a single movable contact 88, which cooperates with the contacts 89 and 90 to break the ground connection of the line limb 3 and its extension conductor *n* by way of the conductors 17 and 20 and to break the bridge including the call-signal lamp 21, while the other connections remain substantially the same as shown in Fig. 1.

In the form of the invention illustrated in Fig. 3, the extension conductors *m* and *n*, which terminate in the jack contacts 9 and 10, have included therein the windings 91 and 92 of a cut-off relay 93, having a movable contact 94 which cooperates with a grounded contact 95 and a contact 96, connected by a conductor 17 to the extension conductors *m* of limb 3 of the telephone line, to make and break the connection of said line limb to ground and to interrupt the bridge including the call-signal lamp 21. At the opposite end of the core of the relay 93, is a movable contact 97 which cooperates with a fixed contact 98 to short circuit the winding 91 of the relay by way of the conductor 99. The line relay 15 is connected, as before, between the point 12 and the line limb 4 and the live pole of the battery 16 by way of the conductor 14, and its contacts 23 and 25 similarly cooperate in the control of the bridge including the signal lamp 21.

In this particular form of the invention, the lines 3 and 4 are arranged for party lines and lead to the substations A—A' which have their transmitters 5 and receivers 6 arranged in normally open bridge as before, but in which the call-bells 1, in series with the condensers 2, are connected to ground from a contact 100 which, in the case of substation A, is normally connected to the line limb 4 and which, in the case of substation A', is normally connected to the line limb 3. The equipment, associated with the line limbs 2' and 4' at the substations B' and B' and the central office, is substantially the same as that described in connection with the telephone line 3—4 and is indicated by similar primed characters. At the central office, in this form of the invention, I have illustrated a different cord circuit arrangement in which an independent source of current, such as the battery 101, is employed for supplying transmission current to the connected telephone lines. In this instance, the answering plug 102 has its tip contact 103 connected by strands 104 and 105 to the tip contact 106 of the calling plug 107, while its sleeve contact 108 is connected by the strands 109 and 110 to the sleeve contact 111 of the calling plug. The usual condensers 112 and 113 are interposed between the strands 104 and 105 on the one hand, and 109 and 110 on the other. In this instance, the supervisory lamp 114, associated with the answering end of the cord circuit, is included in a branch 115 between the live conductor 116 and ground,

and is normally closed at the contacts 116^a—117 of the associated relay 118, and normally open at the contacts 119—120 of the associated relay 121. The winding of the relay 118 is included in a branch 122 between the cord strand 109 and the live conductor 116, while the winding of the relay 121 is included in the branch 123 between the strand 104 and ground. A supervisory lamp 124, associated with the calling end of the cord circuit, is similarly included in a branch 125 extending through the contacts 126 and 127 of the relay 128 and the contacts 129 and 130 of the relay 131. The windings of these relays are similarly included, on the one hand, by a branch 132 between the live conductor 116 and the strand 110, and on the other hand by a conductor 133 between the strand 105 and ground. The usual listening-key 134—135, cooperating with the contacts 136 and 137, is provided for closing a bridge between the strands 105 and 110 including the operator's receiver 138, the condenser 139 and the secondary of an induction coil 140. The operator's transmitter 141 is included in a local circuit with the primary winding of the induction coil 140 and the battery 142. The ringing generator 143, having one of its poles grounded at 144, has its active pole connected through a lamp 145 and conductors 146 to the contacts 147 and 148, which cooperate with the levers 149 and 150 of the ringing-keys 149—151 and 150—152, respectively. The grounded pole of the generator is connected by conductors 153 to contacts 154 and 155, which cooperate with the levers 152 and 151, respectively, of the listening-keys.

In the operation of the system disclosed in this figure, a party at either substation A' or A², desiring to converse with a party at either substation B' or B², upon removing his receiver from its hook, closes a metallic circuit between the telephone limbs 3 and 4 and thereby energizes the relay 15 sufficiently to display the call signal 21, as a signal to the operator that he desires connection. This circuit extends from the live pole of the battery 16, through the conductor 14, conductor *m*, line limbs 4 and 3, conductors *n* and 17, relay contacts 96, 94 and 95, to ground. Upon observing this signal, the operator will insert the plug 102 into the answering jack associated with the line 3—4 and thereby close a circuit through the cut-off relay winding 92 over a path extending from the live pole of the battery 16, through the conductor 14, extension conductor *m* including the winding 92, jack contact 10, tip 103, strand 104 and conductor 123 to ground, through the winding of the relay 121. At the same time, a circuit will be closed from the live pole of the battery 101 through conductor 116, branch 122 including the winding of the relay 118, strand 109, plug sleeve

108, jack contact 9, cut-off relay contacts 97—98, conductors 99 and 17, and cut-off relay contacts 96, 94 and 95, to ground. The closing of the former circuit will energize the cut-off relay 93 sufficiently to attract its movable contacts 94 and 97, thus opening the latter circuit at the contacts 94—96, removing the normal ground from the extension conductor *n* of the line limb 3 and breaking the branch including the call signal lamp 21, thus removing its control from the calling subscriber. The energization of the cut-off relay 93 will also remove the short circuit through the conductor 99 around the relay winding 91. Thus, after the operation of the cut-off relay 93, the circuit from the battery 101 is continued from the jack contact 9, through the extension conductor *n* including the winding 91 of the cut-off relay, line limb 3, the closed bridge at the substation, line limb 4, extension conductor *m* including the winding 92 of the cut-off relay, to jack contact 10, thence by way of the tip contact 103, strand 104 and conductor 123, to ground. The resulting energization of the relay 93, due to the excess of current in one winding over the other, is sufficient to retain the contacts 94 and 97 in their attracted positions. The current flow in the supervisory relays 118 and 121 is also sufficient to attract their contacts 116^a and 119 respectively, thus breaking the grounded branch 115 at one point and closing it at another, thereby preventing the lighting of the supervisory lamp 114.

By depressing the listening-key 134—135, the operator may close a circuit through her receiver 138 and obtain the wishes of the calling party. Upon learning that connection is desired with the line 3'—4', she will then, in order to determine the busy or idle condition of the line, touch the tip 106 of the calling-plug 107 against the contact 9' of one of the jacks connected with said line, and if the said line is busy, the potential on the contact 9' will cause a flow of current from the tip contact 106, over the strand 105 and conductor 133, to ground, which will be sufficient to modify the charge on the condenser 139—resulting from the initial closing of the listening-key 134—135—to cause a "click" in her receiver 138, thus indicating the busy condition of the line. If the line is found to be idle, she will then insert the plug 107 into the jack 11'. As previously indicated, this will close a circuit from the live pole of the battery 16, over the conductor 14, through the winding 92' of the cut-off relay 93' to the tip strand of the cord circuit, thence to ground through the conductor 133. The closing of this circuit will sufficiently energize the relay 131 to close the contacts 129 and 130 to complete the grounded branch 125, thereby causing the display of the signal lamp 124. At the same time, as previously indicated, a circuit will be completed from the live pole of

the battery 101, over the sleeve strand of the cord circuit, through the short-circuiting conductor 99' and the conductor 17' of relay contacts 96', 94' and 95', to ground. The result of the completion of these circuits will be the actuation of the cut-off relay contacts to remove the call signal 21' from the control of the subscribers at substations B' and B², to remove the normal ground from the extension conductor n' of the line limb 3', thereby interrupting the circuit from the battery 101, and to remove the short circuit through the conductor 99', thereby establishing the circuit from the sleeve strand of the cord circuit through the extension conductor n including the winding 91 of the cut-off relay 93, over the line limb 3' to the open bridges at the substation, thence by way of the line limb 4', extension conductor m including the cut-off relay winding 92', jack contact 10', through the tip strand of the cord circuit and the conductor 133, to ground. After establishing the connection with the telephone line 3'-4', if conversation is desired with the party at substation B', the operator depresses the ringing-key 149-151, thereby connecting the line limb 3' to ground and sending calling current over the line limb 4', through the call-bell 1' at the substation B'. If, on the other hand, conversation is desired with the party at substation B², the operator depresses the ringing-key 152-150, thus connecting the line limb 4' to ground and sending ringing current over the line limb 3', through the call-bell 1' at substation B², to ground. As soon as the called party removes his receiver, he will close the normally open bridge through his transmitter and receiver and thereby complete the normally open circuit through the windings of the supervisory relays 128 and 131, previously traced. The completion of this circuit will energize the relay 128 sufficiently to separate the contacts 126-127 and thereby break the grounded branch 125 through the supervisory lamp 124, to extinguish it. With the parties thus connected, the supervisory lamps 114 and 124 will remain dark and continue in this condition until either party hangs up his receiver, at which time the corresponding lamp is lighted. The lighting of both of these lamps is a signal to the operator to disconnect the parties.

In the present form of the invention, another well known means is provided for rendering the relays 93 and 93' non-inductive. In this instance, this is accomplished by providing the relay with "twin" windings—in other words, by winding the two conductors, which are included in the extensions of the telephone line limb, side by side upon the core of the relay magnet.

In carrying out my invention, obviously many other means for rendering the cut-off relays non-inductive might be employed,

and many other alterations and modifications might be made in the specific matter herein disclosed, without departing from the spirit and scope of my invention. I, therefore, do not wish to be limited to the specific matter disclosed, but aim to cover, by the terms of the appended claims, all such alterations and modifications. Throughout the claims, I have employed the term, "telephone line," to include not only the telephone line proper, which terminates at the distributing board, but also the extensions thereof from said board to the connected jacks and the source of current.

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

1. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, an electromagnet having an energizing winding in the talking circuit when connection is made for conversation, and means for making and breaking a short-circuit about said magnet winding.

2. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, an electromagnet having an energizing winding in one limb of the telephone line, and included in the talking circuit when connection is made for conversation, and means for making and breaking a short-circuit about said magnet winding.

3. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, an electromagnet having an energizing winding in the talking circuit when connection is made for conversation, means for making and breaking a short-circuit about said magnet winding, and means for furnishing transmission current to the connected telephone line over the link-circuit only.

4. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, an electromagnet having an energizing winding in one limb of the telephone line and included in the talking circuit when connection is made for conversation, means for making and breaking a short-circuit about said magnet winding, and means for

furnishing transmission current to the connected telephone line over the link-circuit only.

5. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, an electromagnet having an energizing winding in the talking circuit when connection is made for conversation, and means actuated by said electromagnet to interrupt a normal short-circuit about said electromagnet winding.

6. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, an electromagnet having an energizing winding in one limb of the telephone line, and means actuated by said electromagnet to interrupt a normal short-circuit about said electromagnet winding.

7. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, a call-signal normally under the control of the subscriber, an electromagnet having an energizing winding in the talking circuit when connection is made for conversation, means for making and breaking a short-circuit about said magnet winding, and means actuated by said electromagnet to destroy the substation control of said call signal.

8. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, a call-signal normally under the control of the subscriber, an electromagnet having an energizing winding in the talking circuit when connection is made for conversation, and means actuated by said electromagnet to interrupt a normal short-circuit about said electromagnet winding and to destroy the substation control of said call signal.

9. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, a call-signal normally under the control of the subscriber, an electromagnet

having an energizing winding in one limb of the telephone line, and means actuated by said electromagnet to interrupt a normal short-circuit about said electromagnet winding and to destroy the substation control of said call signal.

10. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, an electromagnet having an energizing winding in the talking circuit when connection is made for conversation, means operative upon the connection of said link-circuit to said line to energize said electromagnet, and means actuated by said electromagnet to interrupt a normal short-circuit about said electromagnet winding.

11. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, an electromagnet having an energizing winding in one limb of the telephone line, means operative upon the connection of said link-circuit to said line to energize said electromagnet, and means actuated by said electromagnet to interrupt a normal short-circuit about said electromagnet winding.

12. A "two wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, a call-signal, a single-winding line relay normally operative to display said signal when energized, a control relay for said signal having an energizing winding in the talking circuit when connection is made for conversation, means operative upon the connection of said link-circuits to said line to initially energize said control relay by closing a circuit local to the central office through the winding of said line relay.

13. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, a call-signal normally under the control of the subscriber, an electromagnet having an energizing winding in the talking circuit when connection is made for conversation, means operative upon the connection of said link-circuit to said line to energize said electromagnet, and means actuated by said electromagnet to interrupt a normal

short-circuit about said electromagnet winding and to destroy the substation control of said call signal.

14. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, an electromagnet having an energizing winding in each side of the talking circuit when connection is made for conversation, and means for making and breaking a short-circuit about one of said magnet windings.

15. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, an electromagnet having an energizing winding in each limb of the telephone line when connection is made for conversation, and means for making and breaking a short-circuit about one of said magnet windings.

16. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, an electromagnet having an energizing winding in each side of the talking circuit when connection is made for conversation, and means actuated by said electromagnet to interrupt a normal short-circuit about one of said magnet windings.

17. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, an electromagnet having an energizing winding in each limb of the telephone line when connection is made for conversation, and means actuated by said electromagnet to interrupt a normal short-circuit about one of said magnet windings.

18. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, a call-signal normally under the control of the subscriber, an electromagnet having an energizing winding in each side of the talking circuit when connection is made for conversation, and means for making and breaking a short-circuit about one of said magnet windings.

19. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, a call-signal normally under the control of the subscriber, an electromagnet having an energizing winding in each limb of the telephone line when connection is made for conversation, means for making and breaking a short-circuit about one of said magnet windings, and means actuated by said electromagnet to destroy the substation control of said call signal.

20. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, a call-signal normally under the control of the subscriber, an electromagnet having an energizing winding in each side of the talking circuit when connection is made for conversation, and means actuated by said electromagnet to interrupt a normal short-circuit about one of said magnet windings and to destroy the normal substation control of said call signal.

21. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, a call-signal normally under the control of the subscriber, an electromagnet having an energizing winding in each limb of the telephone line when connection is made for conversation, and means actuated by said electromagnet to interrupt a normal short-circuit about one of said magnet windings and to destroy the normal substation control of said call signal.

22. A "two wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, an electromagnet having an energizing winding in each side of the talking circuit when connection is made for conversation, means operative upon the connection of said link-circuit to said line to energize said electromagnet, and means actuated by said electromagnet to interrupt a normal short-circuit about one of said magnet windings.

23. A "two wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding

conversation over the connected line and link-circuit, an electromagnet having an energizing winding in each limb of the telephone line when connection is made for conversation, means operative upon the connection of said link-circuit to said line to energize said electromagnet, and means actuated by said electromagnet to interrupt a normal short-circuit about one of said magnet windings.

24. A "two wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, a call-signal normally under the control of the subscriber, an electromagnet having an energizing winding in each side of the talking circuit when connection is made for conversation, means operative upon the connection of said link-circuit to said line to energize said electromagnet, and means actuated by said electromagnet to interrupt a normal short-circuit about one of said magnet windings.

25. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, a call-signal normally under the control of the subscriber, an electromagnet having an energizing winding in each limb of the telephone line when connection is made for conversation, means operative upon the connection of said link-circuit to said line to energize said electromagnet, and means actuated by said electromagnet to interrupt a normal short-circuit about one of said magnet windings.

26. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and link-circuit, a call-signal normally under the control of the subscriber, an electromagnet having an energizing winding in each side of the talking circuit when connection is made for conversation, means operative upon the connection of said link-circuit to said line to energize said electromagnet, and means actuated by said electromagnet to interrupt a normal short-circuit about one of said magnet windings and to destroy the normal substation control of said call-signal.

27. A "two-wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, means for holding conversation over the connected line and

link-circuit, a call-signal normally under the control of the subscriber, an electromagnet having an energizing winding in each limb of the telephone line when connection is made for conversation, means operative upon the connection of said link-circuit to said line to energize said electromagnet, and means actuated by said electromagnet to interrupt a normal short-circuit about one of said magnet windings and to destroy the normal substation control of said call-signal.

28. A "two wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a battery, a line signal, a line relay connected only between one line limb and battery, a cut-off relay having an energizing winding permanently included in the same line limb, a two-strand link-circuit for making connection to said line limbs, and means responsive to such connection to close a circuit through said relays in series.

29. A "two wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, a grounded battery in bridge of said strands and having its grounded terminal connected to the tip strand, a line signal, a line relay connected between the tip limb of the line and the live pole of said battery, a cut-off relay having an energizing winding included in the tip limb of the line, and a grounded branch extending from the sleeve limb of the line through normally closed contacts of said cut-off relay.

30. A "two wire" telephone system comprising a telephone line extending in two limbs from a substation to a central office, a two-strand link-circuit for making connection to said line limbs, a grounded battery in bridge of said strands and having its grounded terminal connected to the tip strand, a line signal, a line relay connected between the tip limb of the line and the live pole of said battery, a cut-off relay having an energizing winding included in the tip limb of the line, a grounded branch extending from the sleeve limb of the line through normally closed contacts of said cut-off relay, and supervisory relay windings included in said battery bridge.

31. A telephone exchange system comprising a telephone line extending from a substation to a source of current at the exchange, a line signal normally responsive to calling current in said line, a switching terminal for the line, a cut-off relay, a winding for said relay associated with that portion of the line extending to the substation, means for rendering said winding inert to calling current, a neutralizing winding associated with said winding, a link-conductor, means whereby the connection of said link-conductor with

said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to serially include said windings in differential relation in the talking circuit of said line, whereby the impedance of said windings is neutralized.

32. A telephone exchange system comprising a telephone line extending from a substation to a source of current at the exchange, a line signal normally responsive to calling current in said line, a switching terminal for the line, a cut-off relay, a winding for said relay included in that portion of the line extending to the substation, means for rendering said winding inert to calling current, a neutralizing winding associated with said winding, a link-conductor, means whereby said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to serially include said windings in differential relation in the talking circuit of said line, whereby the impedance of said windings is neutralized.

33. A telephone exchange system comprising a telephone line extending from a substation to a source of current at the exchange, a line signal normally responsive to calling current in said line, a switching terminal for the line, a cut-off relay, a winding for said relay serially included in that portion of the line extending to the substation, means for ren-

dering said winding inert to calling current, a neutralizing winding associated with said winding, a link-conductor, means whereby the connection of said link-conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to serially include said windings in differential relation in the talking circuit of said line, whereby the impedance of said windings is neutralized.

34. A telephone exchange system comprising a telephone line connecting a substation with the exchange, a line signal normally under the control of the substation, a relay for destroying the substation control, a winding for said relay in a normally open circuit, a normally short-circuited winding for said relay, means under the control of an operator for closing circuit through said first mentioned winding to destroy said substation control, and to bring said short-circuited winding into differential relation with said first-mentioned winding, and means for maintaining an unequal flow of current in the two windings.

In witness whereof, I hereunto subscribe my name this 11th day of January, A. D., 1906.

HARRY G. WEBSTER.

Witnesses:

L. D. KELLOGG,
CAROLYN WEBER.

It is hereby certified that in Letters Patent No. 930,517, granted August 10, 1909, upon the application of Harry G. Webster, of Chicago, Illinois, for an improvement in "Telephone-Exchange Systems," errors appear in the printed specification requiring correction, as follows: In line 107, page 3, the reference-numeral "2'" should read 3'; line 111, page 6, the compound word "link-circuits" should read *link-circuit*, and line 85, page 8, the word "mean" should read *means*; and that the said Letters Patent should be read with these corrections 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.