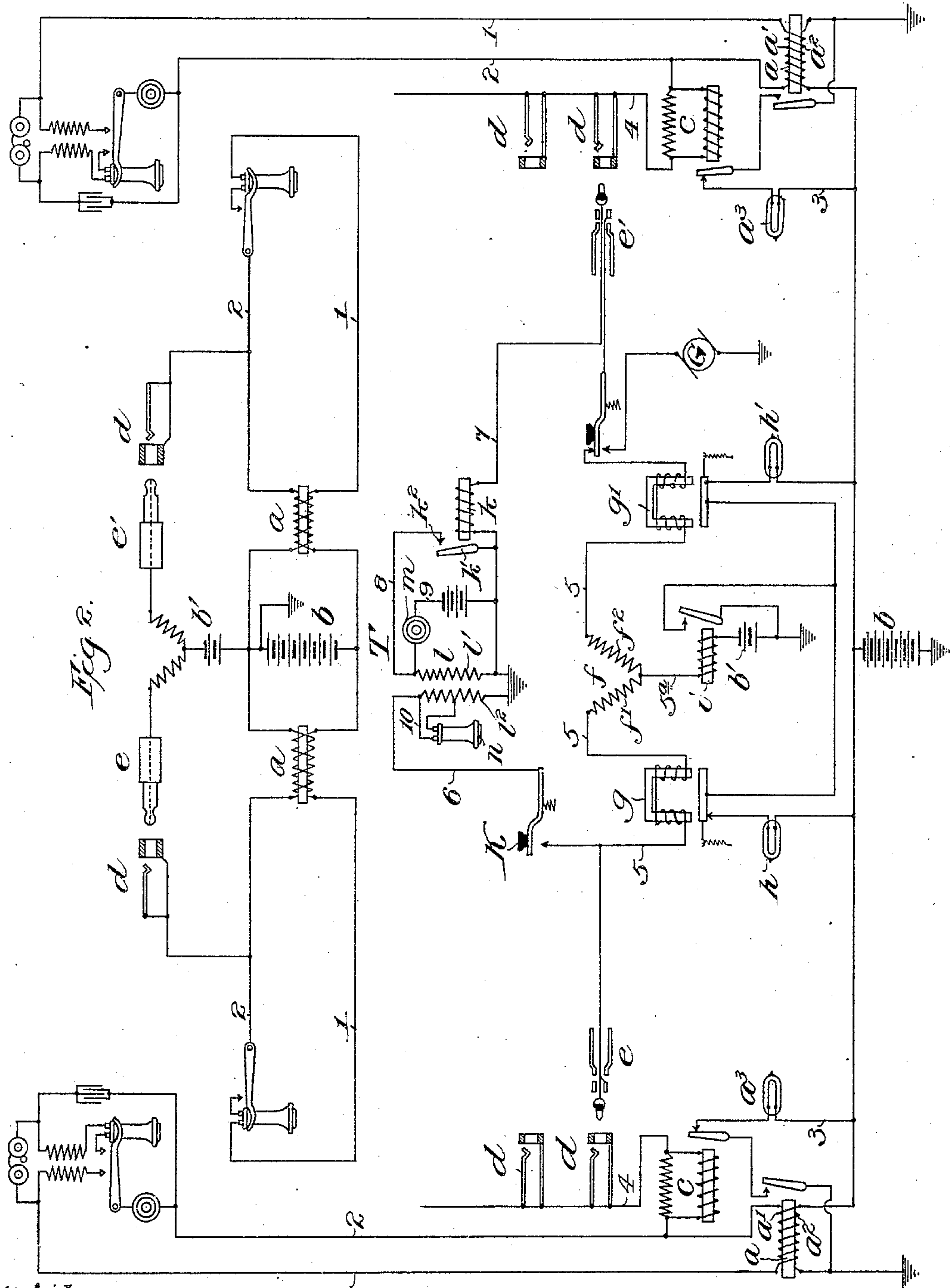


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 TELEPHONE EXCHANGE SWITCHBOARD APPARATUS.
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Witnesses:
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 Alfred H. Moore

Fig. 1.

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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SWITCHBOARD APPARATUS.

No. 931,330.

Specification of Letters Patent.

Patented Aug. 17, 1909.

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To all whom it may concern:

Be it known that I, JAMES L. McQUARRIE, citizen of the United States, residing at Oak Park, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Telephone-Exchange Switchboard Apparatus, of which the following is a full, clear, concise, and exact description.

My invention relates to a telephone exchange system, and has for its object to provide an improved organization of apparatus and circuits whereby connection may be established between two metallic circuit lines at the central office by means of a single link conductor and connection switches of the simplest character, while providing for the operation of line and supervisory signals, and without sacrificing good telephone transmission.

In other words, my invention relates to what is known among telephone engineers as a "one wire" circuit for central office switchboards, meaning that a single conductor only is required to unite metallic circuit lines. The object of the schemes of this character is, of course, to simplify multiple switchboards by reducing the number of contacts required in the springjacks and the amount of cables necessary, as well as to simplify the cord circuits or link conductors by which connections are established.

I will describe my invention by reference to the accompanying drawing, in which—

Figure 1 is a diagram illustrating two metallic circuit telephone lines extending from substations to a central office, together with an operator's cord circuit and accessory apparatus for uniting the lines, the system being organized and equipped in accordance with my invention; Fig. 2 is a simplified diagram illustrating merely the two lines extending to the poles of the central battery with the windings of the line relays interposed, and the link conductor with the connection terminals by which the lines may be telephonically united.

In the system embodying my invention, a line signal magnet having two windings is permanently associated with each line, said windings being included respectively in the two line conductors which are led to the poles of a central battery. The coils of the line signal magnet are wound in close inductive relation to each other and are so con-

nected that the effect of currents flowing through them in series will be cumulative. To unite another telephone circuit with any line, such other circuit is connected in a shunt about one of the magnet windings, so that said windings are thus connected in parallel with respect to currents in the telephone circuit thus established. The impedance of each winding to telephone current flowing in the united circuit is neutralized by the effect of current in the other parallel winding. Any two lines of an exchange may be united by a single link conductor connecting one of the line wires of each line at a point between the line signal magnet and the substation, with a similar wire of another line, said link conductor being permanently connected through an induction device with one pole of the common source of current. The magnet windings are thus included in parallel branches of the telephone circuit established by said link conductor and neutralize one another with respect to telephone currents.

The signal displayed by the line relay of a line is adapted to be rendered inoperative when the cord circuit is connected with such line, by a cut-off relay included in the branch of the line leading to the springjack, the cord circuit being provided with a source of current for operating said relay when connection is made with the line. The cord circuit contains supervisory signal controlling devices, unresponsive to current from said source, but adapted to respond under the control of the switches at the respective substations, to current from said central office battery.

In the system shown in the drawing, the two conductors 1, 2, of each line extend through the windings a' a'' of the line relay a to the poles of a central battery b . One pole of said battery may be connected to earth, or other return conductor, as usual. The line relay controls a local circuit 3 including a line signal lamp a^3 , said local circuit being further controlled by the normally-closed contact of a cut-off relay c , which is included in an extension 4 of the line conductor 2 leading to the springjacks or connection terminals d d' of the multiple switchboard.

The operator is provided with a pair of simple plugs e e' united by a link conductor 5, whereby any two lines may be connected together by inserting the plugs into

the respective springjacks thereof. Said plugs and springjacks constitute connection switches for uniting the cord circuit with the telephone lines. The link conductor includes the two windings f' f^2 of a repeating coil f , and the middle point between said windings is connected to the grounded pole of the central battery.

Supervisory relays g g' are included in the link conductor 5 between the ground connection and the plugs e and e' respectively. Said supervisory relays control local circuits which include supervisory signal lamps h h' respectively, said local circuits being supplied with current from the central battery b under the control of the normally open contacts of a master relay i . The relay i is included with a battery b' in the conductor 5^a leading from the middle point between the windings of the repeating coil to earth or said return conductor. The battery b' may be of four volts, and is connected with the same pole to ground as the battery b , but offering but slight opposition to the current from the battery b when the link conductor is connected with the line, on account of the difference in voltage between the two batteries. When plug e is inserted in jack d , a circuit 5^a , 5, 4, 2, is completed for relay i , which closes its contact and brings the supervisory signal circuits under the control of their respective relays. The supervisory relays are arranged to be unresponsive to current from battery b' , being preferably polarized. Each supervisory relay is adapted to close at one point the local circuit containing its supervisory signal lamp when inert and to open said circuit when excited, the master relay i , however, exercising the primary control over said circuits. I have shown a ringing key by which the link conductor may be severed and the end thereof leading to the calling plug e' connected to the pole of a grounded generator G .

A listening key K is provided, which is adapted when depressed to connect the answering plug with the conductor 6 leading to the operator's telephone set T . I have also shown special apparatus for making the busy test. The tip contact of the calling plug is connected with a conductor 7, which leads through a test relay k to earth. The relay k is provided with an armature k' connected with conductor 7 between the relay and earth, said armature being adapted when attracted to engage a contact anvil k^2 , connected with a conductor 8 leading through the primary winding l' of the induction coil l of the operator's telephone set, to conductor 7 and earth. The transmitter m of the operator's set is included with a source of current in a conductor 9 connected with conductors 7 and 8 so that a local circuit is provided for the transmitter including the primary winding l' . The telephone re-

ceiver n of the set is included in a conductor 10 extending from wire 6 to the middle point of the secondary winding l^2 of the induction coil l . Thus when the relay k is energized and its contacts k' k^2 are closed, as when the tip of calling plug e is brought into contact with the test thimble of a busy line, a click is produced in the operator's receiver.

The operation of the system is as follows: A subscriber desiring an exchange connection sends in a call in the usual way by removing his telephone from its hook, whereby circuit is completed from the central battery b through both windings of his line relay, which being excited draws up its armature and closes the local circuit 3 containing the line signal lamp a^3 . The operator in response to this call inserts her answering plug e in one of the springjacks d of the line and depresses her listening key k . Her telephone circuit 7 is thus completed in shunt of one winding of the line relay, and telephone currents traversing this circuit pass through the windings of the line relay in parallel. The windings are disposed in close inductive relation to one another, so that the impedance offered by one winding will be neutralized by the effect of the current in the other winding. I have found in practice that excellent transmission can be obtained by winding the line relays as I have indicated, but if the coils of the line relay are not disposed in close inductive relation to one another, such as by twin or parallel winding, that is, if the two windings are simply placed end on end upon a common core, the impedance will not be neutralized and the transmission will be seriously impaired.

The completion of the circuit 5^a —5—4—2, including the battery b' , when the plug e is inserted in the jack d in response to a call, brings about the excitement of the cut-off relay c , whereby the local circuit 3, containing the line signal lamp, is opened, and the lamp extinguished. The master relay i being in said circuit, draws up its armature, grounding the circuit of the supervisory lamps h h' . The supervisory relay g included in the circuit above traced is polarized and unresponsive to battery b' , but responds to the battery b , which, owing to the removal of the telephone at the calling station, applies battery over the limb 1 through the substation apparatus, limb 2, through the cut-off relay c , conductor 4, springjack and plug, conductor 5, through the winding of the supervisory relay g and repeating coil, conductor 5^a and earth. The relay g in drawing up its armature opens the circuit of the supervisory lamp h . The supervisory relay g' representing the called line is de-energized at this time, and the circuit is completed for the supervisory lamp h' . Upon inserting the calling plug e' into the jack d of an idle line, current from battery b' flows

through the conductors 5^a and 5, supervisory relay *g'*, plug *e'*, jack *d*, through the cut-off relay *c* of the called line, to earth through the winding of the line relay, said current, however, being without effect upon the supervisory relay *g'* and the line relay of the called line, but causing the operation of the cut-off relay *c* of said called line, which opens the line signaling circuit. When the called subscriber responds by removing his telephone from its hook, the polarized supervisory relay *g'* is supplied with current from battery *b*, and attracts its armature, opening the circuit of the supervisory lamp *h'*.

In testing a line, the operator touches the plug *e'* to the springjack of the line in question. If the line is free the operator may complete the connection by inserting the plug in the jack and signal the called subscriber by means of the generator *G* in the usual way. If, however, a connection already exists at another multiple springjack of the line being tested, a circuit will be completed to earth through the relay *k*, which in drawing up its armature closes conductor 8, and causes a click to be produced in the operator's telephone. If the line tested is free, the operator completes the connection in the usual way by inserting the calling plug *e'* in the springjack thereof. The two lines are now united in a telephonic circuit by the link conductor 5, and the windings of the line relay of each line are in parallel branches of the circuit thus established.

The circuit of the voice currents will be understood more readily by reference to Fig. 2, which shows simply the circuits concerned in the telephone current transmission. Assume, for example, that the transmitter at the station at the left of Fig. 2 is being used; fluctuations will occur in the current flowing in the circuit of said station from the direct current battery. These fluctuations or variations in the current from the direct battery will cause the winding of the repeating coil included in the line circuit of said station to induce talking currents in the winding of the repeating coil included in the line circuit of the other station, and such currents will flow, for example, from the upper point of said repeating coil winding through the plug and jack to the limb of the line, when said talking currents will divide, a portion flowing through the winding of the line relay back to the lower terminal of the said repeating coil winding, while the other portion of said currents will flow through the telephone at the distant station and back over the other limb of the line, through the other winding of the line relay, and back to the lower terminal of the repeating coil winding. The talking current thus flows through the windings of the line relay in parallel, that is, in a direction to cause the neutralization of the self-induction of said relay.

I claim:

1. The combination with a telephone line extending from a substation to a central office, of a battery at the central office connected with said line, a line signal magnet having two windings, one in each line conductor, said windings being disposed in close inductive relation to each other, a second telephone circuit and a connection switch adapted to establish the same in shunt of one of said windings, said windings being included in the talking circuit and connected to neutralize one another with respect to telephone currents in the united circuit flowing through said magnet.

2. The combination with a telephone line extending from a substation to a central office, of a battery at the central office connected with said line, a line signal magnet arranged to display a signal when excited, said magnet having two windings in the line conductors, respectively, said windings being disposed in close inductive relation to each other and being connected so that the effects therein of current from said battery will be cumulative, a connection switch for the line, and a telephone circuit adapted to be established thereby in shunt of one of the windings of said line signal magnet, said windings being included in the talking circuit, a relay controlled by current in said shunt for effacing the line signal, and an independent supervisory signal also included in said shunt, as set forth.

3. In a telephone exchange system, the combination with metallic circuit telephone lines extending from substations to a central office, of a battery at the central office connected with said lines, a line signal magnet for each line having two windings in close inductive relation to each other included respectively in the two sides of the line, a connection switch terminal for each line connected with one line conductor thereof between the line relay and the substation, and a single link conductor adapted to unite the connection switch terminals of two lines, said link conductor being connected through an induction device with one pole of said battery, the two windings of the line signal magnet being thus connected, respectively, in parallel branches of the telephone circuit which is established by said link conductor, said windings being connected and disposed to neutralize each other as to telephone currents in the link conductor circuit, while being cumulative with respect to current from said battery.

4. The combination with a pair of metallic circuit telephone lines extending from substations to a central office, of a battery at the central office connected with said lines, a one-wire cord circuit, connection switches for connecting said cord circuit with corresponding limbs of said lines for conversation, a repeat-

ing coil in said cord circuit having its middle point connected with the pole of said battery to which said limbs are connected, a line signal associated with each line at the central office, means controlled from the substation of such line for operating said signal, a cut-off relay for each line controlling said line signal, a circuit therefor completed by the connection of said cord circuit with said line, and supervisory signal controlling relays in said cord-circuit controlled from the substations of said lines.

5. The combination with a metallic circuit telephone line extending from a substation to a central office, of a battery at said central office connected with said line, a line relay in said circuit, a line signal controlled thereby, a springjack for the line, a branch conductor uniting one limb of the line with said jack, a cut-off relay in said conductor adapted to render the line signal inoperative, a plug and single wire cord-circuit adapted to be connected with said jack, a source of current connected with said cord-circuit, and a circuit for said cut-off relay completed when said plug and jack are united.

6. The combination with a metallic circuit telephone line extending in two limbs to the central office, of a line battery having one pole connected with one of said limbs, a return conductor connecting the other limb with the other pole of said battery, a line relay in said circuit, a line signal controlled thereby, a spring jack for the line, a branch conductor uniting said springjack with the limb of the line connected with said return conductor, a cut-off relay in said conductor adapted when energized to render said line signal inoperative, a plug and single wire cord circuit adapted to be connected with said jack, a source of current for operating said cut-off relay having one pole connected with said return conductor and the other pole connected to said cord circuit, and a supervisory-signal-controlling device in said cord circuit unresponsive to current from said source, but responsive under the control of the subscriber during connection of the cord circuit with his line, to current from said line battery.

7. The combination with a pair of metallic circuit telephone lines each extending in two limbs from a substation to the poles of a grounded central office battery, of a single wire cord circuit, a repeating coil in said cord circuit having its middle point grounded, electrically controlled supervisory signaling mechanisms in said cord circuit on opposite

sides of said repeating coil, and connection switches for connecting said cord circuit with the grounded limbs of said lines, each of said switches completing a circuit for its corresponding signaling mechanism from the grounded repeating coil over the metallic circuit telephone line to the free pole of the grounded central battery, whereby said signaling mechanisms are responsive to the control of the respective substations.

8. The combination with two metallic circuit telephone lines extending from substations to a central office, of a battery at the central office having its poles connected with said lines, of a one-wire cord circuit, connection switches adapted to connect said cord circuit with corresponding limbs of the lines for conversation, supervisory relays in said cord circuit, one for each line, a source of current in a branch conductor connected with said cord circuit between said relays, a circuit therefor completed when the cord circuit is united with either line, a master relay in said branch, said supervisory relays being unresponsive to current from said source, but adapted to respond under the control of their respective substations to said central office battery, and supervisory signals for said lines under the joint control of said master relay and supervisory relays.

9. The combination with two telephone lines each extending in two limbs from a substation to a central office, of a grounded central battery having its poles connected with the limbs of said line, a single wire cord circuit, connection switches adapted to connect said cord circuit with the grounded limbs of said lines for conversation, a repeating coil in said cord circuit, a grounded branch from the middle point thereof, a battery in said branch, a master relay in said branch, the circuit of said battery being completed when either connection switch is closed, supervisory relays in said cord circuit on opposite sides of said repeating coil, unresponsive to said last mentioned battery, but responsive under the control of the respective substations to current from said central office battery, supervisory signals for said lines, and circuits therefor controlled jointly by said master relay and supervisory relays.

In witness whereof, I hereunto subscribe my name this 3rd day of March A. D. 1906.

JAMES L. McQUARRIE.

Witnesses:

ROY T. ALLOWAY,
E. F. BEAUBIEN.