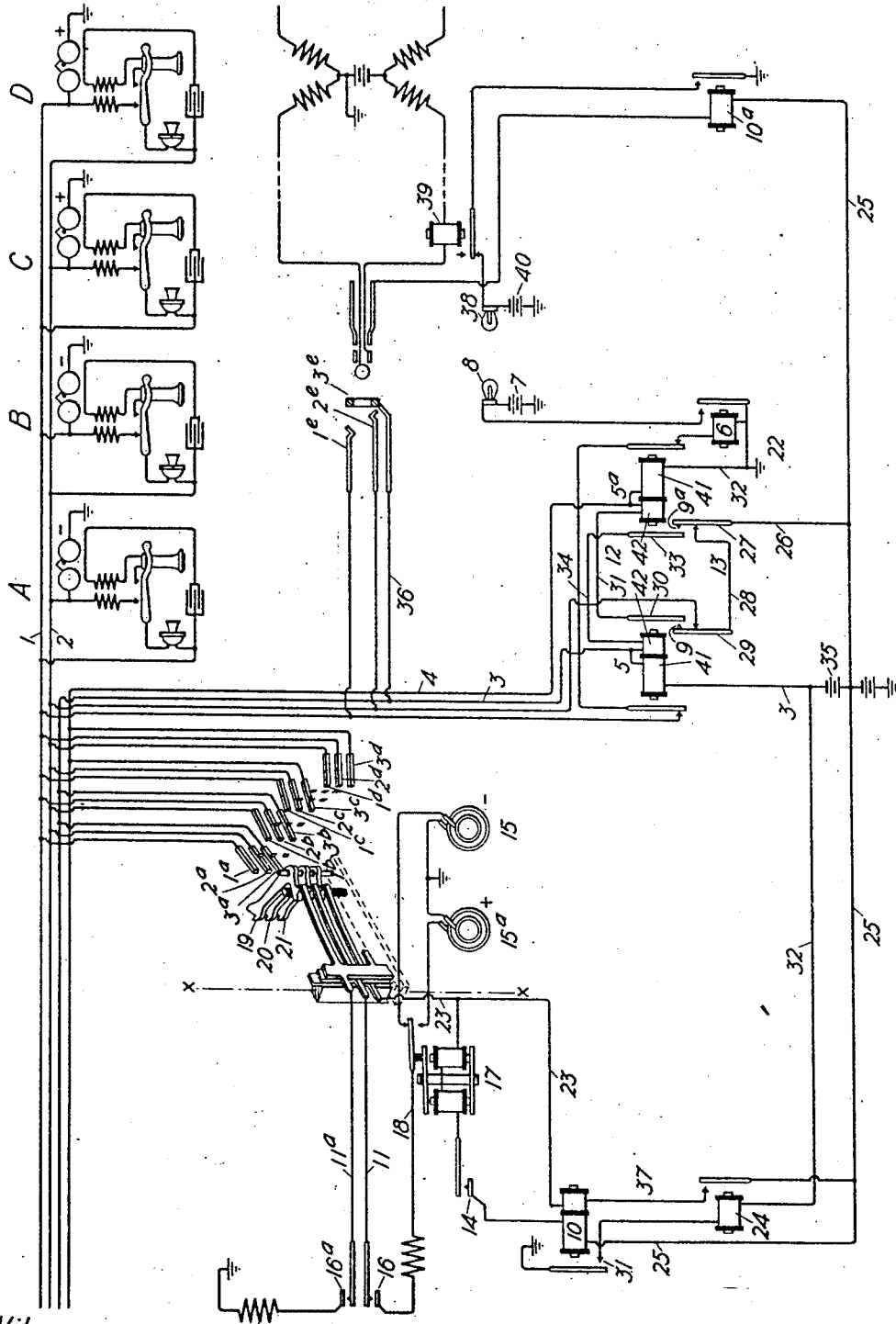


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 BUSY TEST SYSTEM FOR PARTY TELEPHONE LINES.
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UNITED STATES PATENT OFFICE.

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BUSY-TEST SYSTEM FOR PARTY TELEPHONE-LINES.

1,045,306.

Specification of Letters Patent.

Patented Nov. 26, 1912.

Application filed December 18, 1909. Serial No. 533,928.

To all whom it may concern:

Be it known that I, FRANK R. McBERTY, citizen of the United States, residing at New Rochelle, in the county of Westchester and State of New York, have invented a certain new and useful Improvement in Busy-Test Systems for Party Telephone-Lines, of which the following is a full, clear, concise, and exact description.

The present invention relates to a busy test system for a telephone line having a plurality of responsive devices adapted to be selectively signaled, and contemplates providing a separate test terminal for each responsive device, and means actuated upon the engagement of a switching device with a test terminal for establishing a changed electrical condition of the remaining test terminals.

It is the modern practice to impress potential of a certain value or character upon the multiple test terminals of telephone lines, the connection of the answering plug or other connecting device with a test terminal causing a change in the electrical condition of its multiple test terminals, this changed condition serving as a warning that the line has been taken for use.

In accordance with this invention when each of two stations of a party telephone line is equipped at the central office with line terminals and a test terminal, and each test terminal is connected with a source of current by a separate test conductor, a magnet is provided in each test conductor adapted to be energized upon the engagement of a connecting device with a test terminal, to cause a change in the electrical condition of the test terminal of the other substation.

In the present embodiment of the invention in a four party telephone line, a test terminal is provided for each substation of the line, and a test conductor may connect the test terminals of the substations having responsive devices in different ground branches from opposite sides of the line and adapted to respond to current of a certain character with a source of current, and a second test conductor may connect the test terminals of the other two substations having responsive devices also in different ground branches from opposite sides of the line and adapted to respond to current of another character with a source of current different in character from that connected with the

first test conductor. A responsive device, which may be a relay, is included in the circuit of each test conductor and, upon the engagement of the connecting device with a test terminal, may change the potential applied to its associate test terminal, and close a local circuit including the other test conductor, thereby changing the potential applied to its associate test terminals. A busy test potential will thus be caused to exist upon the test terminal associated with each substation. In the present embodiment of the invention, the busy test condition of the test terminals is indicated by a reduced potential. This result may be accomplished by providing a pair of relays, one in each test conductor, each adapted to reciprocally control a local circuit including the other, the arrangement being such that one relay will be rendered active, upon the connection of the switching device with a test terminal to close a local circuit through the other differentially. This may be brought about by having the local circuit of each relay open at an armature contact of the other.

The system of circuits herein described embodies certain features of invention which are not claimed in this application. These are made the subject-matter of my copending application, Serial No. 573,517, filed July 23, 1910.

The invention will be particularly described by reference to the accompanying drawing, which illustrates its application to a semi-automatic telephone exchange system, certain circuits and apparatus necessary to a complete disclosure of the invention being also shown, it being of course understood that the invention is in nowise limited to such a system, but is just as well adapted for use with either "full" automatic or manual telephone exchange systems.

In the drawings, 19, 20, 21 represent the brushes of a final switch or connector, which is adapted to be rotated about its axis X X to advance the said brushes to the terminals of a predetermined line by automatic mechanism under the control of an operator. The contacts 16, 16^a control the completion of the circuit from the calling party to the called party, and may be operated manually at the time the brushes make connection with the desired terminals, provided the line is free, but are preferably arranged to be

closed by an automatic switch under the control of the calling operator when connection is made with a free line, and may be prevented from operating when connection is made with a busy line. The contact 14 may be adapted to be closed by the mechanism which controls the closure of contacts 16, 16^a or may be manually operated. In the former case this contact is closed immediately upon the engagement of the brushes with the desired terminals, but should such line be busy, ringing current will not be impressed upon it, because the contact 16 will not be closed.

The line conductors 1, 2 are multiplied, as shown, one set for each substation of the party line, the terminals 1^a, 2^a being the terminals of substation A, 1^b, 2^b, for substation B, 1^c, 2^c for substation C and 1^d, 2^d for substation D. These multiple terminals may not necessarily be adjacent each other upon the terminal support of the connector, but may be distributed, as shown among terminals which may lead to single lines, trunks, etc., and may even be located upon different connectors according as traffic conditions may require. The line conductors 1, 2 are extended as shown and may lead to multiple terminals of the party line upon other connectors or may terminate in springjacks in a manual exchange.

The signaling and telephonic appliances represented at the substations are of well-known type and therefore need not be particularly described, it being sufficient to merely say that two of the bells, those at stations A and C are oppositely polarized and placed in independent ground branches from line conductor 2, and that the other two bells, those at substations B and D are also oppositely polarized and placed in independent ground branches of line conductor 1.

In order that the invention may be more readily understood, means are shown and will be briefly described for automatically selecting and impressing upon the line the particular character of current required to operate the responsive device of the predetermined substation upon the engagement of the connector brushes with its terminals, provided the desired party line is not already in use at another multiple terminal of the party line, in which case the contacts 16, 16^a will remain open, thus preventing ringing current from being impressed upon the line.

The line conductors 1, 2 are multiplied to the tip and ring of the jack of an answering operator's connecting circuit, which jack is adapted to be engaged by the associated plug. When a subscriber on the party line removes his telephone, thereby energizing the line relay 6, a circuit is closed from grounded battery 7 through the

usual line lamp 8 to ground at 22, signifying that a connection is desired.

A test terminal is associated with each set of line terminals on the connector and also with the answering jack. The test terminals 3^a and 3^b of stations A and B adapted to be signaled by current of the same character are connected together by a test conductor 3, the test contact 3^c of the jack being also connected with said conductor for a purpose to be later set forth. The test contacts 3^c and 3^d of substation C and D adapted to be signaled by current of the same character, though different from that applied to signal A and B, are also connected together by a test conductor 4. Current of negative polarity may be impressed upon test conductor 3 and consequently its associate test terminals. Current of positive polarity may be impressed upon test conductor 4 and its associate test terminals.

For convenience in describing the manner in which the potential of the sources of current of different characters impressed upon the test terminals may be reduced, a battery 35 is shown having its free pole, which in this case is negative, connected with test conductor 3 and its positive pole grounded. It has been found in practice that the potential of this battery may be 48 volts. From the middle point of this battery a conductor 25 is connected to the test brush 21. The test conductor 4 is connected to ground at 22.

It will thus be evident that the test terminals 3^a, 3^b and 3^c have a potential of 24 volts minus with respect to test brush 21 and conductor 25, and that test terminals 3^c, 3^d, being connected through relay 5^a to ground, have impressed upon them a potential of 24 volts plus with respect to test brush 21 and conductor 25.

With this explanation, it will be clearly seen that the test terminals 3^a, 3^b, 3^c may be considered as being impressed with negative potential of 24 volts and that the test terminals 3^c, 3^d may be considered as being impressed with positive potential of 24 volts.

A cut-off relay 5 is included in test conductor 3 and a cut-off relay 5^a is included in test conductor 4. Both of these relays are adapted to be included in the circuit of their respective test conductors upon the engagement of a test brush with a test terminal. A convenient circuit arrangement for accomplishing this result is made by providing each cut-off relay, in addition to the usual energizing winding 41, with a differential winding 42 tapped onto the energizing winding and having its circuit normally open at the armature contact of the opposite relay, so that upon the actuation of either cut-off relay 5 or 5^a by a flow of current through the corresponding test con-

ductor 3 or 4, due to the connection of the test brush with a test terminal, a local circuit 12 or 13 is closed including the opposite relay differentially. It has been found in practice that the energizing windings of each of the cut-off relays 5, 5^a may be of 100 ohms resistance and that the resistance of the differential winding may be 50 ohms. The cut-off relay 5 is adapted upon its excitation to open the line circuit at the contacts of its armatures, thereby extinguishing the line lamp 8.

A conductor 23 leads from the test brush of the connector to the middle of the battery or ground, and a circuit is adapted to be closed through this conductor upon the connection of said brush with a test terminal, provided the line is free, which will be indicated by the presence of normal potential thereupon. A relay 17, polarized to respond to positive current from test brush 21 only, is included in a branch of conductor 23, and is adapted normally to connect a source of negative ringing current 15 with a conductor 18 leading to the ringing brush 20 upon the connection of the brushes with the terminals of a substation having a test terminal upon which negative current is impressed, substation A or B, but upon the connection of the brushes with the terminals of a station having a test terminal upon which positive current is impressed, substation B or C, the relay will operate to shift the ringing lead to a source of positive current 15^a. In order that the same brush may serve to conduct the ringing current over both sides of the line, the connections of the leads from the conductors 1, 2 to the line terminals of two substations are reversed with respect to those of the remaining two substations. It will, of course, be understood that the sources of current 15 and 15^a may be of any character suitable for the purpose of signaling and that there is no significance in the coincidence that in this particular case the negative potential selects negative current and the positive potential positive current.

The energization of the cut-off relays 5 and 5^a is controlled by the relay 10. This relay has two windings of different resistances. The high resistance winding is included in series with the relay 17 upon closure of the contact 14 and the low resistance winding is included in a shunt about the relay 17 which is closed upon the energization of the relay 24. If a multiple terminal of the party line is in use a reduced potential will exist on the test terminals of the "selected line. When the test brush makes connection to a test terminal on which reduced potential exists, the relay 10 will not be energized on account of the low potential on the test terminal. However, should no substation of the party line be in

use, the normal potential of the test terminal will cause the operation of this relay. It has been found in practice that the high resistance winding of this relay 10 may be 100 ohms; and the low resistance winding 50 ohms for efficient operation. The relay 10 is adapted upon its energization to close a circuit through a relay 24, which in turn operates and shunts the high resistance winding of relay 10 to provide a margin of current for the energization of the cut-off relay associated with the test terminal of the line taken for use, which in operating closes a local circuit through the neutralizing winding of its companion relay including the other test conductor, thus causing a reduction of potential upon the test terminals of the party line and upon their multiple test terminals, to prevent the operation of a corresponding governing relay at a connector upon which a multiple terminal of the party line is located.

Assuming connection is desired with substation A and the party line to be free, the connector switch is advanced until its brushes 19, 20, 21 are in contact with terminals 1^a, 2^a, 3^a of the desired substation. Current of a negative character is now impressed upon the line and rings the bell of substation A over the following circuit: from generator 15, conductor 18, contact 16, (which is closed at this time) conductor 11, the middle brush 20 of the connector switch, line terminal 2^a, conductor 2, and to ground through the negatively-polarized bell in the grounded branch at station A. The connection of the brush 21 to the test contact 3^a closes a circuit for the relay 10 which subsequently causes the energization of relay 5. This circuit may be traced as follows: from the free pole of battery 35, conductor 3, in which is included the relay 5, test contact 3^a, brush 21, conductor 23, relay 17, high resistance winding of relay 10, conductor 25 to the neutral point of said battery. The relay 10 is a quick acting relay and immediately draws up its armature, closing a circuit from its grounded armature, contact 31, conductor 32, in which is included relay 24, to the free pole of battery 35. The armature of relay 24 is now attracted and closes at its contact a shunt of the high resistance winding of relay 10 through the low resistance winding, the circuit for which is closed at the armature contact of relay 24. The relay 5 is marginal in operation and will be energized immediately upon the operation of relay 24 and the consequent reduction in the resistance of the circuit due to the shunting of the high resistance winding of relay 10. The cut-off relay 5 upon its excitation attracts its armatures, thereby opening the circuit of the line on one side at a contact of spring 29 and on the other at a contact leading to the line relay 6. The

energization of relay 5 also closes at contact 9 a local circuit 12 through the windings of relay 5^a, and since the current flow in winding 42 of said relay is opposite to that of the current flow in winding 41 of the relay, the same is not energized. The current flow in this local circuit 12 is derived from the source applying potential of a positive character upon test terminals 3^a 4^a and may be considered as flowing from ground at 22, through conductor 32, relay 5^a differentially, conductor 31, armature 30, contact 9, spring 29, conductor 28, spring 27, conductors 26, 25, to the middle point of battery 35. It will be noted that since the resistance of the differential windings of the cut-off relays is equal to that of the low resistance winding of relay 10, the potential impressed upon the test terminals of conductor 4 will be reduced in like manner with that impressed upon the test terminals of conductor 3, thereby providing for the prevention of a busy line being taken for use at a multiple terminal of the party line.

Assuming now that the calling operator causes the connector to bring its contact brushes into connection with the terminals of either substation C or D, for instance C, the bell of which is polarized to respond to positive current only, and assuming no other multiple terminal of the party line is in use, the relay 17, biased to respond to positive current only, from the test terminal 3^a, is operated and attracts its armature, closing at its lower contact a circuit for ringing current of positive sign from generator 15^a to operate the positively biased bell in the ground branch at substation C, through conductor 18, contact 16, (closed at this time) conductor 11, brush 20, terminal 2^c, conductor 2 to ground at C, causing the bell to ring to notify the subscriber of a call. In the circuit with relay 17 are also relays 5^a, and 10. This circuit may be traced as follows: from ground at 22, energizing winding of relay 5^a, conductor 4, test terminal 3^a, test brush 21, conductor 23, relay 17, high resistance winding of relay 10, conductor 25 to battery 35. The relay 10 will thereupon operate in the same manner as has been described in connection with substation A to shunt its high resistance winding. The cut-off relay 5^a will thereupon be operated and will close at contact 9^a a local circuit 13 through relay 5 differentially, thus reducing the test potential impressed upon test terminals 3^a and 3^b. This local circuit may be traced as follows: from the free pole of battery 35, conductor 3, through relay 5 differentially, conductor 34, armature 35, contact 9^a, armature 27, conductors 26, 25 to the middle point of battery 35.

It is essential that a busy condition be maintained upon the test terminals of the party line when a call from any of them is

being answered and while connection is being extended and until connection has been taken down. In order to accomplish this result the test thimble or sleeve 3^a of the springjack of the position where the calls from this party line are answered is connected with test conductor 3, as before stated, and upon the insertion of the plug in the jack a circuit for relay 5 is completed as follows: from the neutral point of battery 35, conductor 25, including relay 10^a, sleeve of the plug, sleeve contact of the jack, conductor 36, conductor 3 including the energizing winding of cut-off relay 5, to the free pole of battery 35. The resistance of relay 10^a may be the same as the low resistance winding of relay 10, namely 50 ohms. The cut-off relay 5 in operating closes at contact 9 the local circuit 12 including cut-off relay 5^a differentially. The potential upon the multiple test terminals of the party line is now reduced to indicate a busy condition. Upon the replacement of the receiver by the subscriber, the circuit of relay 39, which relay by its energization in a circuit closed through the substation telephonic apparatus maintained open the circuit of supervisory lamp 38, is now deenergized and the retraction of its armature causes supervisory lamp 38 to be illuminated in a circuit from the grounded armature of relay 10^a to the free pole of a battery 40, whereupon the operator will remove the plug and the apparatus will be restored to normal.

Having thus described my invention, I claim:—

1. In a party telephone line, the combination with line terminals for each of two stations, of a test terminal for each station, a test conductor connecting each test terminal with a source of current, a switch adapted to engage with said terminals and close a circuit through one of said test conductors, and a responsive device in each test conductor adapted to close a circuit including the other test conductor.

2. In a party telephone line, the combination with line terminals for each of two stations, a test terminal for each station, test conductors connecting said test terminals with a source of current, of a switching device adapted to engage with said terminals and complete a circuit including one of said test terminals, and means introduced by said switching device in closing said circuit for changing the potential of said circuit, said means in turn actuating means for causing a change in the potential applied to the other test terminal.

3. In a party telephone line, the combination with line terminals for each of two substations, of a test terminal for each station, test conductors, one for each test terminal, joining said test terminals with

sources of current of different potential, a switch adapted to make connection to either of said test terminals and to close a circuit therethrough, and a responsive device in each test conductor adapted to close a circuit including the other test conductor.

4. In a party telephone line, the combination with line terminals for each of two stations, a test terminal for each station, two test conductors, one for each test terminal, joining said test terminals with sources of current of opposite polarity, a switch adapted to make connection to either of said test terminals and thereby to close a circuit therethrough, and a responsive device in each test conductor adapted to close a local circuit including the other test conductor.

5. In a party telephone line, the combination with line terminals for each of two stations, a test terminal for each station, test conductors connecting said test terminals with sources of current of opposite polarity, a switching device adapted to engage with said terminals and complete a circuit including one of said test terminals, means for changing the potential of said circuit arranged to be introduced by the said switching device in closing said circuit and means, actuated in turn by said other means, for causing a change in potential between the other test terminal and its source of current.

6. In a party telephone line, the combination with line terminals for each of two stations, a test terminal for each station, test conductors connecting said test terminals with sources of current of different character, a switching device adapted to engage with said terminals and complete a circuit including one of said test terminals, means for producing current changes arranged to be introduced by the said switching device in closing said circuit and means, actuated in turn by said other means, for causing a change in the character of the current applied to the other test terminal.

7. In a party telephone line, the combination with line terminals for each of two stations, a test terminal for each station, test wires connecting said test terminals with sources of current, a switching device adapted to engage said terminals and thereby to close a circuit including one of said test terminals for reducing the potential applied to said test terminal, and a cut-off relay included in said circuit, said relay in operating being adapted to close a circuit having included therein means for reducing the potential applied to the other test terminal.

8. In a party telephone line, the combination with a metallic telephone line, of a pair of responsive devices in different ground branches from each line conductor, the responsive devices in branches of the same line conductor being adapted to re-

spond to current of different character, a set of terminals for each station consisting of two line contacts and a test contact, two test conductors each connecting test terminals associated with each side of the line with sources of current of opposite polarity, a switching device adapted to engage with said terminals and thereby to complete a circuit including one of said sources of current and its associate test terminals, a cut-off relay included in said circuit, and a local circuit including a resistance, said cut-off relay upon its energization closing said local circuit and including the source of current of the other test terminals through said resistance, whereby the potential of the test terminals of both sides of the line is reduced.

9. In a party telephone line, the combination with a pair of metallic conductors having a pair of responsive devices in different ground branches from each line conductor adapted to be selectively signaled, of a test terminal for each station, two test conductors each connecting test terminals associated with each side of the line with sources of current of opposite polarity, a cut-off relay in each test conductor, two local circuits each with a connection to one of said cut-off relays, and a switching device adapted to close the circuit of one of said sources of current through one of said relays, and thereby to complete a local circuit including the other relay, upon its engagement with any of said test terminals.

10. In a semi-automatic party telephone line, the combination with a pair of metallic conductors having a pair of responsive devices in different ground branches from each line conductor adapted to be selectively signaled, of a test terminal for each station, two test conductors each connecting test terminals associated with each side of the line with sources of current of opposite polarity, two cut-off relays, two local circuits each with a connection to one of said cut-off relays, and a test brush adapted to close the circuit of one of said sources of current through one of said relays and thereby complete a local circuit including the other relay upon its engagement with any of said test terminals.

11. In a semi-automatic party telephone line, the combination with line terminals and a test terminal for each of two stations, test conductors connecting said test terminals with sources of current of opposite polarity, a cut-off relay in each test conductor, two local circuits each with a connection to one of said relays, and a test brush adapted to engage with said test terminals and thereby to complete the circuit of a test conductor including one of said sources of current and the corresponding relay, and a local circuit controlled by said last mentioned relay including the other relay.

12. In a busy test for a party telephone line, the combination with line terminals and a test terminal for each of two stations, test conductors connecting said test terminals with sources of current of opposite polarity, a cut-off relay in each test conductor, two local circuits each including one of said relays, each of said local circuits being open at a contact of the other relay, and a switching device adapted to engage with said test terminals and thereby to close a circuit including one of said sources of current and the corresponding relay, which is thereupon adapted to close a local circuit including the other relay.

13. In a busy test for a party telephone line, the combination with line terminals and a test terminal for each of two stations, test conductors connecting said test terminals with sources of current of opposite polarity, a cut-off relay in each test conductor, and two local circuits reciprocally controlled by said relays, each of said relays being included in one of said local circuits.

14. In a busy test for a multi-party telephone line, the combination with stations provided with signal devices some of which are adapted to be operated by current of one character, and others by current of an opposite character, line terminals and a test terminal for each station, test conductors connecting the test terminals of the stations adapted to be signaled by current of like character with sources of current of that character, a cut-off relay in the circuit of each test conductor, a connection device adapted to engage with said test terminals

and to close a circuit for one of said cut-off relays, and a local circuit adapted to be closed by said latter relay to include said other relay.

15. In a party telephone line, the combination with line terminals and a test terminal for each of two stations, test conductors, one for each test terminal, connecting said terminals with sources of current of opposite polarity, a cut-off relay in each test conductor having an energizing winding and a neutralizing winding, two local circuits each including the neutralizing windings of the respective relays and each having its circuit controlled at a contact of the other, whereby upon the energization of either relay a local circuit is closed through the neutralizing winding of the other.

16. In a party telephone line, the combination with a test thimble for each station, a plug adapted to engage therewith, a test conductor connecting said test thimbles to sources of current of opposite polarity, a cut-off relay in each test conductor, two local circuits each with a connection to one of said cut-off relays, the energization of one relay upon the contact of the plug with a test thimble causing said relay to close the local circuit including the other.

In witness whereof, I, hereunto subscribe my name this 17th day of December A. D., 1909.

FRANK R. McBERTY.

Witnesses:

IRVING MACDONALD,
EDGAR F. BEAUBIEN.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."