

May 1, 1923.

O. B. BLACKWELL

1,453,430

VOICE OPERATED RELAY

Filed Nov. 22, 1919

Fig. 1

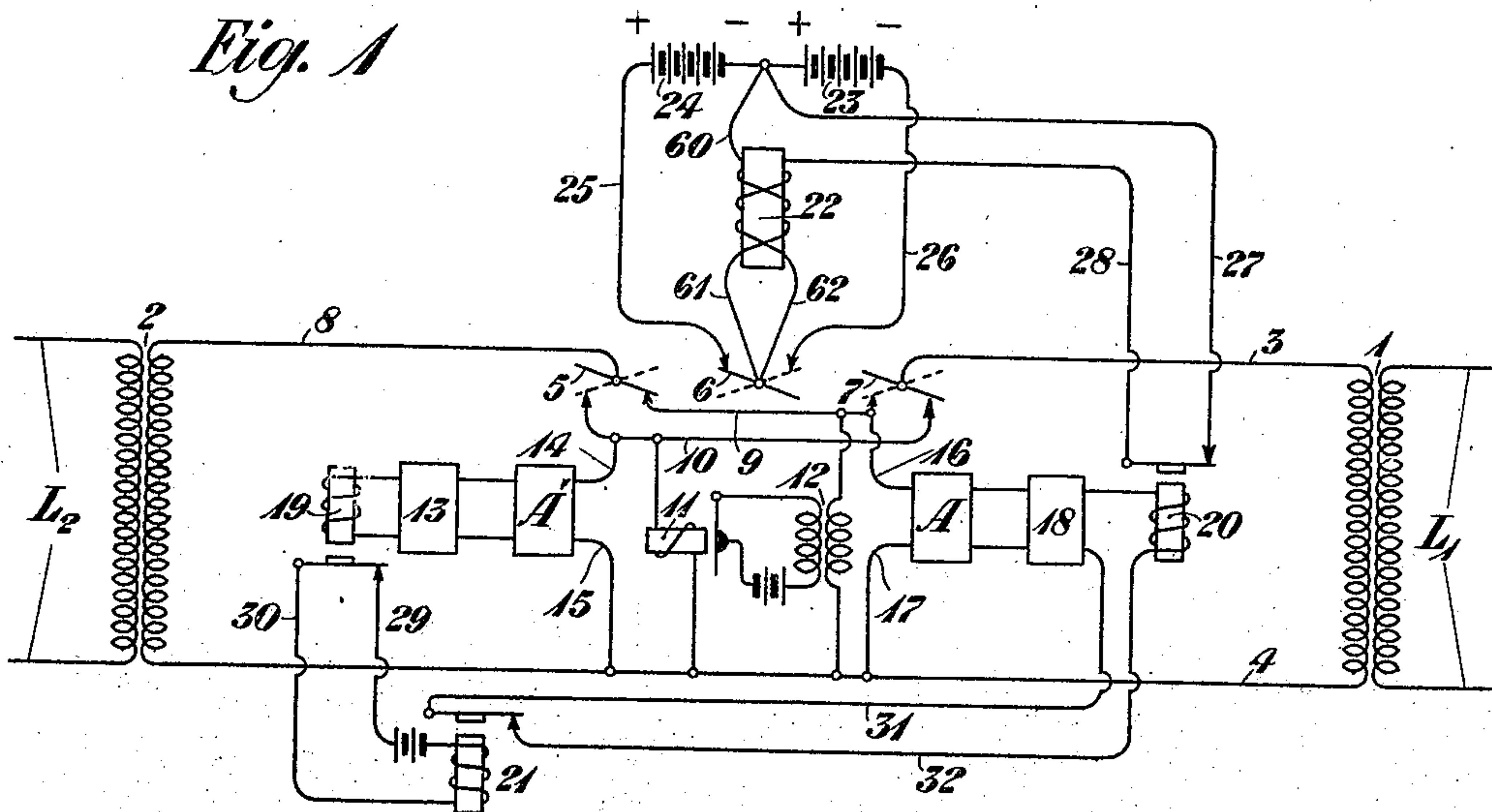


Fig. 2

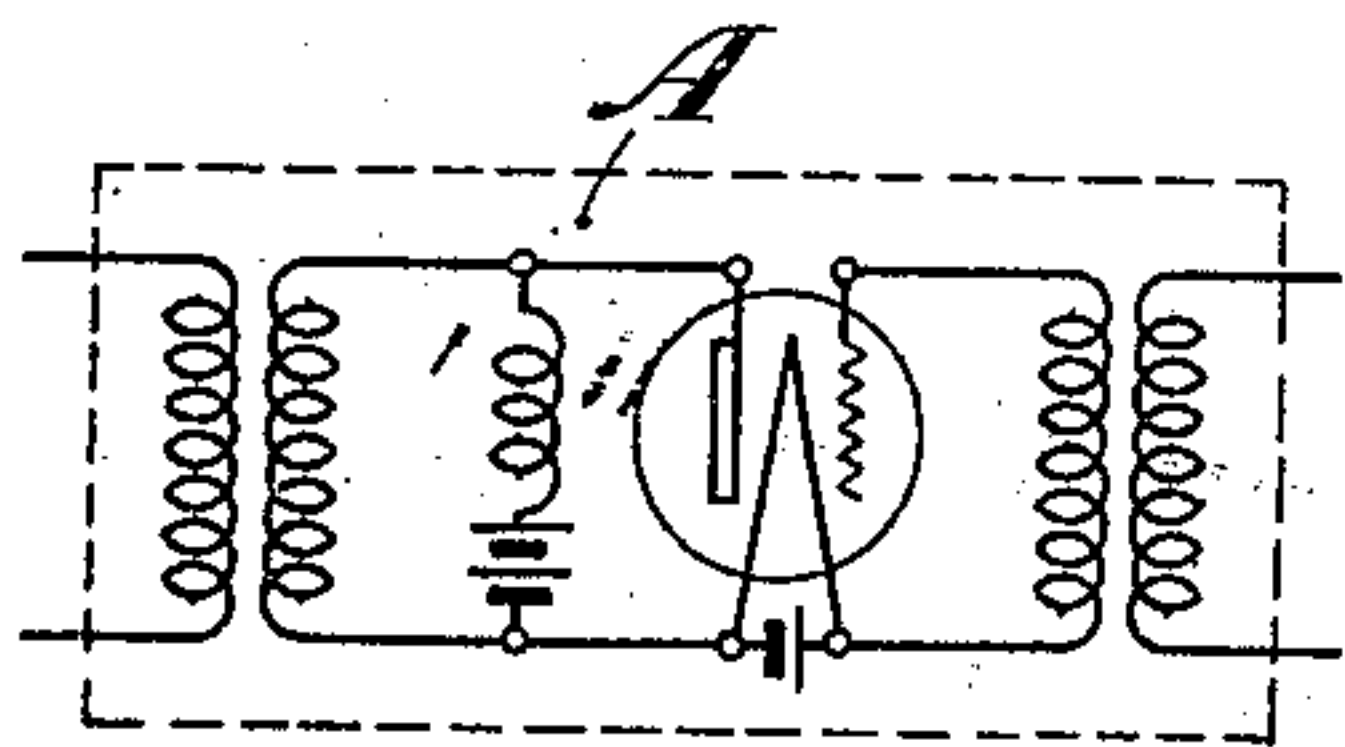
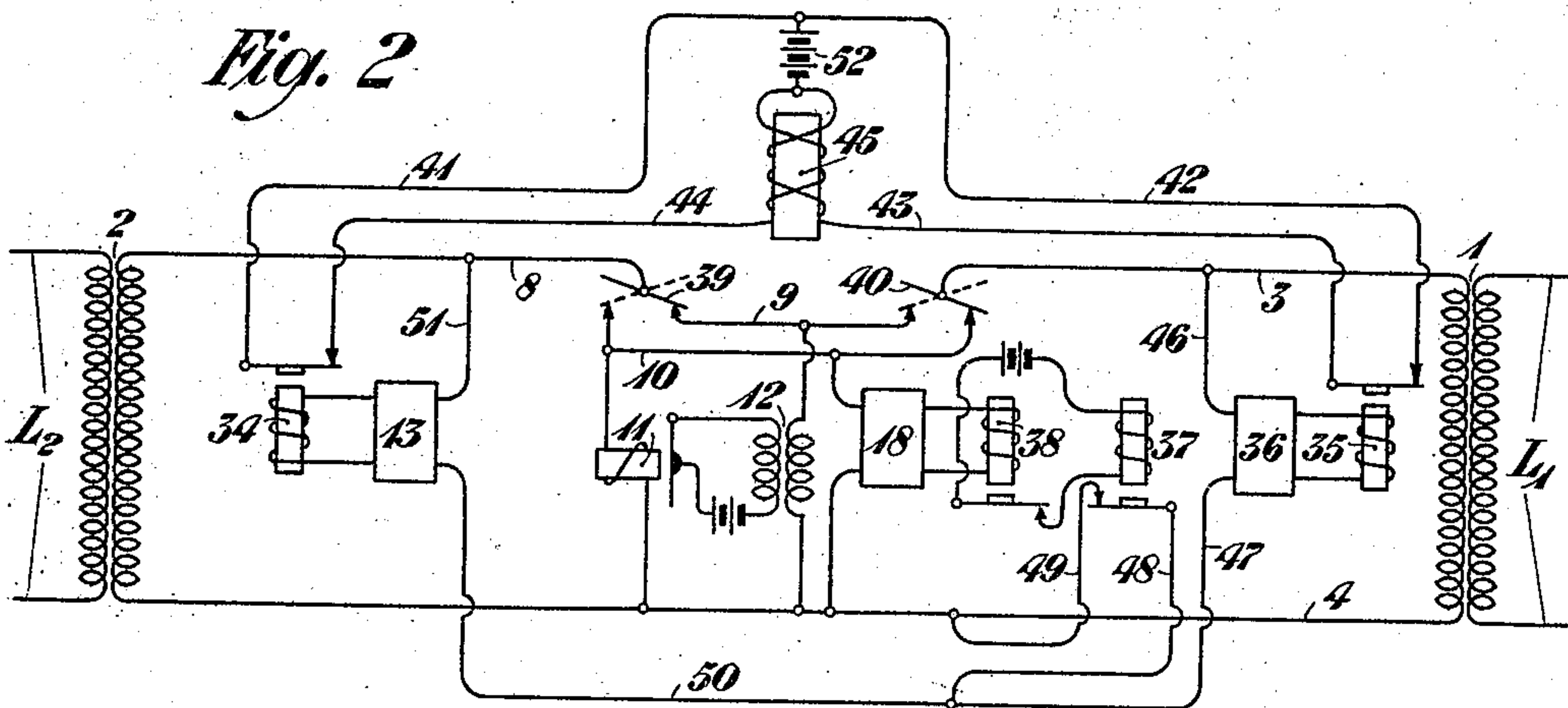


Fig. 3

INVENTOR
O. B. Blackwell
BY *g v 70 r*
ATTORNEY

UNITED STATES PATENT OFFICE.

OTTO B. BLACKWELL, OF GARDEN CITY, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

VOICE-OPERATED RELAY.

Application filed November 22, 1919. Serial No. 339,799.

To all whom it may concern:

Be it known that I, OTTO B. BLACKWELL, residing at Garden City, in the county of Nassau and State of New York, have invented certain Improvements in Voice-Operated Relays, of which the following is a specification.

This invention relates to transmission systems and more particularly to such systems which include repeaters or relaying arrangements for the reinforcement of the transmitted energy.

The repeating or relaying arrangements of this invention are of the voice operated type, in which a two-way one element repeater is employed, the proper association of the device with the circuit being controlled by the voice or speech currents transmitted over the circuit. It is a general feature of this invention to provide an improved arrangement of this character in which the voice operated relaying device will not be subject to interference from currents of frequencies or characteristics other than those of the voice or speech currents and accordingly will not be subject to false operation. Another feature consists in an improved arrangement whereby the relay or repeater upon being operatively associated with the transmission line when speech is being transmitted thereover in one direction, will remain permanently associated with the line in such manner until speech is transmitted thereover in an opposite direction. Other and further features of the invention will be clear from the detailed description of the invention hereinafter given.

The repeater device of this invention is operatively connected to the transmission line by a plurality of switches, the switches in turn being controlled by relay means operated by the voice currents transmitted over the line. In order to prevent false operation of the device filtering arrangements are associated with these relay means. These filters are adapted to readily allow the transmission of currents of telephonic or voice frequencies, but serve to attenuate and practically extinguish currents of other frequencies. This arrangement prevents the relay means controlling the repeater device from operating on currents of other than voice frequencies, such as currents used for signaling or other purposes. The switches employed are of the overbalanced type, which

when thrown in one direction tend to remain in that position until again acted upon by exterior forces.

The invention may be more fully understood from the following description when taken in connection with the accompanying drawing in the Figures 1 and 2 of which are illustrated circuit diagrams embodying a preferred form of the invention and a modification thereof. Fig. 3 illustrates a conventional type of audion amplifier.

In the arrangements illustrated in Fig. 1 are shown two sections L_1 and L_2 of a transmission line which are inter-connected through transformers 1 and 2 by an auxiliary circuit including the voice operated repeater device. By means of these transformers the condition of unbalance in the auxiliary circuit is prevented from affecting the lines. The repeater element 11 is shown as of the mechanical type although other types, such as the well known vacuum bulb repeater may equally well be employed. The input circuit of repeater 11 is connected to conductors 10 and 4 of the auxiliary circuit, while the output circuit of repeater 11 is connected through transformer 12 to conductors 9 and 4 of the auxiliary circuit. The conductors 9 and 10 are associated with conductors 8 and 3 of the auxiliary circuit by means of the switches 5 and 7, which as has been formerly pointed out are of the overbalanced type. The switches 5 and 7 and also the switch 6 are controlled by the polarized relay 22, the windings of which are differentially arranged. This arrangement may be termed the reversing switch. Relay 22 is in turn controlled by the relays 19, 20, and 21. The relay 19 responds to voice currents transmitted over the system when the transmission is taking place from line L_1 to line L_2 , and the relay 20 is operative with voice currents transmitted over the system when transmission is taking place from line L_2 to line L_1 . Relay 20 may be termed the master switch. Associated with relays 19 and 20 are the filters 13 and 18 respectively. These filters may be of the type illustrated in the patents issued to G. A. Campbell, on May 22, 1917, #1227113 and 1227114, and are adapted to readily allow the transmission of currents of voice or telephonic frequencies but which attenuate and practically extinguish currents of other frequencies, thereby preventing relays 19 and 20 from

operating with currents other than those of telephonic frequency transmitted over the system, such for example as noise or signaling currents, and thus obviating the false operation of switches 5 and 7. Associated with relays 19 and 20 are the amplifiers A' and A, illustrated more fully in Fig. 3. These amplifiers are provided to strengthen the voice current sufficiently to operate the voice relays and also furnish means for adjustment of this current to the most suitable value.

The operation of the arrangements illustrated in Fig. 1 is as follows: If the switches 5 and 7 have been thrown to the right so that their right hand contacts are closed transmission of voice currents may take place from line L_1 to line L_2 in the following manner: from line L_1 , through transformer 1, thence over conductor 3, switch 7, right hand contact of switch 7, conductor 10, through winding of repeater 11, and over conductor 4, to the transformer 1. The electro-magnetic waves transmitted over this circuit will be transmitted in amplified form from the repeater 11 and through transformer 12, whence they will be transmitted over the following circuit; from one terminal of the transformer winding, over conductor 9, right hand contact of switch 5, switch 5, conductor 8, right hand winding of transformer 2, conductor 4, to the other terminal of the winding of transformer 12. The amplified waves will then be transmitted through the transformer 2 and out over the line L_2 . A portion of the current coming in from line L_1 will be transmitted from conductor 10, over conductor 14, filter 13, winding of relay 19, filter 13, conductor 15, to conductor 4. This current will operate relay 19 which will pull up its armature and open the following normally closed circuit: from one pole of battery, winding of relay 21, conductor 30, armature and contact of relay 19, conductor 29, to opposite pole of battery. The opening of this circuit will deenergize relay 21 which will open at its armature and break the following normally closed bridge across conductors 9 and 4: from conductor 9, conductor 16, filter 18, winding of relay 20, conductor 32, contact and armature of relay 21, conductor 31, filter 18, conductor 17, to conductor 4. The opening of this normally closed bridge will prevent the amplified talking currents transmitted through transformer 12 from being transmitted through said bridge and actuating relay 20. In order to provide additional insurance against the operation of relay 20 under such conditions the relay 19 may be adjusted to operate slightly faster than relay 20. When the relay 20 remains unoperated current will be transmitted through the windings of relay 22 in the following manner: from negative pole of bat-

tery 24, conductor 60, winding of relay 22, conductor 61, switch 6, left hand contact of switch 6, conductor 25, to positive pole of battery 24; and at the same time from negative pole of battery 24, conductor 27, contact and armature of relay 20, conductor 28, winding of relay 22, conductor 62, switch 6, left hand contact of switch 6, conductor 25, to positive pole of battery 24. As the two windings of relay 22 are differentially arranged the currents transmitted over the two last mentioned circuits will neutralize each other and the relay 22 will not be operated and the switches will not be thrown. Furthermore as the switches are of the over-balanced type they will remain in their original position even after the transmission of voice currents from line L_1 to line L_2 has ceased. If transmission of speech now starts to take place from the other end of the system, from line L_2 to line L_1 , the voice currents will be transmitted from the line L_2 through the transformer 2 and thence over the following circuit: from the winding of transformer 2, over conductor 8, switch 5 and right hand contact thereof, conductor 9, conductor 16, filter 18, winding of relay 20, conductor 32, contact and armature of relay 21, conductor 31, filter 18, conductor 17, over conductor 4, to the winding of transformer 2. The transmission of current over this circuit will operate relay 20. The operation of relay 20 will open a previously traced circuit including one of the differential windings about relay 22. Accordingly the current through the other previously traced circuit including the other winding of relay 22 will operate the polarized relay 22 which upon operating will cause the switches 5 and 7 to be thrown into the position indicated in the drawing by the dotted lines. The switch 6 will also be thrown at a slight interval after the operation of switches 5 and 7 for reasons which will be pointed out later. Upon the operation of switches 5 and 7 the voice currents coming in from line L_2 will be transmitted over the following circuit: from the winding of transformer 2, over conductor 8, switch 5 and left hand contact thereof, conductor 10, through winding of repeater 11, and over conductor 4 to the winding of transformer 2. The voice currents will then be transmitted in amplified form from the repeater 11 through transformer 12 and over the following circuit: from winding of transformer 12, conductor 9, left hand contact of switch 7, switch 7, conductor 3, winding of transformer 1, conductor 4, to winding of transformer 12. The amplified talking currents will then be transmitted through transformer 1 and out over line L_1 . When the switch 5 has been thrown into the position indicated by the dotted line a portion of the talking current coming in over line L_2 will be transmitted

over the following circuit: from winding of transformer 2, conductor 8, switch 5, left hand contact of switch 5, conductor 10, conductor 14, filter 13, winding of relay 19, filter 13, conductor 15, conductor 4, to winding of transformer 2. The current transmitted over this circuit will energize relay 19, which in the same manner as previously pointed out will deenergize relay 21, which will open the circuit of relay 20, thereby deenergizing relay 20. As has been formerly pointed out the energization of relay 20 served to open a circuit including one of the differential windings of polar relay 22, thereby allowing the relay 22 to be energized by current flowing from the negative pole of battery 24 through the other differential winding thereof. If the switch 6 was operated instantaneously and thrown while relay 20 was operated current would now flow from the positive pole of battery 23, conductor 60, winding of relay 22, conductor 61, switch 6, right hand contact of switch 6, conductor 26, to negative pole of battery 23. As this current is of the opposite polarity it would tend to throw the switch 6 back at once to its original position. Accordingly the switch 6 must be regulated so that by the time it has made contact with its right hand contact the relays 19 and 20 will have operated and 21 will have been released, in turn releasing 20. Accordingly when the right hand contact of switch 6 is closed the current from battery 23 will be flowing through both of the differential windings of relay 22 and the relay will not tend to throw the switch back to its original position. As the switch 6 is of the overbalanced type it will tend to remain as thrown and maintain its right hand contact closed until acted upon again by exterior forces. If the direction of speech should again be reversed and transmission should take place again from line L_1 to line L_2 the voice currents would now be transmitted over the following circuit: from winding of transformer 1, conductor 3, switch 7, left hand contact of switch 7, conductor 16, filter 18, winding of relay 20, conductor 32, contact and armature of relay 21, conductor 31, filter 18, conductor 17, conductor 4, to winding of transformer 1. These voice currents will operate relay 20 and open the circuit including one of the differential windings of relay 22. Current will now flow from positive pole of battery 23, over conductor 60, winding of relay 22, conductor 61, switch 6, right hand contact of switch 6, conductor 26, to negative pole of battery 23. As has been formerly pointed out this current is of a polarity suitable to cause the operation of the polar relay 22 which upon operating will throw the switches 5, 7, and 6. For the same reasons as previously pointed out if the switch 6 was operated instantly and thrown while relay

20 was operated the current flowing from the negative pole of battery 24 through only one of the differential windings of relay 22 would tend to throw switch 6 back again to its former position as soon as it made contact with its left hand contact. Accordingly the switch 6 must be made to act sufficiently slow so that by the time it closes its left hand contact the incoming voice currents will have operated relays 19 and 21 and thereby allowed relay 20 to be released. Accordingly when the switch 6 closes its left hand contact current will flow from the negative pole of battery 24 through both of the differential windings of relay 22 and the relay will remain unenergized. Accordingly by making the switch 6 of the overbalanced type and regulating its operation as described the relay 22 may be controlled by the opening and closing of relay 20 and the switches 5, 7, and 6 may be controlled by the direction of transmission of the voice currents, the switches remaining in operated position even after the transmission of voice currents has ceased. This feature serves to prevent any distortion of the voice currents which would otherwise result if, as in former arrangements, the switches tended to fall back in to a non-operative position upon the cessation of the voice currents.

In the arrangement illustrated in Fig. 2 is shown a modification of the arrangements of Fig. 1. Similar reference numerals have been used to denote like parts in both figures of the invention. Two sections L_1 and L_2 of the transmission line are shown interconnected by an auxiliary circuit, in which is included the repeater device 11. The repeater device is associated with the talking conductors of the auxiliary circuit by means of the switches 39 and 40. The switches 39 and 40 are of the overbalanced type and are controlled by the differentially wound polar relay 45. The relay 45 is controlled by the direction of the voice currents transmitted over the line through the operation of the relays 34 and 35. Associated with the relays 34 and 35 and also with the relay 38 are the filters 13, 36 and 18, respectively. These filters are adapted to readily allow the transmission of currents of telephonic or voice frequency, but serve to attenuate and extinguish currents of all other frequencies.

The operation of the arrangement illustrated in Fig. 2 is as follows: With the switches 39 and 40 thrown in the position as indicated in the drawing, transmission may take place from the line L to the line L_2 in the following manner: from the winding of transformer 1, over conductor 3, switch 40, right hand contact of switch 40, conductor 10, winding of repeater 11 and over conductor 4 to the winding of transformer 1. The electro-magnetic waves transmitted over this circuit will operate the

repeater 11. The talking currents will then be transmitted in amplified form from the repeater 11, through the transformer 12 and over the following circuit: from the winding of transformer 12, over conductor 9, right hand contact of switch 39, switch 39, conductor 8, winding of transformer 2, conductor 4 to the winding of transformer 12. The amplified voice currents will then be transmitted through the transformer 2 and out over the line L_2 . The voice currents transmitted in the above described manner from the line L_1 to the line L_2 will also be transmitted from conductors 10 and 4, through the filter 18 and about the winding of relay 38, thereby operating relay 38. The operation of relay 38 opens a local circuit for relay 37, thereby deenergizing said relay. The deenergization of relay 37 allows its armature to retract and thereby opens the normally closed bridges across the auxiliary circuit which include the windings of relays 34 and 35. It is pointed out that the relays 38 and 37 are adjusted to be slightly faster in their operation than either of the relays 34 and 35, so that the voice currents transmitted from line L_1 to line L_2 will cause them to operate before the same current might cause the relays 34 and 35 to operate. Accordingly these two last mentioned relays will remain unaffected by the voice currents transmitted from line L_1 to line L_2 , and the relay 45 and the switches 39 and 40 will be undisturbed.

If the direction of speech is now reversed and transmission takes place from the line L_2 to the line L_1 , the cessation of the voice currents from line L_1 to line L_2 will cause the relays 38 and 37 to be released. A portion of the voice currents coming in from line L_2 will be transmitted over the following circuit: from conductor 8, over conductor 51, filter 13, winding of relay 34, filter 13, conductor 50, conductor 48, armature and contact of relay 37, conductor 49 to conductor 4. These voice currents will not be transmitted through the relays 38 or 35. These currents will operate relay 34 and will open a circuit including one of the differentially arranged windings of relay 45. Current will then be transmitted through the other differentially arranged winding of relay 45 over the following circuit: from one pole of battery 52, winding of relay 45, conductor 43, armature and contact of relay 35, conductor 42 to the other pole of battery 52. As relay 45 is polarized the current flowing through this winding thereof will operate relay 45 and will cause the switches 39 and 40 to be thrown to the position indicated by the dotted line. When the switches 39 and 40 are thrown in the position indicated by the dotted line the voice currents coming in over line 2 will be transmitted over the following

circuit: from the winding of transformer 2, conductor 8, switch 39, left hand contact of switch 39, winding of repeater 11, conductor 4, to the winding of transformer 2. The electromagnetic waves transmitted over this circuit will operate the repeater 11. The voice currents will then be transmitted in amplified form through the transformer 12 and over the following circuit: from the winding of transformer 12, conductor 9, left hand contact of switch 40, switch 40, conductor 3, winding of transformer 1, conductor 4 to the winding of transformer 12. The amplified voice currents will then be transmitted through transformer 1, out over the line L_1 . As soon as the switch 39 has been thrown to the position indicated by the dotted line by the operation of relay 45, the voice currents from line L_2 will be transmitted over the following circuit: from conductor 8, switch 39, left hand contact of switch 39, conductor 10, filter 18, winding of relay 38, filter 18, to conductor 4. In the same manner as previously pointed out this will operate relay 38, which in turn will release relay 37 and thus open the previously traced circuit through relay 34 and deenergize relay 34. When relay 34 is deenergized the relay 45 will remain unaffected because of the differential arrangement of its windings and the switches 39 and 40 being of the overbalanced type will remain in the position indicated by the dotted line and the transmission of speech may continue to take place from line L_2 to line L_1 .

When the transmission of speech from line L_2 to line L_1 ceases, the switches, as they are of the overbalanced type, will remain in the position indicated by the dotted line. If under such conditions it is now desirable to transmit speech from line L_1 to line L_2 once again, the voice currents transmitted from line L_1 will be transmitted over the following circuit: from conductor 3, conductor 46, filter 36, winding of relay 35, filter 36, conductor 47, conductor 48, armature and contact of relay 37, conductor 49, to conductor 4. This will operate relay 35. However, these voice currents from line L_1 will not be transmitted to relays 34 or 38 when the switches are in the dotted position. The operation of relay 35 will open a circuit including one of the differential windings of polar relay 45. Current will then be transmitted through the other differential winding of relay 45 over the following circuit: from one pole of battery 52, winding of relay 45, conductor 44, contact and armature of relay 34, conductor 41, to the other pole of battery 52. As the relay 45 is polarized the current flowing through this other differential winding thereof will operate relay 45 and will cause the switches 39 and 40 to be thrown from the dotted position to their original position. Transmission

may then take place from line L_1 to line L_2 in the same manner as already described.

While the invention has disclosed an arrangement of filtering devices and voice operated relays which serve to control a telephone repeater in a line, it is understood that these filtering and relaying devices may be utilized to control devices or apparatus other than telephone repeaters. Accordingly while the invention has been disclosed in certain specific arrangements which have been deemed desirable it is understood that it is capable of embodiment in many and widely varied forms without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. A telephone line, a repeater associated therewith, a circuit changing device comprising a differentially wound polarized relay and a plurality of switches for operatively associating said repeater with said line for transmission in either direction, said circuit changing device being controlled by the direction of transmission of voice currents transmitted over said line, and a filter associated with said circuit changing device adapted to readily allow the transmission of currents of voice frequencies and to attenuate and practically extinguish currents of other frequencies.

2. In a telephone system, two line sections interconnected by an auxiliary circuit, a repeater in said auxiliary circuit, a plurality of switches so arranged that when said switches are thrown in one direction the input circuit of said repeater will be associated with one of said line sections and the output circuit of said repeater will be associated with the other of said line sections and when thrown in the opposite direction said input and output circuits will be associated with said second mentioned and first mentioned line sections respectively, said switches being of the overbalanced type, a differentially wound polarized relay for controlling said switches, relay means for controlling said differentially wound polarized relay, said relay means being responsive to the voice currents transmitted over said system, and means for preventing currents other than voice currents from operating said last mentioned relay means.

3. A telephone line, a repeater associated therewith, and a circuit changing device for operatively associating said repeater with said line for transmission in either direction, said circuit changing device comprising a plurality of switches of the overbalanced type, a polarized and differentially wound relay controlling said switches, and means responding in accordance to the direction of flow of the voice currents transmitted over said line for momentarily open-

ing a circuit including one of the differentially arranged windings of said polar relay.

4. A telephone line, a repeater associated therewith, and a circuit changing device for operatively associating said repeater with said line for transmission in either direction, said circuit changing device comprising a plurality of switches of the overbalanced type, a polarized and differentially wound relay controlling said switches, means responding to the transmission of voice currents over said line for momentarily opening and closing a circuit including one of the differentially arranged windings of said polar relay thereby operating said relay, and means controlled by the operation of said relay for reversing the polarity of the current flowing through both of said differentially arranged windings.

5. A telephone line, a repeater associated therewith, and a circuit changing device for operatively associating said repeater with said line for transmission in either direction, said circuit changing device comprising a polarized and differentially wound relay, means responding to the transmission of voice currents over said line for momentarily opening and closing a circuit, including one of the differentially arranged windings of said polar relay thereby operating said relay to associate said repeater with said line for transmission in one direction, and means controlled by the operation of said relay for reversing the polarity of the current flowing through both of said differentially arranged windings whereby when one of said differential windings is again opened said polar relay will operate to associate said repeater with said line for transmission in the opposite direction.

6. A telephone line, a repeater associated therewith, and a circuit changing device for operatively associating said repeater with said line for transmission in either direction, said circuit changing device comprising, a relay with a plurality of windings, means responding to the transmission of voice currents over said line for momentarily opening and closing a circuit including one of the windings of said relay thereby operating said relay to associate said repeater with said line for transmission in one direction, and means controlled by the operation of said relay for reversing the polarity of the current flowing through the windings of said relay whereby when one of said windings is again opened said relay will operate to associate said repeater with said line for transmission in the opposite direction.

7. A telephone line, a repeater associated therewith, a circuit changing device for operatively associating said repeater with said line for transmission in either direction, a differentially wound polarized relay and controlling circuits therefor whereby said

circuit changing device may be controlled by the direction of transmission of voice currents transmitted over said line, a filter associated with said controlling circuits adapted to readily allow the transmission of currents of voice frequencies and to attenuate and practically extinguish currents of other frequencies, and an amplifier associated with said controlling circuits for regulating said voice currents.

8. The combination of two telephone lines, a repeater therebetween, switching means for connecting said repeater to said lines and adapted to assume different positions, whereby the two-way transmission of signals is possible, and means responsive to voice currents for controlling the reversal of said repeater, said means comprising a master switch adapted to assume two positions, in one of which said switching means connects said repeater for the transmission of signals in one direction over said lines and in the other of which said switching means connects said repeater for transmission in the other direction.

9. The combination of two telephone lines, a repeater therebetween, switching means for connecting said repeater to said lines and adapted to assume different positions, whereby the two-way transmission of signals is possible, a master switch adapted to assume two positions, in one of which said switching means connects said repeater for the transmission of signals in one direction over said lines and in the other of which said switching means connects said repeater for transmission in the other direction, said switch normally assuming one of said positions, and means responsive to voice currents to move said switch to the other position if incoming signals do not find said switch in the proper position.

10. The combination of two lines, means adapted to be reversibly connected between said lines, a reversing switch between each of said lines and said means, and a master switch controlling said reversing switch, said master switch being operable under the control of voice currents transmitted over either line, and means whereby when said master switch is operated by voice currents transmitted over one line it is rendered uncontrollable by voice currents transmitted over the other line, the movement of said master switch from one position to another serving to reverse the connection of said first mentioned means to said lines.

11. The combination of two lines, means adapted to be reversibly connected between said lines, a reversing switch between each of said lines and said means, a master switch controlling said reversing switch, the movement of said master switch from one position to another serving to reverse the connection of said means to said lines, means

responsive to voice currents for actuating said master switch, and means to subject said master switch to the control of one line to the exclusion of the other.

12. The combination of two lines, a repeater adapted to be reversibly connected between said lines, a reversing switch between each of said lines and said repeater, a master switch controlling said reversing switch, and means responsive to current impressed on said lines for actuating said master switch, and means to subject said master switch to the control of one line to the exclusion of the other.

13. A repeater system comprising two lines, a unidirectional repeater for repeating current in both directions between said lines, switching means for reversibly connecting said repeater to said lines, a voice operated relay for operating said switching means, and means comprising a second voice operated relay for rendering said first-mentioned relay inoperative, said repeater having input terminals normally disconnected from one of said lines and connected to the other of said lines.

14. A repeating system comprising two lines, a repeater adapted to be connected therebetween, said repeater having its output terminals normally connected to one of said lines and its input side normally disconnected from said line, switching means for reversibly connecting said repeater to said lines, a voice operated relay for controlling said switching means, and means comprising a second voice operated relay for rendering said first-mentioned relay inoperative.

15. The combination of two telephone lines, a relay for each of said lines, mechanically independent armatures for said relays, a unidirectional repeater for transmitting current in both directions between said lines, means whereby said relays control said repeater, and means whereby one of said relays renders the energizing circuit of the other relay ineffective, said repeater having output terminals connected to both sides of one of said lines in the absence of currents to be repeated.

16. The combination of two telephone lines, means adapted to be reversibly connected between said lines, a reversing switch between each of said lines and said means, and switching means responsive to voice currents for controlling the reversal of said means, said switching means comprising a master switch controlling said reversing switch, the movement of said master switch from one position to another serving to reverse the connection of said means to said lines, and means to subject said master switch to the control of one line to the exclusion of the other.

17. The combination of two telephone

lines, a repeater adapted to be reversibly connected between said lines, a reversing switch between each of said lines and said repeater, a master switch controlling said reversing switch, means responsive to voice currents impressed on said lines for actuating said master switch, and means to subject said master switch to the control of one line to the exclusion of the other.

18. Two line sections, a device to be connected therebetween, a relay between said device and each of said sections, mechanically disconnected armatures individual to said relays, one of said relays being adapted to establish and both of said relays being adapted to maintain the connection of said device to said line sections.

19. The combination of two lines, a repeater therebetween, a relay responsive to current originating in one of said lines but initially unresponsive to current coming in over the other of said lines, and means responsive to current impressed on said other line to reverse the connections of said repeater with respect to said lines, whereby said initially unresponsive relay is finally responsive to current impressed on said other line.

20. The combination of two lines, a repeater adapted to be reversibly connected therebetween, a plurality of relays for controlling the connections of said repeater to said lines, one of said relays being in the output circuit of said repeater, and means comprising a movable armature for rendering said last mentioned relay unresponsive to current approaching the input side of said repeater while permitting said last-mentioned relay to respond to current approaching the output side of said repeater.

21. A line, a repeater therefor, a relay in the output circuit of said repeater for establishing the repeater connections, a movable contact for connecting said relay into or out of the output circuit of said repeater, and means responsive to voice current impressed on said line for controlling said contact.

22. The combination of two lines, a device adapted to be reversibly connected therebetween, and switching mechanism for controlling the connection comprising an armature connected to one side of one of said lines, an armature connected to one side of the other of said lines, a plurality of contacts for each armature, the contacts for each of said armatures being connected to the opposite sides of said device, and a relay responsive to current in each of said lines for controlling said switching mechanism.

23. The combination of two telephone lines, a repeater therebetween, and means comprising a relay device responsive to current impressed on said lines for changing the connections of said repeater to said lines,

whereby the two-way transmission of current is provided, said relay being responsive to voice currents transmitted over said lines and the response of said relay being the same regardless of whether the current causing it is impressed on one of said lines or is impressed on the other of said lines.

24. A signaling system comprising two telephone lines, a repeater therefor, a relay for controlling the relation of said repeater to said lines, said relay being adapted to be connected to either of said lines, and means controlled by said relay for connecting the input terminals of said relay to one of said lines to the exclusion of the other in response to voice currents transmitted over one of said lines.

25. A signaling system comprising two lines, a repeater therefor, a relay for controlling the connections of said repeater to said lines, and connections whereby said relay is at times responsive to voice current coming in over either of said lines, is unresponsive to outgoing current, and is disconnected from one of said lines whenever said lines are not in use.

26. The combination of two lines, a repeater therebetween and normally effective to repeat current in one direction between said lines, and means comprising a relay responsive to voice current impressed on said lines for changing the direction in which said repeater points, if not already pointed in the proper direction, whereby the two-way transmission of current is provided.

27. The combination of a relay, a repeater controlled thereby, and means whereby the actuation of said relay renders said relay inoperative.

28. A two-way repeating system comprising two lines, a repeater therebetween, a relay adapted to point said repeater in one direction or the other between said lines, and means whereby the actuation of said relay renders said relay temporarily inoperative.

29. A two-way repeating system comprising two lines, a repeater therebetween, a relay for controlling the relation of said repeater to said lines, said relay being controlled by voice currents, and means comprising said relay for selectively maintaining whichever one of said two lines was last used as the incoming line disconnected from said relay until the other one of said two lines becomes the incoming line.

30. In a two-way repeating system, two lines, a repeater therebetween, and means comprising a relay device responsive to voice current in each of said lines for disconnecting the output side of the repeater from one of said lines in response to current flow in one of said lines.

31. The combination of two lines, a relay adapted to be associated with either of said lines, said relay being controlled by voice

currents, and means responsive to the energization of said relay for transferring the control of said relay from one of said lines exclusively to the other.

5 32. A two-way repeating system comprising two lines, a repeater therebetween, a relay controlling the repeater connections and adapted to be associated with either of said lines, said relay being controlled by voice
10 currents, and means responsive to the energization of said relay for transferring the control of said relay from one of said lines exclusively to the other.

15 33. The combination of two telephone lines, a repeater therebetween, and means comprising a relay device responsive to voice current impressed on said lines for pointing said repeater in each direction whereby the two-way transmission of current is provided,
20 said relay comprising a single pair of contacts for initiating the operations of said means which result in the pointing of the repeater in each direction.

25 34. A signaling system comprising two telephone lines, a repeater therefor, and a relay solenoid responsive to voice current impressed on said lines and adapted to be automatically associated with one or with the other of said lines for controlling the rela-
30 tion of said repeater to said lines.

35 35. The combination of two lines, a repeater adapted to be connected therebetween, a relay responsive to current approaching said repeater for controlling the repeater connections, and means for automatically connecting said relay to or dis-

connecting said relay from the output circuit of said repeater.

36. The combination of two lines, a repeater adapted to be reversibly connected
40 therebetween and normally connected to repeat current in one direction between said lines, and a relay responsive to alternating signal current approaching the repeater by way of its output circuit for reversing the
45 repeater connections to said lines.

37. A two-way repeater system comprising two lines, a repeater adapted to be reversibly connected thereto, and means, comprising a relay coil, for reversing the
50 repeater connections in response to energization of said coil by voice current approaching the repeater in either direction.

38. A repeater system comprising two lines, a repeater therebetween, and means,
55 comprising a relay coil, for controlling said repeater in response to energization of said coil by incoming voice current in each of said lines.

39. A two-way repeater system comprising
60 two lines, a unilateral repeater adapted to be reversibly connected thereto, and means, comprising a relay coil, for reversing the pointing of said repeater in response to energization of said relay coil by voice
65 current approaching the repeater in either direction.

In testimony whereof, I have signed my name to this specification this twenty-first day of November 1919.

OTTO B. BLACKWELL.