March 2, 1926. 1,574,781

H. A. BARTON

VOICE OPERATED REPEATER SYSTEM

Filed Oct. 23, 1923 2 Sheets-Sheet 1

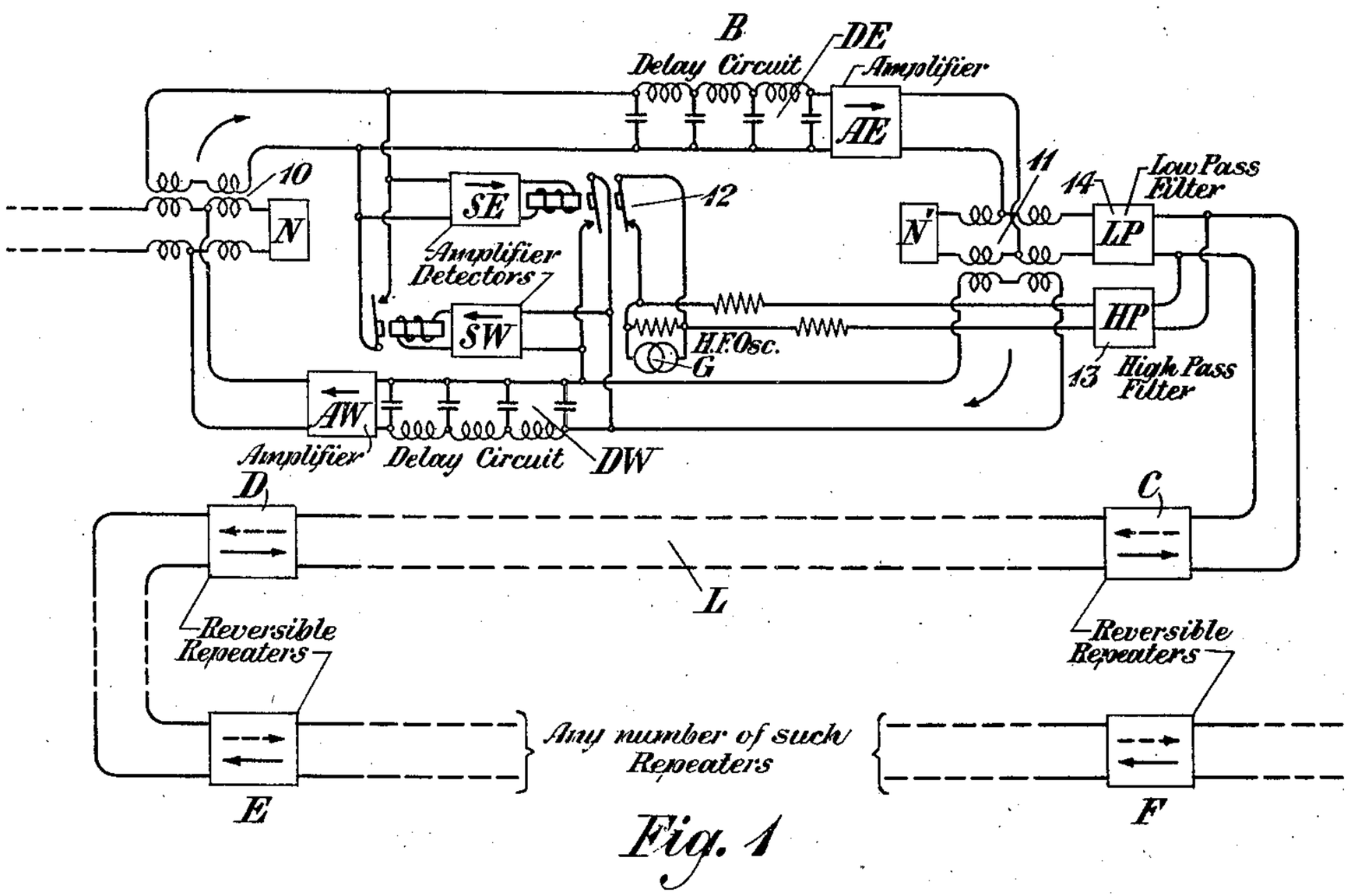

Fig. 1

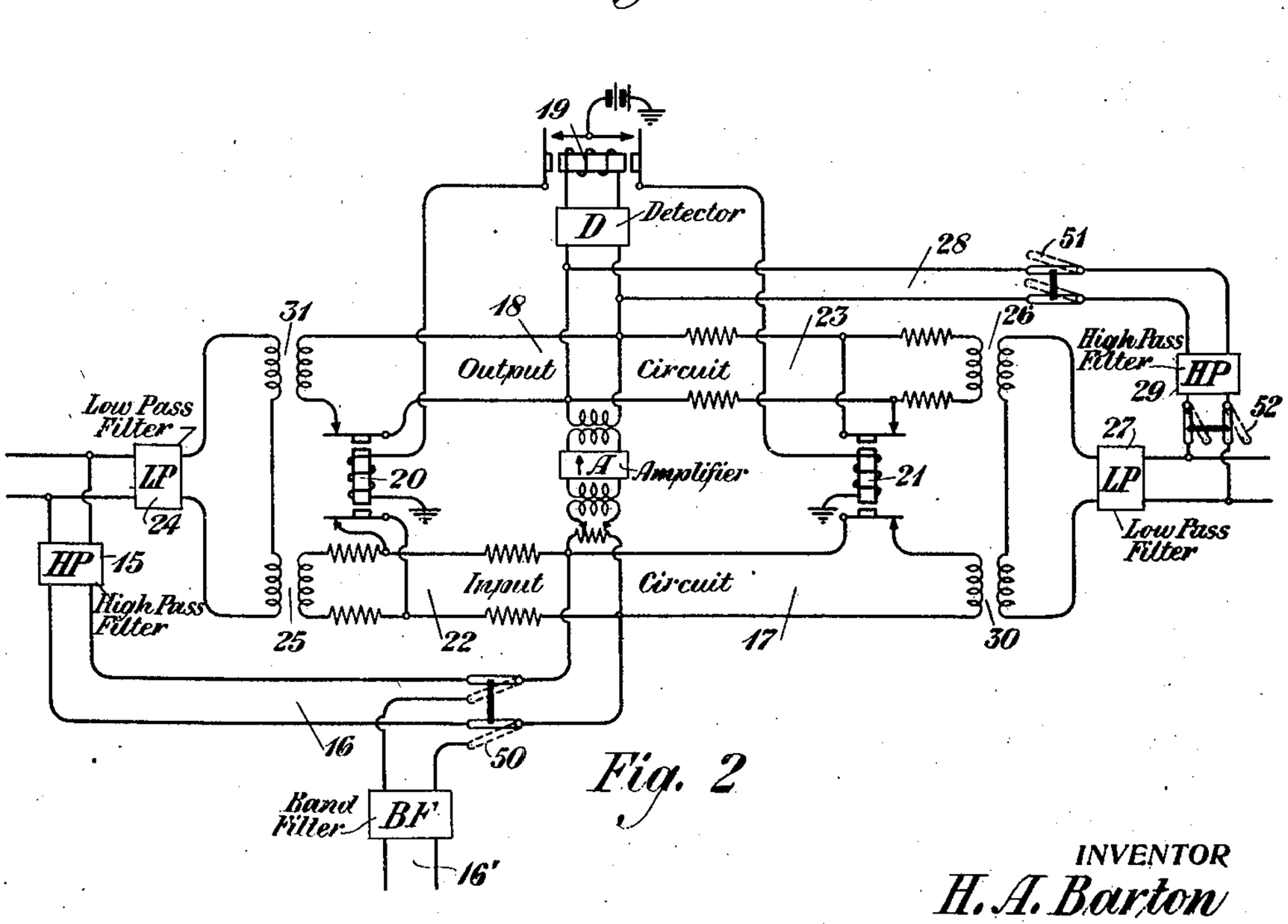

Fig. 2

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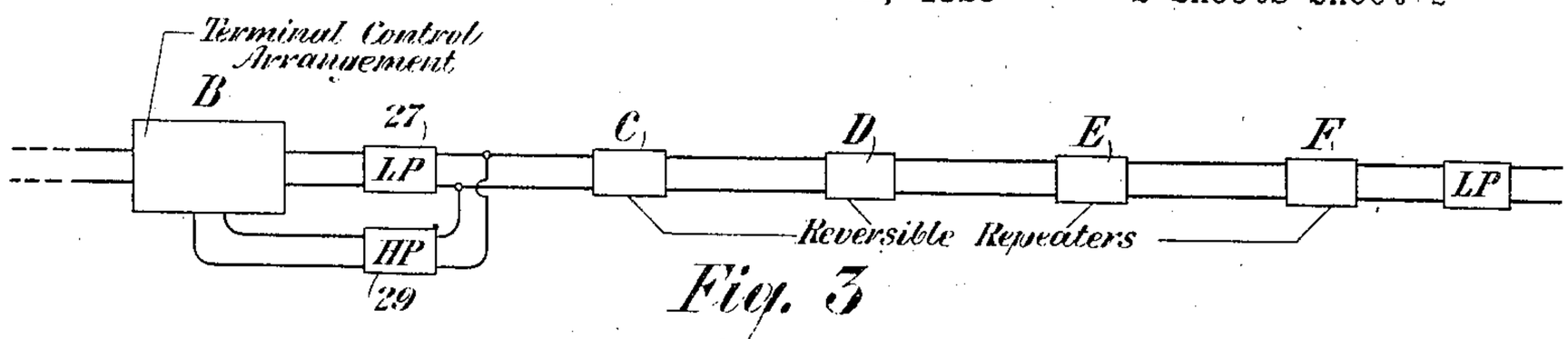

Fig. 3

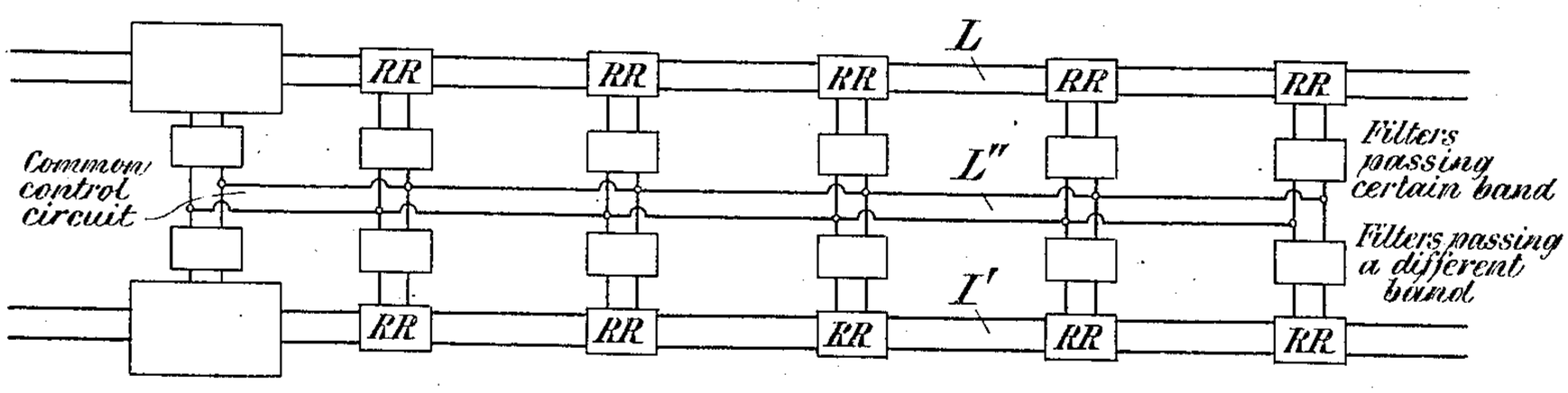

Fig. 4

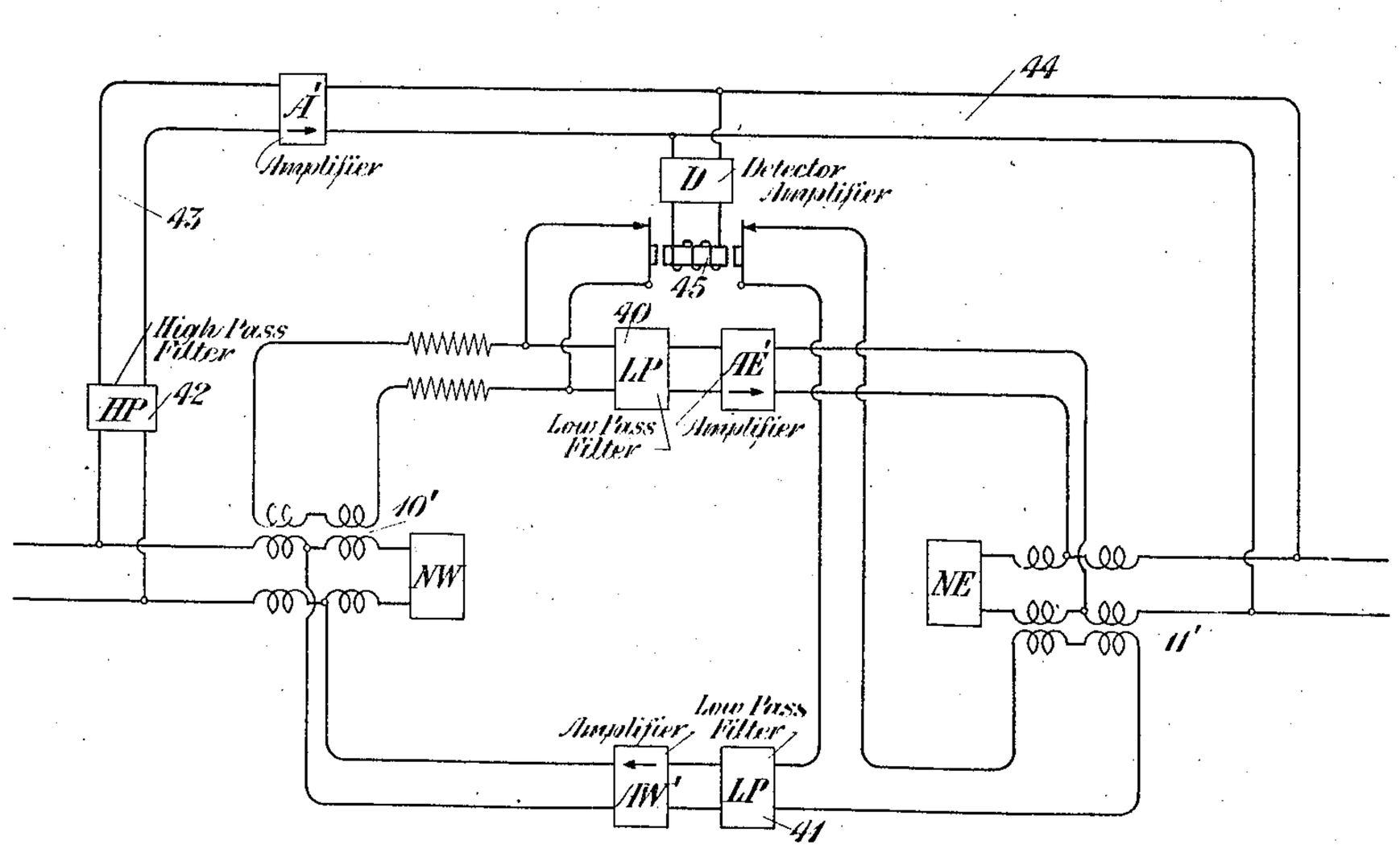

Fig. 5

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UNITED STATES PATENT OFFICE.

HENRY A. BARTON, OF PRINCETON, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

VOICE-OPERATED REPEATER SYSTEM.

Application filed October 23, 1923. Serial No. 670,313.

To all whom it may concern:

Be it known that I, HENRY A. BARTON, residing at Princeton, in the county of Mercer and State of New Jersey, have invented certain Improvements in Voice-Operated Repeater Systems, of which the following is a specification.

This invention relates to repeater systems and more particularly to a system in which one-way repeaters may be used on two-wire circuits.

Various arrangements have heretofore been proposed for operating one-way repeaters in two-wire lines, these arrangements involving the idea of switching the repeater at each repeater station under the control of the voice currents so that it will operate to repeat in the direction in which the voice currents are being transmitted. Systems of this type have heretofore been found to be impractical, however, for the reason that the time required for the switching arrangement to respond to the voice current results in suppressing the beginning of a syllable.

In accordance with the present invention it is proposed to overcome this difficulty by arranging the one-way repeaters so that they will normally be poled for transmission in one direction. In order to reverse the repeaters for transmission in the opposite direction a controlling arrangement will be provided at one terminal, which controlling arrangement, acting under the control of voice currents, will send out a special signaling current from the controlling station, this signaling current actuating switching mechanisms at each repeater point for suitably rearranging the circuit of the repeaters to reverse the direction of transmission. In order that the controlling current may be transmitted ahead of the voice current a delay network is provided at the controlling station. The voice current entering the controlling station at once actuates the operating means to transmit the controlling current to the line. The voice current itself, however, must pass through the delay network before reaching the line so that in effect the controlling current proceeds ahead as a "courier" to prepare the way for the voice currents.

This system possesses the advantages that echo and singing difficulties are eliminated (it being unnecessary to balance the repeaters) and the repeaters may be spaced about twice as far apart as in a balanced repeater system. As compared with prior voice operated repeater arrangements the system possesses the advantage that all of the repeaters are controlled in unison by the operation of the master unit located at the terminal. This master unit employs only two delay networks and voice operated relays. The switching arrangements at the repeater points are quite simple and the repeaters themselves are therefore much more simple and inexpensive than if each repeater were in itself a complete voice operated unit. The system, by arranging for the reversal of the repeaters before the voice currents arrive at the repeater points, eliminates the possibility of cutting off the initial syllable of a word.

The invention may now be more fully understood from the following description when read in connection with the accompanying drawing, Figure 1 of which shows the general layout of the system with the details of terminal control circuit, Fig. 2 of which shows the details of the repeater unit, Figs. 3 and 4 of which show schematically two different arrangements of the repeaters and Fig. 5 of which illustrates a modified form of repeater unit.

Referring to Fig. 1, a transmission line L is illustrated having a control circuit at station B and reversible repeaters at stations C, D, E and F, etc. A control circuit is only required at one terminal for the reason that the reversible repeaters are normally poled to repeat in the direction from the opposite terminal to the control terminal and the control for reversing them need only be exercised when transmitting from the control terminal.

The control circuit comprises essentially a 22-type of repeater circuit having amplifiers AE and AW connected to the line sections through hybrid coils 10 and 11, the line sections being balanced by networks N and N'. A delay circuit or network is associated with each amplifier, as indicated at DE and DW. Bridged across the repeater path east in front of the delay circuit DE is an echo suppressor unit SE. A similar echo suppressor unit SW is bridged across the path transmitting west in front of the delay circuit DW. These echo suppressor units are of a type well known in the art, the detailed arrangements being illustrated,

for example, in the application of George Crisson, Serial No. 670,741, filed October 25, 1923, and include suitable vacuum tube amplifying and rectifying apparatus for rectifying the voice currents to operate the relay. When voice currents are transmitted from west to east the suppressor SE will actuate its relay in response to the voice currents to short circuit the repeater path transmitting west so that the repeater is then only capable of transmitting from west to east. When voice currents are transmitted from east to west the suppressor SW actuates its relay to short circuit the repeater path from west to east so that the repeater will now only transmit from east to west.

The delay circuits associated with each repeater path delay the transmission of the voice currents through a given path for a sufficient time to enable the suppressor to short circuit the opposite path before the voice currents have been transmitted through the hybrid coil or echoes due to unbalance and back over the other path in the opposite direction. The suppressor SE has its relay provided with an extra contact 12, which normally short circuits a source of oscillations G. When the suppressor SE is actuated in response to voice currents transmitted from west to east, the contact 12 is opened and the generator G at once transmits oscillations of the frequency of the generator to the line L through a high pass filter 13. The frequency transmitted by the generator G acts as the controlling current to be transmitted over the line for the purpose of reversing the repeaters at the subsequent repeater stations C, D, E and F, as will be described later. The controlling current is not delayed in its transmission by any delay circuit, as is the case with the voice, and consequently is transmitted over the line before the voice current arrives at the hybrid coil. This controlling current may be either a high or low frequency but for purposes of illustration is herein referred to as a high frequency just above the voice currents but within the cut-off limits of the transmission line. During transmission from west to east the controlling frequency will be transmitted over the line along with voice currents but will be separated therefrom when necessary by means of filters, as will be described later.

The delay circuit DE should be so designed that by the time the voice wave, which operated the echo suppressor, gets through the delay circuit the controlling wave will have been transmitted over the line to reverse all of the repeaters at the subsequent stations. As will be described later, the repeaters, when reversed, remain reversed as long as the control current is transmitted and the control current will be transmitted as long as the talking continues from west to east When talking from west to east ceases, however, the repeaters return to normal ready for transmission from east to west, the return to normal taking place after a slight interval to permit the last syllable to get through the delay circuit and be transmitted. The necessary hangover interval may be provided by designing the echo suppressors in a manner well known in the art so that they will be somewhat slow in releasing their contacts. For example, the echo suppressor SE should be designed to have a sufficient hangover time to permit the last voice wave of a train of waves to pass through the delay circuit DE before the echo suppressor will actually release its contact.

In transmitting from east to west, no control current will be transmitted as there is no controlling station at the east terminal. The voice currents, however, in passing over the line to the control terminal B are transmitted through the low pass filter 14 and the hybrid coil 11 to the path transmitting west, including the delay circuit DW and the amplifier AW. The echo suppressor SW will be actuated as soon as the voice currents arrive at the input side of the delay circuit to short circuit the path transmitting east. In transmitting from east to west the reversible repeaters need not be actuated as they are normally poled for transmission in this direction and return to their normal poling as soon as transmission from west to east ceases.

The reversible repeaters to be employed at repeater points to the east of the control station B may be of the type illustrated in Fig. 2. As shown in said figure the control currents transmitted from west to east may be separated from the voice currents by the high pass filter 15 and transmitted over a circuit 16 to the amplifier A, interconnecting the input circuit 17 with the output circuit 18. The control currents, after passing through the amplifier, are transmitted to a detector D and operate a relay 19, which controls the switching operation of the repeater.

This control is exercised through two relays 20 and 21. The contacts of these relays are so arranged that normally the input circuit 22 and the output circuit 23 are short circuited to prevent transmission from west to east, while the input circuit 17 and the output circuit 18 are operated to transmit from east to west. When the relays 20 and 21 are actuated, however; input circuit 17 and output circuit 18 are opened to prevent transmission from east to west and the short circuits are removed from input circuit 22 and output circuit 23 to permit transmission from west to east. This operation depends merely upon the break of the contacts of the relays and does not depend upon the

armature being completely attracted to its make position. Consequently, the action of the relays is very fast and the delay circuit at the controlling station need not be excessively long.

A low pass filter 24 separates the voice currents transmitted from west to east from the controlling current so that the voice currents may be transmitted through the transformer 25 to the input circuit 22. After the operation of the reversible relays 20 and 21 the voice currents may then be transmitted from the amplifier A to the output circuit 23 and thence through the transformer 26 and a low pass filter 27 to the next line section. The controlling currents passing through the circuit 16 and through the amplifier A to actuate the detector D are also transmitted over the circuit 28 and through the high pass filter 29 to the line section east. It will be noted that resistances are provided in the input and output circuits where necessary to prevent short circuiting the input and output sides of the amplifier A and to prevent short circuiting the line terminals.

The operation of the system as a whole is as follows: Voice currents transmitted from the east terminal arrive at the repeater point F. Assuming that the repeater is of the type shown in Fig. 2, the voice currents pass through the low pass filter 27 (no controlling currents being transmitted in this direction) and pass through transformer 30 into the input circuit 17, this circuit being closed over the lower back contact of relay 21. The voice currents are prevented from passing into the line section west via circuit 16 by reason of the high pass filter 15 and cannot pass through the input circuit 22 to the transformer 25 by reason of the short circuit over the lower back contact of relay 20. The detector D is so arranged by tuning or otherwise as not to respond to voice currents and the short circuit across the output circuit 23 prevents the voice currents from being transmitted east through the transformer 26. The amplified voice currents therefor pass from the output circuit 18 through the transformer 31 and low pass filter 24 to the next adjacent line section west.

At the succeeding repeater stations E, D and C, similar actions take place and the voice currents finally arrive at the control station B, where they are transmitted through the low pass filter 14 and hybrid coil 11 to the delay circuit DW. The echo suppressor SW, which is bridged across the input side of the delay circuit DW, is actuated by the voice currents and short circuits the repeater path transmitting east before the initial voice wave has passed through the delay circuit DW to the amplifier AW. The voice currents, after being passed through the delay circuit, are amplified by the amplifier AW and are then transmitted to the west line terminal.

Voice currents incoming from the west terminal of Fig. 1 are transmitted to the input side of the delay circuit DE and operate the echo suppressor SE to short circuit the repeater path in the opposite direction. At the same time the contact 12 is opened and the control frequency from the generator G is transmitted through the filter 13 to the line L. The control frequency is transmitted to the line L before the voice currents have been transmitted through the delay circuit to the amplifier AE. As the control frequency is transmitted over the line and arrives at the repeater station C, it is selected by a high pass filter 15 into the circuit 16 and impressed upon the amplifier A. The control frequency is amplified by the amplifier A and transmitted to the detector D. The detector D rectifies the control frequency, thereby actuating the relay 19, which completes circuits for relays 20 and 21. These relays, as soon as they break their contacts, rearrange the circuit of the repeater so that it now transmits from west to east. The upper contact of relay 20 opens the output circuit 18 and lower contact of relay 20 removes the short circuit from the input 22. At the same time the lower contact of relay 21 opens the input circuit 17 and the upper contact removes the short circuit from output 23. A part of the amplified controlling current is transmitted over the circuit 28 through the high pass filter 29 and passes along over the line L to the switching repeater at the next station.

The voice frequency incoming to the repeater station just discussed passes through the low pass filter 24 through transformer 25 and into input circuit 22, from which circuit it is impressed upon the amplifier A. After being amplified the voice energy passes through the output circuit 23 and the transformer 26 and thence through the low pass filter 27 to the line to be transmitted to the next repeater, which in the meantime will have been reversed by the control current. This operation is continued until the last repeater station has been passed and the voice currents are impressed upon the terminal line.

The schematic arrangement of the circuit just described is indicated in Fig. 3, in which the rectangle at B designates the terminal control arrangement and the rectangles at C, D, E and F represent reversible repeaters which may be of the type shown in Fig. 2. Between the last reversible repeater and the terminal line a low pass filter may be inserted, as indicated, this being for the purpose of preventing the control frequency from being transmitted over the terminal line.

While, as already stated, the control fre-

quency may be either below or above the voice range it is possible to use different control frequencies for different circuits and if desired, all of the control frequencies may be above the voice range. By transmitting the control frequency over a separate control circuit a common control circuit may be used for controlling the repeaters of a number of lines. An arrangement of this character is shown in Fig. 4, in which L and L′ are transmission lines provided with reversible repeaters at the points designated RR, each line having a terminal control arrangement at the point corresponding to station B of Fig 3. The control frequency sent out by each control arrangement will be different and will be passed through a suitable band filter to a common control line L″. The control frequencies sent out along the line L″ are selected at each repeater station through proper band filters and are impressed upon the controlling apparatus of the reversible repeater arrangement at each station. The reversible repeater apparatus may be as shown in Fig. 2, the circuit 16 in this case being, however, opened by switch 50 and the input of amplifier A connected by circuit 16′ through the band filter BF to the control line L″ instead of to the transmission line over which the voice currents are transmitted. As circuit 28 and filter 29 are not necessary when used in the system of Fig. 4 these elements may be cut out by means of switches 51 and 52.

Fig. 5 shows another arrangement of reversible repeater which may be used instead of the reversible repeater of Fig. 2. In this case the repeater is provided with two amplifiers, one amplifier AE′ being used for transmission from west to east and the other amplifier AW′ being used for transmission from east to west. These amplifiers are associated with the line terminals through hybrid coils 10′ and 11′, the line terminals being balanced by suitable network such as NW and NE. Low pass filters 40 and 41 are included in the amplifier paths to prevent the control frequencies from entering the repeater paths. The control frequency is carried through a high pass filter 42 into a circuit 43, which includes an amplifier A′. The output circuit 44 of the amplifier is connected to the east line terminal.

A detector amplifier arrangement D is bridged across the circuit 44 and controls by means of a relay 45 the two repeater paths. Normally, with the relay deenergized, the lower repeater path is closed at the right-hand back contact of the relay so that transmission may take place from east to west, while the upper repeater path is short circuited at the left-hand back contact of the relay to prevent transmission from west to east. When the control current arrives, however, and passes into the circuit 43, the detector D is operated to energize the relay 45, which opens the lower repeater path to prevent transmission from east to west and at the same time opens the short circuit across the upper repeater path. Transmission may now take place from west to east.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. A repeater system comprising reversible repeaters at points along a transmission line, means associated with each repeater to reverse the direction of such repeater in response to an alternating control current, a terminal control station, and means at said control station responsive to voice currents to transmit an alternating control current to the reversible repeaters.

2. A repeater system comprising reversible repeaters at points along a transmission line, means associated with each repeater to reverse the direction of such repeater in response to a control current, a terminal control station, means at said control station responsive to voice currents to transmit a control current to the reversible repeaters, and means to delay the transmission of the voice currents until the control current has been transmited.

3. In a repeater system, a plurality of reversible repeaters at points along a transmission line, said repeaters normally transmitting in one direction, means associated with said repeaters to reverse the direction of transmission thereof in response to an alternating control current and to restore the repeaters to their normal condition when the control current ceases, a terminal control station, and means at said station responsive to voice currents for transmitting an alternating controlling current to the reversible repeaters.

4. In a repeater system, a plurality of reversible repeaters at points along a transmission line, said repeaters normally transmitting in one direction, means associated with said repeaters to reverse the direction of transmission thereof in response to a control current and to restore the repeaters to their normal condition when the control current ceases, a terminal control station, means at said station responsive to voice currents for transmitting a controlling current to the reversible repeaters, and means to delay the transmission of the voice frequencies to the reversible repeaters until after the control current has been transmitted.

5. A repeater system comprising a plurality of reversible repeaters at points along a transmission line, said repeaters being arranged to transmit normally in one direction,

switching means associated with said repeaters for rearranging the circuits so as to transmit in the opposite direction, controlling means for said switching means responsive to alternating controlling currents, a terminal controlling station, and means at said controlling station responsive to voice currents for transmitting alternating controlling currents to said reversible repeaters.

6. A repeater system comprising a plurality of reversible repeaters at points along a transmission line, said repeaters being arranged to transmit normally in one direction, switching means associated with said repeaters for rearranging the circuits so as to transmit in the opposite direction, controlling means for said switching means responsive to controlling currents, a terminal controlling station, means at said controlling station responsive to voice currents for transmitting controlling currents to said reversible repeaters, and means to delay the transmission of voice currents from said controlling station until after the controlling currents have been transmitted.

7. A repeater system comprising reversible repeaters at different points along a transmission line, means associated with each repeater for reversing the direction thereof in response to controlling currents, a terminal controlling station comprising a two-way repeater circuit having one path for transmission in one direction and the other path for transmission in the opposite direction, delay circuits in each path, voice operated means associated with each path on the input side of the delay circuit to render the opposite path inoperative and means controlled by said voice operating means to transmit a controlling current to the reversible repeaters.

8. A repeater system comprising reversible repeaters at different points along a transmission line, means associated with each repeater for reversing the direction thereof in response to controlling currents, a terminal controlling station comprising a two-repeater circuit having one path for transmission in one direction and the other path for transmission in the opposite direction, delay circuits in each path, voice operated means associated with each path on the input side of the delay circuit to render the opposite path inoperative. and means controlled by said voice operated means to transmit a controlling current to the reversible repeaters, said last mentioned means being effective to transmit said controlling currents before the voice currents have passed the delay circuit.

In testimony whereof, I have signed my name to this specification this 17th day of October 1923.

HENRY A. BARTON.