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H. D. ARNOLD

TWO-WAY REPEATER CIRCUITS

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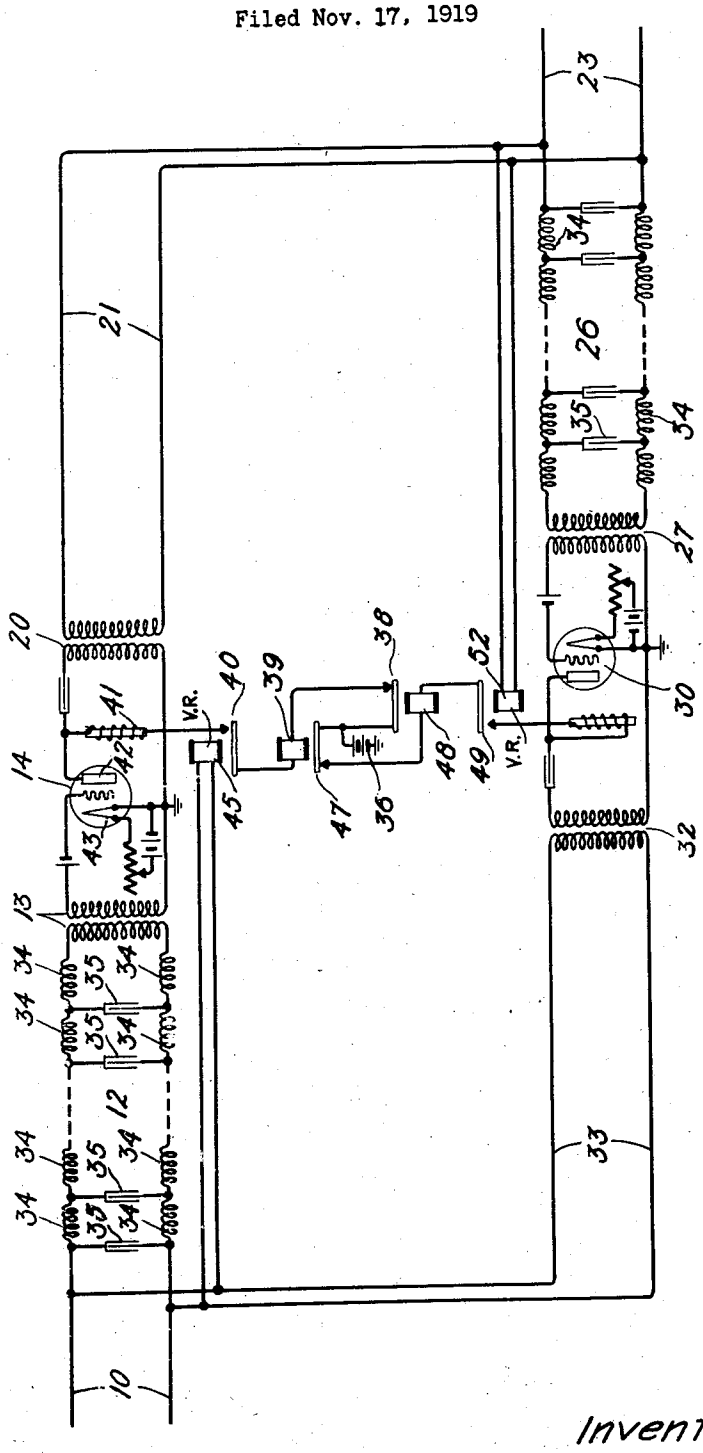

Inventor:
Harold D. Arnold
by [signature] Atty.

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UNITED STATES PATENT OFFICE.

HAROLD D. ARNOLD, OF MAPLEWOOD, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TWO-WAY REPEATER CIRCUITS.

Application filed November 17, 1919. Serial No. 338,759.

To all whom it may concern:

Be it known that I, HAROLD DE F. ARNOLD, a citizen of the United States, residing at Maplewood, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Two-Way Repeater Circuits, of which the following is a full, clear, concise, and exact description.

This invention relates to repeater circuits and methods of operation and more particularly to two-way repeater circuits, which, when in use, are conditioned to give good transmission in one direction and to give zero or very poor transmission in the opposite direction.

Various two-way repeater circuits of the above character have been devised, some of which employ two oppositely directed repeaters and some of which employ a single repeater which is adapted to be directed in either direction according as the signaling current is coming from one direction or the other. The circuit shown herein is of the type employing two oppositely directed repeaters, but it will be apparent from the following description that the invention in its broader aspects is not limited to the particular type of repeater circuit shown.

In the usual operation of circuits of the above types, a relay is actuated by incoming signal currents, such as voice currents, for conditioning the repeater to transmit in the direction in which the signal currents are flowing. A disadvantage heretofore encountered has been that on account of the relatively slow mechanical movements of the relay the apparatus was not put in condition to repeat until the first part of the message had been lost, or, in case a telephone message comprised only a single word, it might not be transmitted at all.

It is an object of this invention to provide an arrangement which will permit the use of incoming signaling currents for putting a repeater in the desired operative condition without causing the loss of any part of the incoming signals.

This object is accomplished by interposing a delay circuit between the incoming line and the repeater. The connections from the line to the signal operated relay are made at points in advance of the delay circuit. The time constant of the delay circuit is so chosen that the signaling currents will not reach the input side of the repeater until the means for putting it in operative condition has been operated by the relay. Similarly, upon the termination of a message, the time lag of the relay may be such that the repeater is not rendered inoperative until the last part of the message has traversed the delay circuit and has been transmitted by the repeater.

The delay circuit may also serve the purpose of insuring that the relay connected to the incoming line will be actuated before the relay connected to the outgoing line can be actuated.

The delay circuit, as shown, is in the form of a loaded line having series inductance and shunt capacity. The manner in which a loaded line acts to slow down transmission is discussed in U. S. Patent to Pupin #652,231, dated June 19, 1900, to which reference is hereby made for the theoretical considerations contained therein.

The invention further resides in the circuits and arrangements disclosed herein, a more complete understanding of which will be had from the following detailed description and claims taken in connection with the accompanying drawing.

The view in the drawing is a diagrammatic circuit of a two-way repeater embodying the invention.

Referring to the drawing by reference numerals, the line 10 is connected through loaded line 12, transformer 13, vacuum tube repeater 14, transformer 20, and circuit 21 to the line 23. This forms a unidirectional path for transmission in one direction. The

path for transmission in the opposite direction is traced from line 23 through loaded line 26, transformer 27, repeater 30, transformer 32, and circuit 33 to line 10. Loaded lines 12 and 26 are substantially similar and comprise series inductances 34 and shunt condensers 35.

Space current for repeater 14 is supplied by source of current 36, the circuit for which comprises contact 38, relay winding 39, contact 40, choke coil 41, anode 42, cathode 43 and ground. For controlling contact 40 there is provided relay 45, which may, if the repeater is employed for telephonic transmission, be a voice operated relay of any desired type. Relay 45 is connected to line 10 and may include any suitable means for amplifying the currents supplied thereto.

Space current for the other repeater 30 is also supplied by source 36 through contact 47, winding 48 and contact 49. Contact 49 is controlled by signal or voice operated relay 52 which is similar to relay 45. Contacts 40 and 49 are normally open and contacts 38 and 47 are normally closed.

In the operation of the circuit, assume that a speech message comes in on line 10. Relay 45 is energized and contact 40 is closed. This closes the circuit for source 36 through the evacuated space of repeater 14 thus putting the repeater in condition for efficiently repeating and amplifying the incoming message. As soon as current begins to flow in the circuit, contact 47 is opened through the action of relay 39 and the repeater 30 is prevented from becoming operative, even though the contact 49 may be subsequently closed.

Due to the inertia of the mechanical parts of relay 45 and contact 40, a time lag intervenes before the repeater 14 is put in operative condition. If the repeater were directly connected to the line this would result in the cutting off of and the loss of the first part of the message. The function of the loaded line 12 is then to delay the message for a length of time equal to the time lag of the relay 45. As ordinarily regarded, the effect of the inductances 34 in the loaded line is analogous to the inertia of moving mechanical parts and this effect is to slow down the passage of electric waves attempting to pass therethrough. The energy of the incoming wave is stored up in the electromagnetic field surrounding the inductances and, after a definite time interval, this energy is discharged as a current flowing in the original direction.

At the termination of the message, the relay 45 will be deenergized and contact 40 opened, and upon the cessation of direct current through the winding 39 the contact 47 is permitted to close. Thus the repeater circuit as a whole is restored to its original condition and incoming signals coming from either line 10 or line 23 may energize the respective repeater, to the exclusion of the oppositely directed repeater, for the transmission of the signals in the desired direction.

Since both repeaters are never in condition for operation at the same time, singing of the repeater set is impossible and it is also impossible for a signal current being transmitted in one direction to be reflected back through the oppositely directed repeater so as to be heard by the sender.

While one embodiment of the invention has been shown and described in detail, it is to be understood that the invention is generic in character and is entitled to the use of equivalents within the scope of the appended claims.

What is claimed is:

1. The method of operating a repeater, which comprises putting said repeater in condition for repeating in response to signal currents to be repeated, delaying the flow of said signal currents to said repeater until said repeater is in condition for repeating, and then supplying said delayed currents to said repeater.

2. The method of operating a two-way repeater, which comprises putting said repeater in condition for repeating in one direction only in response to signal currents to be repeated, delaying the flow of said signal currents to said repeater until said repeater is in condition for repeating, and then supplying said delayed currents to said repeater.

3. The method of operating a repeater which comprises putting said repeater in condition for repeating in response to signal currents, storing up the energy of said signal currents, and impressing said stored up energy on said repeater after it has been put in condition for repeating.

4. In combination, a repeater, means operated in response to signal currents for conditioning said repeater for operation and means for delaying the flow of said signal currents to said repeater and forwarding said currents to said repeater after said conditioning means has operated.

5. In combination, a two-way repeater, means operated in response to signal currents for conditioning said repeater for transmission in one direction only, and means for delaying the flow of said signal currents to said repeater and forwarding said currents to said repeater after said conditioning means has operated.

6. In combination, a line, a repeater station comprising a repeater connected to said line, apparatus at said station requiring an appreciable time to be traversed by electric currents, and a relay for controlling said

repeater, said relay being connected to said line at points separated from said repeater by said apparatus.

7. In combination, a line, a repeater connected thereto, a relay for controlling said repeater in response to signal currents in said line, and a normally closed delay circuit interposed between said line and said repeater, said relay being connected so as to receive signal currents prior to their passage through said circuit.

8. In combination, a line, a repeater connected thereto, a relay for controlling said repeater in response to signal currents in said line, and a normally closed circuit comprising inductance for delaying the passage of signal currents from said line to said repeater, said relay being connected so as to receive signal currents prior to their passage through said circuit.

9. In combination, a line, a repeater connected thereto, a relay for controlling said repeater in response to signal currents in said line, and means comprising a plurality of series inductances and shunt capacities for delaying the passage of signal currents from said line to said repeater, said relay being connected so as to receive signal currents prior to their passage through said means.

10. A two-way repeater circuit, comprising a plurality of oppositely directed unidirectional repeaters, means normally reducing the efficiency of one of said repeaters, and means operated by incoming voice currents for rendering said reducing means inoperative.

11. A two-way repeater circuit, comprising a plurality of oppositely directed uni-directional repeaters for repeating incoming signal waves, one of said repeaters being normally inoperative, and means responsive to said waves for rendering said repeater operative.

12. In combination, two lines, two oppositely directed uni-directional repeaters connected therebetween, one of said repeaters having its efficiency normally reduced, and means responsive to voice currents in one of said lines for rendering said repeater fully efficient.

13. In combination, two lines, two oppositely directed unidirectional repeaters connected to repeat signal waves therebetween, one of said repeaters having its efficiency normally reduced, means responsive to said waves in one of said lines for rendering said repeater fully efficient, and a delay path between said line and said repeater and between said means and said repeater.

14. In combination, a line, a repeater, a circuit comprising a source of direct current for energizing said repeater, said circuit being normally open, and means actuated in response to signal currents in said line for closing said circuit.

15. In combination, a line, a repeater, a circuit comprising a source of direct current for energizing said repeater, said circuit being normally open, means actuated in response to signal currents in said line for closing said circuit, and a delay circuit between said line and said repeater.

16. In combination, two lines, two oppositely directed repeaters therebetween, a circuit comprising a source of direct current for energizing each of said repeaters, said circuits being normally open, means actuated in response to signal currents in one of said lines for closing one of said circuits, and means controlled by said last mentioned means for maintaining the other of said circuits open.

17. In combination, two lines, two oppositely directed repeaters therebetween, circuits for supplying direct current to said repeaters, each of said circuits having a normally closed and a normally open contact in series therein, and means actuated in response to signal currents in one of said lines for closing the open contact in one of said circuits and opening the closed contact in the other of said circuits.

18. In combination, two lines, two oppositely directed normally inoperative repeaters therebetween, and means controlled by signal currents in one of said lines for rendering one of said repeaters operative and for maintaining the other of said repeaters inoperative.

19. In combination, two lines, two oppositely directed normally inoperative repeaters therebetween, means controlled by signal currents for rendering one of said repeaters operative and for maintaining the other of said repeaters inoperative, and current delaying means interposed between said line and said first repeater.

20. In combination, a line, a repeater, a relay for controlling said repeater, said relay having a connection to said line, and an artificial line comprising shunt and series impedances, between said connection and said repeater.

21. In combination, a line, a repeater, a voice operated relay for controlling said repeater, said relay having a connection to said line, and an artificial line comprising shunt and series impedances, between said connection and said repeater.

22. A two-way repeater circuit comprising a plurality of oppositely directed, unidirectional, space discharge repeaters for repeating incoming signal waves, one of said unidirectional repeaters normally having zero space current, and means responsive to said waves for causing space current to flow in said repeater.

23. A transmission system comprising a circuit for transmitting in opposite directions, two unidirectional, oppositely directed repeating paths for transmitting to and from said circuit, respectively, means operable to alter the transmitting efficiency of the path in one direction, means responsive to flow of voice current energy in the other direction for operating said first means, and means comprising a movable contact maintaining said transmitting efficiency in said one direction low during a time interval following initiation of restoration of said first means to its unoperated condition.

24. A transmission system comprising a circuit for transmitting in opposite directions, two unidirectional, oppositely directed paths for transmitting to and from said circuit, respectively, a circuit comprising means for controlling the transmitting efficiency of the path in one direction, and two relays, both controlled by transmission in the other direction, each of said relays having a contact and said contacts being in series in said last mentioned circuit.

25. A transmission system comprising a circuit for transmitting in opposite directions, two unidirectional, oppositely directed repeating paths for transmitting to and from said circuit, respectively, a circuit comprising means for controlling the transmitting efficiency of the path in one direction, two voice current responsive relays, each having a contact and said contacts being in series in said last mentioned circuit, and means for causing one of said relays to open its said contact and the other to close its said contact, upon flow of voice current energy in said other direction.

26. In combination, a wave motion propagating path extending from one point to another, means deriving energy of waves from said path at said one point, and means operating in response to said derived energy and comprising a switch contact controlling the transmitting efficiency of said path at said other point, said path comprising a transmission retarding path delaying waves of the frequency of said first mentioned waves during their passage through said retarding path at least an amount approximately equal to the time required for said means to effect its transmission efficiency controlling action in response to said derived energy, and said retarding path having all of its parts at the same geographical location.

27. In combination, a wave propagation path and means responsive to waves at one point in their propagation along said path for controlling the transmitting efficiency of said path at another point thereof but only after a substantial time subsequent to the arrival of said waves at said one point, said path comprising a wave retarding path delaying, with negligible attenuation, waves of the frequency of said first mentioned waves in their propagation along said retarding path by at least an amount of the order of said time required for said controlling action of said means to be effected.

28. A transmission system comprising a wave propagation path, and means movable, under the control of energy derived from voice current waves at one portion of said path, for controlling the transmitting efficiency of said path at another portion thereof, the part of said path between said portions comprising a transmission retarding path delaying waves of voice frequency while propagating them along said retarding path, by at least an amount of the order of the time required for said means to effect said control of the transmitting efficiency of said path, and said retarding path having substantially negligible length compared to that of said system.

29. A transmission system comprising a wave propagation path and means responsive to waves at one point in their propagation along said path for controlling the transmitting efficiency of said path at another point thereof but only after a substantial time subsequent to the arrival of said waves at said one point, said path comprising a wave retarding path delaying waves of the frequency of said first mentioned waves in their propagation along said retarding path by at least an amount of the order of said time required for said controlling action of said means to be effected, said retarding path having a propagating speed for waves of said frequency, low in comparison to the average propagating speed of the remainder of said system for waves of said frequency.

30. A transmission system comprising a circuit for transmitting in opposite directions, two unidirectional, oppositely directed paths for transmitting to and from said circuit, respectively, means normally reducing the transmitting efficiency of the path in one direction, and means responsive to transmission in said one direction for increasing the transmitting efficiency of the path in that direction and preventing transmission through the path in the other direction, said path in said one direction comprising a transmission retarding portion for delaying transmission during its passage through said portion at least an amount of the order of the time required for said increase of transmitting efficiency, and said portion having all of its parts at the same geographical location.

31. A transmission system comprising a circuit for transmitting in opposite directions, two unidirectional, oppositely directed paths for transmitting to and from said circuit, respectively, means normally reduc-

ing the transmitting efficiency of the path in one direction, means responsive to transmission in said one direction for increasing the transmitting efficiency of the path in that direction and preventing transmission through the path in the other direction, and means responsive to transmission in said other direction for preventing the flow of that transmission from causing said second mentioned means to increase the transmitting efficiency of said path in said one direction, said path in said one direction comprising a transmission retarding portion for delaying transmission during its passage through said portion at least an amount of the order of the time required for said first mentioned increase of transmitting efficiency, and said portion having all of its parts at the same geographical location.

In witness whereof, I hereunto subscribe my name this 13th day of November A. D., 1919.

HAROLD D. ARNOLD.