

Dec. 13, 1949

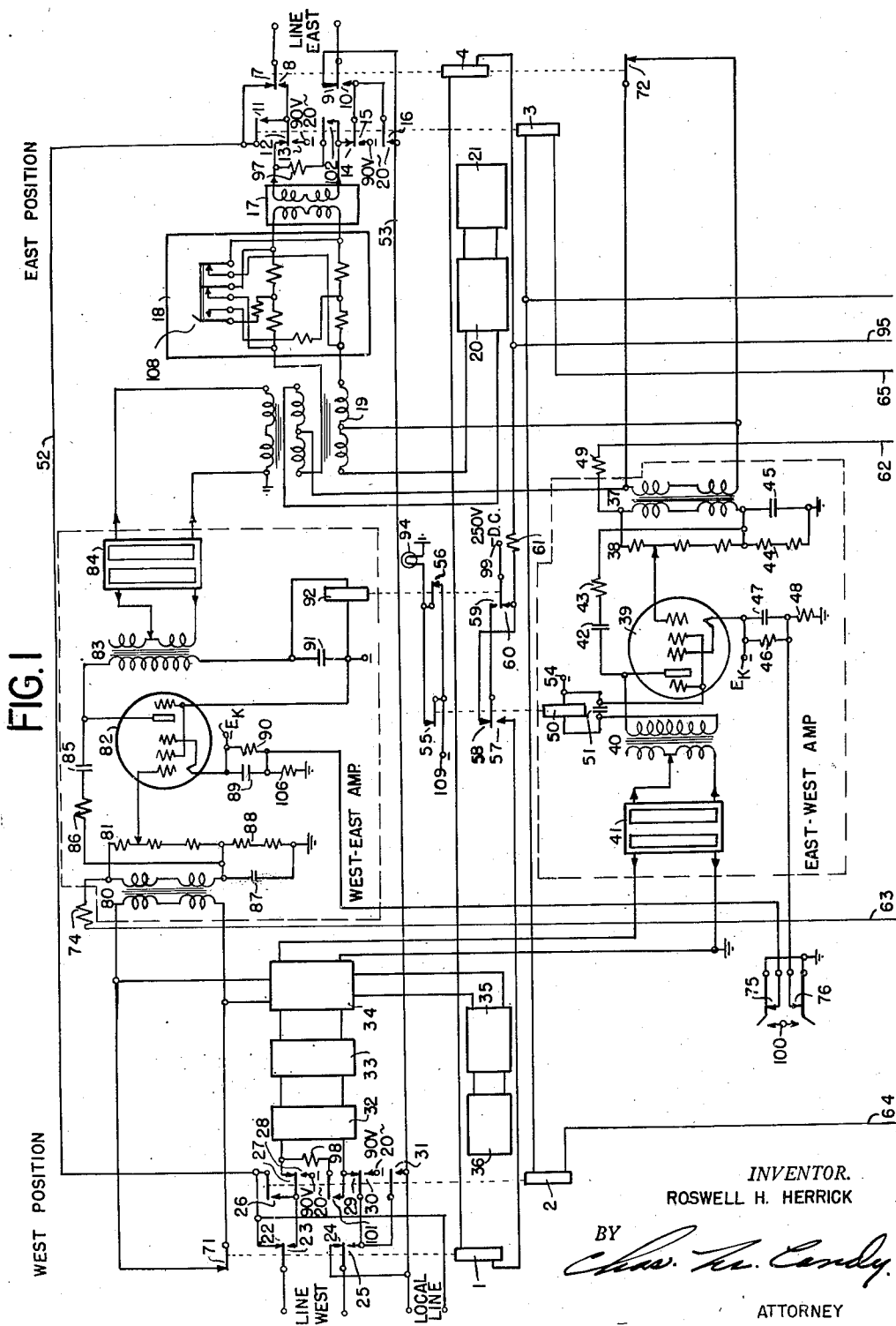
R. H. HERRICK

2,491,263

RINGING SYSTEM FOR VOICE CURRENT REPEATERS

Filed Nov. 1, 1946

2 Sheets-Sheet 1



Dec. 13, 1949

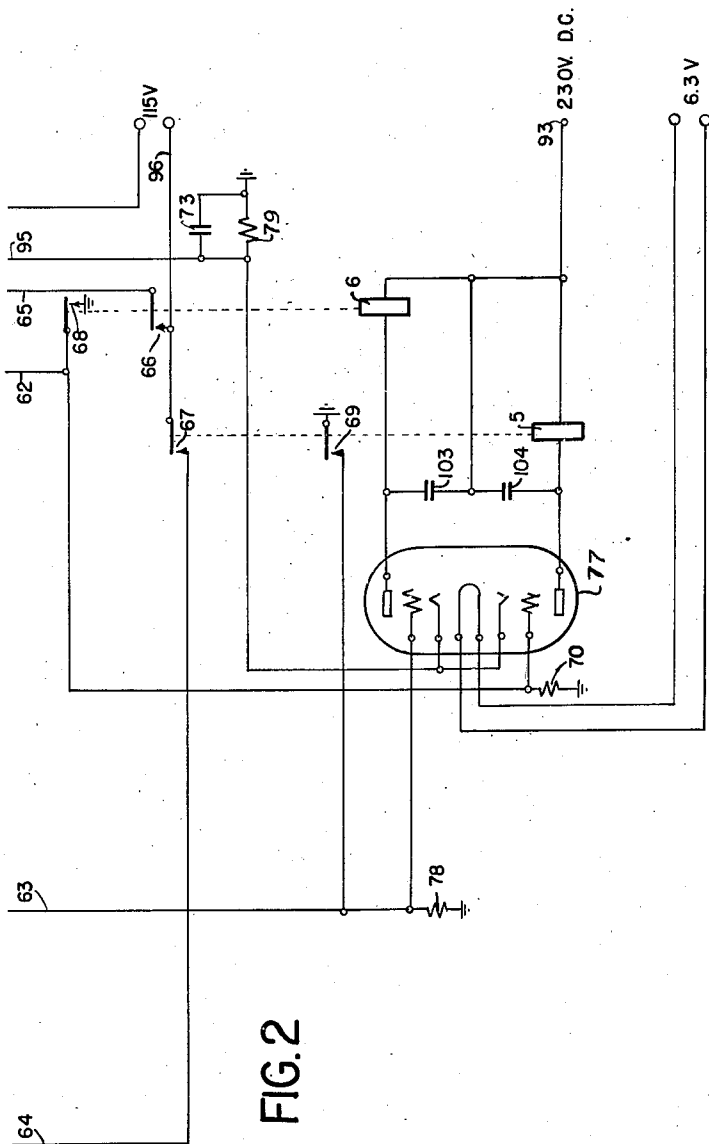
R. H. HERRICK

2,491,263

RINGING SYSTEM FOR VOICE CURRENT REPEATERS

Filed Nov. 1, 1946

2 Sheets-Sheet 2



INVENTOR.
ROSWELL H. HERRICK

BY

BY
Chas. M. Condy

ATTORNEY

UNITED STATES PATENT OFFICE

2,491,263

RINGING SYSTEM FOR VOICE CURRENT REPEATERS

Roswell H. Herrick, Lorain, Ohio, assignor to Automatic Electric Laboratories, Inc., Chicago, Ill., a corporation of Delaware

Application November 1, 1946, Serial No. 707,100

12 Claims. (Cl. 179-84)

1

The present invention relates in general to two-way transmission systems which employ separate amplifying means for transmitting signals in each direction and is concerned more particularly with new and useful improvements in the ringing systems of voice current repeaters.

It is an object of this invention to provide an improved ringing circuit for use in a standard 22-type telephone repeater.

It is a further object of this invention to utilize this new ringing circuit in conjunction with an improved method of frequency characteristic control in a standard 22-type telephone repeater.

A feature of this invention is to provide facilities in a repeater system of the standard 22-type telephone repeater for transmitting ringing signals.

Another feature of the invention is the manner in which it is possible to ring through one of the repeater channels and at the same time disable the complementary repeater channel thereby avoiding introduction of a singing disturbance in the complementary channel due to imperfect line balance.

It is still another feature of the invention to provide for a pair of leads connected between the repeater and a local exchange thereby establishing a three exchange ringing system for use in a telephone system employing a repeater. In conjunction with this local circuit, another feature of this invention is the manner in which the by-pass circuit is used as part of the ringing circuit.

Another feature of the invention is the manner in which the ringing control circuit is maintained energized when the repeater system is removed from the line and the connection switched through a by-pass channel in the event of either a tube or power supply failure in the amplifier. The channel switching feature utilized in conjunction with this ringing control circuit is disclosed in Roswell H. Herrick's co-pending application Serial No. 711,962 filed November 23, 1946.

A further feature of the invention is the manner in which the ringing control circuit is connected to the amplifiers at their input transformers thereby increasing signal potential for use with the two-section triode tube without disturbing hybrid balance and without the expense of a second transformer.

Novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention, together with further objects and features thereof, will best be understood by reference to the following

2

specification, taken in connection with the accompanying drawings, in which Figure 1 and Figure 2 when placed together as specified, illustrate a telephone repeater system having incorporated therein the features of the invention as briefly outlined above.

Referring now to the drawings, Figure 1 shows a conventional "22 type" repeater, that is, there are two distinct one-way amplifiers arranged for use with an ordinary two-way telephone circuit. In addition to the repeater circuit, Figure 2 shows a ringing control circuit with conductors therebetween. The system, briefly consists of a repeater circuit, a ringing control circuit and a repeater by-pass channel.

The repeater is comprised of an east and west position, an east-west channel, and west-east channel. The line terminals are located at the east and west positions. When the line circuit enters the east position from the east lines, it will be connected to the line terminals at the west position either through the repeater by-pass channel or the east-west channel. The line voice current entering the west position from the west line terminals will be connected to the east line terminals either through the west-east channel or the repeater by-pass channel.

The by-pass channel is comprised of contacts 7 and 9, conductors 52 and 53, and contacts 22 and 24. The east-west channel consists of contacts 8 and 10, 12 and 14, repeating coil 17, balancing pads 18, hybrid system 19, east-west amplifier, hybrid system 34, balancing pad 33, repeating coil 32, contacts 27 and 29, and contacts 23 and 25. The west-east channel is comprised of contacts 23, 25 and 27, 29, repeater coil 32, balance pads 33 and 35, balancing network for the west line 36, hybrid system 34, west-east amplifier, hybrid system 19, balance pads 18 and 20, balance network for east line 21, repeater coil 17, contacts 12 and 14 and contacts 8 and 10.

The ringing control circuit consists of a two section triode tube 77, resistors 49, 70, 74, 78, 79, condensers 73, 103, 104, relays 1, 2, 3, 4, 5, and 6 and their associated contacts. The contacts of relays 5 and 6 are respectively 67, 69 and 66, 68 and are located in the ringing control circuit. Contacts 22, 23, 24, 25, 71 and 7, 8, 9, 40, 12 are associated respectively with relays 1 and 4 and are connected in the repeater circuit at the east and west positions. Relays 2 and 3, likewise, have their contacts 26, 27, 28, 29, 30, 31 and 11, 12, 13, 14, 15, 16 respectively positioned in the repeater circuit. The ringing control cir-

cuit also includes a ring-in east path associated with a control circuit for the ring-out west, and a ring-in west path associated with a control circuit for the ring-out east.

The ring-in east path includes the east-west channel from the east line terminals through the secondary winding of the input transformer 37 at which point it passes through resistor 49, conductor 62, resistor 70, and the grid of the lower section of tube 77, thereby causing the completion of the path from a source of potential 93 through relay 5 and the lower section of tube 77. The ring-out west control circuit, which is utilized in combination with the ring-in east path, consists of an alternating current source of potential 96, contact 67, and relay 2. The path for a ringing signal from the west position is through the west-east channel to the secondary winding of the input transformer 80 and continues through resistor 74 conductor 63, the upper section of tube 77 and completes another path from the source of potential 93 through relay 6. The associated ring-out east control circuit is composed of contact 66, conductor 65, relay 3, and an alternating current source of potential 96.

Referring now more particularly to the operation of the system in the transmission of signals from the east position for repeated transmission to the west position. Assuming the repeater in the normally operated position relay 50 in the east amplifier and relay 92 in the west amplifier will be energized. The current paths of the energizing circuits are essentially the anode circuits of the tubes and more specifically for relay 50, from the high voltage source 54 through the relay 50, the primary winding of the coupling transformer 40, the anode-cathode circuit of amplifier tube 39, the resistance 46, and contact 76 to ground. An identical path is traceable for relay 92 in the west amplifier. Relays 50 and 92, therefore, at their respective contacts 57 and 59 complete a circuit in the ringing control system from the high voltage source 99, through relays 1 and 4 in series, through resistor 79 in shunt of condenser 73 to ground. Resistor 79 is of a predetermined value and effective in conjunction with either relays 1 and 4 or resistance 61 to supply the proper cathode bias to the two sections of tube 77. Relays 1 and 4 are therefore normally energized and at their respective contacts 23, 25 and 8, 10 connect the east and west lines to the repeater. Additionally, on operating, relays 1 and 4 remove the short circuit imposed on the repeater systems at their contacts 71 and 72.

Assume a ringing signal is received over the east line from a distant exchange and passes over contacts 8 and 10, 12 and 14, through repeating coil 17, balance pad 18, hybrid system 19, to the input transformer 37, where the signal voltage is increased for use with the high impedance grid circuit of tube 77. The signal, unable to pass further through the east-west amplifier circuit because of filter 41 travels over resistance 49 and conductor 62 to resistance 70 and ground. As a result of the incoming signal received through resistances 49 and 70, the required voltage is impressed upon the lower grid of tube 77 thereby causing the tube to become conductive and further complete the circuit of relay 5 from the source of potential 93. The value of current through the relay is a function of ringing signal frequency which is of an alternating current nature. A condenser 104 is placed in parallel with relay 5 to maintain the relay energized for the entire period

of time that the incoming signal is effective. Relay 5 at its contacts 69 places a ground on the west repeater and thereby prevents the signal from initiating a singing disturbance within that circuit, and at its contacts 67 completes a circuit from the 115 volt source to relay 2. Relay 2 operates and at its contacts 27 and 29 breaks the line connection to the repeater channels and at its contacts 28 and 30 in the west position applies a 20 cycle signal to the west line through contacts 23 and 25. This ringing signal is likewise transmitted to a local circuit by relay 2 at its contacts 26 and 31. This circuit is employed in systems where the repeater system is located in the proximity of an exchange and through a predetermined code allows the operator at one exchange to contact either of the other two exchanges. Signals to the local line are transmitted by the east control circuit over the by-pass line when the ringing signal is applied at contacts 13 and 15 for a ring east signal. When the calling operator terminates the ringing signal, tube 77 again becomes non-conductive and stops the current supply to relay 5. Relay 5 releases and at its contact 67 breaks the holding circuit for relay 2. Relay 2 releases and at its contacts 26, 31 and 28, 30 terminates the ringing signal on the west and local lines.

When voice currents are imposed on the east line by the distant exchange, if the distance is at all large, a greatly attenuated voice current enters the repeating coil 17 of the telephone repeater.

In lines of varied construction, by means of key 108, it is possible to insert the conventional resistor balance pads 18 and 20 into the circuit whenever an imperfect balance exists over the requisite frequency range, thereby introducing a line loss which minimizes line discontinuities and permits overall balance. The voice current thereupon passes through a hybrid system 19, to the input transformer 37 of the east-west amplifier system, the input potentiometer gain control 38, amplifier tube 39, output transformer 40, filter 41, to hybrid system 34 at the west position, half of the energy being lost in the balancing network and the other half being transmitted through the balance pad system 33, the repeating coil 32 and over the west line via contacts 27, 29 and 23, 25.

The voice current value entering the amplifier tube 39 is controlled by the input potentiometer 38. The feedback connection from the plate passes through a condenser 42 and resistor 43 to a set of resistances 44 shunted by condenser 45 and to ground. Assuming a low voice frequency is transmitted to the amplifier, the tube will amplify in a normal manner. Being a low frequency, the feedback circuit impresses a large percentage of the potential across the input potentiometer 38 and resistances 44. This potential being approximately 180° out of phase with the input due to the tube characteristics, will be of a gain reducing nature and of a comparatively large value. With a voice current of higher frequency, however, a smaller amount of feedback will occur and cause greater amplification. The negative feedback is, therefore, a function of the input frequency, the gain reducing value being proportionally smaller with frequency increase. In view of the fact that telephone attenuation is such that the input to the receiver normally decreases with frequency increase, this negative feedback method of control is extremely practical. The value of resistance required for different systems is a variable factor and likewise the rising frequency characteristic desired is dependent entirely upon the

nature of the installation and the surrounding environments. For this reason, resistance 44 is comprised of a group of 2 resistances, which may be selectively eliminated with by-pass straps. The insertion of a greater value of resistance naturally increases the rising frequency characteristic whereas the complete elimination of resistances will yield a flat response. Similar connections exist in the west amplifier and its manner of operation is identical to the sequence previously narrated.

Relays 50 and 92 are located in series with the anode circuit, and their contacts are interconnected in the ringing control circuit in such a manner that if anode current of either channel amplifier falls below the operating value, the relay associated with the failing system will deenergize, and thereupon break the circuits for relays 1 and 4 which in turn remove the repeaters from the line at their associated contacts 8, 10 and 23, 25 and connect the line terminals to the by-pass channel at their contacts 7, 9 and 22, 24. If relay 50 deenergizes, it will light supervisory lamp 94 at its contact 55. Relay 92, at its contact 56 will likewise light lamp 94, if the anode circuit of its associated amplifier fails in any manner.

Voice currents initiated on the west lines will be transmitted by the repeater through its west-east channel or by-pass channel in a similar manner to that signal transmitted through the east-west channel as previously described. The ringing signal initiated on the west conductor passes over the west-east channel to the input transformer of the west-east amplifier. The signal then passes through resistance 74, conductor 63, to resistor 78 which with resistor 74 is effective as a voltage divider. A voltage of predetermined value is impressed upon the grid of the second section of tube 77 as a result of the incoming signal received through resistors 74 and 78 and thereby energizes tube 77. Relay 6 energizes on the increased average anode current flow from source of potential 93 and at its contacts 66 completes a path from alternating current source 96 through relay 3 and at its contacts 68 places a ground on the east amplifier circuit. Relay 3 energizes and at its contacts 13 and 15 transmits a ring signal on the east line and at its contacts 12 and 14 breaks the line connection to the repeaters and at its contacts 11 and 16 transmits a signal over the by-pass channel to the local line circuit. It will be noted that the ring-in east and ring-in west paths are grounded respectively by the operation of relay 6 and relay 5 thereby averting secondary line ringing effects caused by imperfect line balance.

The supervisory test key 100 when operated in the downward position removes ground from the anode circuit of tube 39 at its contact 76 and inserts resistance 48 in the anode cathode circuit. The IR drop across the resistance 48 places a high negative potential on the grid whereupon the anode current decreases and relay 50 deenergizes. The object of this key is to provide a simple and economical relay and tube test for the amplifier. The key when operated in the upward position makes a similar test on the west amplifier. When either relay deenergizes they will in turn break the circuits for relays 1 and 4 and insert equivalent resistance 61 in the cathode circuit of tube 77. At their contacts 71 and 72, relays 1 and 4 place a short circuit on the amplifiers which on reoperation precludes a singing disturbance from entering the line because of the extreme amount of unbalance in the hybrid sys-

tem while the testing operation is being consummated.

Relays 2 and 3 accomplish a similar method of singing preclusive when they insert resistances 97 and 98 across the repeater systems at their respective contacts 101 and 102 during the ringing periods.

It will be noted that the input signal to the ringing control circuit is received from the output connection of the amplifier transformers. In this manner the hybrid system balance is maintained and the signal potential is properly increased for use with the triode tube without the need of a second transformer in the arrangement.

Terminals Ek are located in the cathode circuits of tubes 39 and 82 as an aid to maintenance work and the grid value of the amplifier tube may be readily determined by inserting a voltmeter between terminal Ek and ground.

A conventional power supply unit is used in combination with the voice repeater. The power supply unit is operated on a 115 volt, 60 circuit and includes a power transformer with various taps and a 5U3 GT tube which with the associated circuits is effective to supply the desired 250 volt source, 230 volt source and the 6.3 volt source.

It is to be understood that various modifications may be made in the form of this invention above described without departing from the spirit of the invention as cited in the appended claims.

What is claimed is:

1. In a transmission system, an amplifier, an incoming and an outgoing line connected thereto, a ringing control circuit connected to said lines including a vacuum tube normally nonconductive, an incoming signal, amplifying means in said amplifier for amplifying said incoming signal, said tube rendered conductive by said amplified signal on said incoming line, a source of signal current, means for transmitting an outgoing signal from said source over said outgoing line, a relay responsive to said tube being rendered conductive by said incoming signal to operate said means to transmit said outgoing signal and to disconnect said amplifier from said outgoing line.

2. A claim as claimed in claim 1 in which there is a third line, and in which operation of said means also connects said third line to said source, said outgoing signal thereby transmitted over said outgoing and said third lines, a second relay operated by said amplifier to one position to connect said outgoing line to said amplifier and in another position to disconnect said outgoing line from said amplifier and to connect said outgoing line to said third line, said means effective to transmit a signal from said source to said outgoing and said third lines when said second relay is in either of said positions.

3. In a transmission system, an incoming line, an outgoing line, an amplifier connected therebetween, a ringing circuit connected to said lines including a vacuum tube having a cathode and a grid, a relay connected to said cathode, a resistor, a first circuit for connecting said resistor between said amplifier and said grid, a second resistor, a second circuit for connecting said second resistor between said grid and ground, means including said first circuit, said first resistor, said second circuit and said second resistor responsive to the receipt of a signal over said incoming line for applying a potential to said grid to render said tube conductive, said relay responsive to said tube becoming conductive to thereby operate, and means for transmitting an outgoing signal over

said outgoing line responsive to the operation of said relay.

4. In a transmission system, a line circuit over which voice currents may be transmitted in either direction, one amplifier responsive to voice currents from one direction having an output circuit connection to said line circuit, another amplifier responsive to voice currents from the other direction having an output connection to said line circuit, and a ringing control circuit connected to said line circuit, said control circuit including a first relay, a means operated by a signal transmitted over the line from one of said directions to energize said first relay, a source of signal current, a second relay, means controlled by said first relay for operating said second relay, means responsive to the operation of said second relay for disconnecting the output circuit of said one amplifier from said line circuit and for transmitting a signal over said line circuit from said source of signal current in said one direction, a third relay, said means also responsive to a signal transmitted over said line in said other direction to energize said third relay, a fourth relay, means controlled by said third relay for operating said fourth relay, means responsive to the operation of said fourth relay for disconnecting the output circuit of said other amplifier from said line circuit and for transmitting a signal over said line circuit from said source in said other direction, thereby causing said ringing signals in either of said directions to by-pass said amplifiers.

5. In a transmission system, a pair of lines, a two way voice current repeater including a pair of amplifiers connecting said lines, a ringing control circuit connected to said repeater, including a two section vacuum tube, one section rendered conductive only on receipt of an incoming signal from one of said lines, the second section of said vacuum tube rendered conductive only on receipt of a second incoming signal from the other of said lines, a source of signal current, a relay operative to transmit a signal from said source over said other line independent of said amplifiers, a second relay operative to transmit a signal from said source over said one line independent of said amplifiers, a first means responsive to said first section of said tube being rendered conductive to operate said first relay, and a second means responsive to said second section of said tube being rendered conductive to operate said second relay.

6. In a transmission system, an incoming line and an outgoing line, a first voice current channel connected to said incoming and said outgoing line, a first amplifier in said channel having an input transformer, a second voice current channel connected to said incoming and said outgoing lines, a second amplifier in said second channel having an input transformer, a ringing circuit connected to said first channel, said second channel, said first amplifier input transformer and said second amplifier input transformer, said ringing circuit including a vacuum tube having one section comprised of a grid, an anode, and a cathode, and a second section comprised of a grid, an anode, and a cathode, a first resistor connected in series with said first amplifier input transformer and the grid of said first section of said tube, a second resistor connected between the grid of said first section of said tube and ground, said first resistor and said second resistor effective to apply a potential to said first section of said tube on receipt of a signal from said incoming line through said first channel and said first amplifier input transformer to render said

first section of said tube conductive, a relay, a condenser in shunt of said relay, a source of signal current, means connected to said outgoing line for transmitting a signal from said source over said outgoing line, said relay responsive to said first section of said vacuum tube becoming conductive to operate said means, a third resistor connected in series with said second amplifier input transformer and said grid of said second section of said tube, a fourth resistor connected between said second grid and ground, said third resistor and said fourth resistor effective on receipt of a signal from said outgoing line through said second channel and said second amplifier input transformer to render said second section of said tube conductive, a second relay, a second condenser connected in shunt of said second relay, a second means connected to said incoming line for transmitting a signal from said source over said incoming line, said second relay responsive to said second section of said vacuum tube becoming conductive to operate said second means.

7. In a transmission system, a pair of lines, a two way voice current repeater, including a pair of amplifiers, connecting said lines, a first relay and a second relay connected in series and operative to remove said amplifiers from said line circuit, a third relay in and responsive to one of said amplifiers, a fourth relay in and responsive to the other of said amplifiers, said third and fourth relays operative to two positions, a ringing control circuit connected to said lines having a two section tube including a pair of cathodes, a resistance, a second resistance, circuit means connecting said second resistance between ground and said cathodes to maintain the grid bias of said tube constant regardless of anode current value, means responsive to the operation of said third and fourth relays to one of said positions for connecting said first and second relays to said cathodes, means responsive to the operation of said third and fourth relays to the other of said positions for disconnecting said first and second relays from said cathodes and for connecting said first resistance to said cathodes, said first resistance thereby effective to prevent possible damage to said tube when said first and second relays are disconnected from said source.

8. In a transmission system, a bidirectional line circuit, a first voice current channel having input and output terminals connected to said line, an amplifier in said channel responsive to signals from one direction, a second voice current channel having input and output terminals connected to said line, an amplifier in said second channel responsive to signals from the other direction, a ringing control circuit connected to said line circuit including a two section vacuum tube, means for rendering one section of said tube conductive on receipt of a signal from said one direction on said input terminals of said first channel, a relay controlled by said one section of said tube, a source of ringing current, a first means connected to control said output terminals of said first channel controlled by said relay for transmitting from said source a signal in said other direction over said line, means for rendering the second section of said tube conductive on receipt of a signal from said other direction on said input terminals of said second channel, a second relay controlled by said second section of said tube, a second means connected to control said output terminals of said second channel for transmitting a signal from

9

said source in said one direction controlled by said second relay, said relays also operated to disconnect said channels from said line circuit.

9. A system as claimed in claim 5 in which there is an input transformer having secondary connections in said amplifier, said secondary connections being connected to said amplifier and also to said one section of said tube, thereby increasing the potential of said first incoming signal for energization of said tube and maintaining a balance system in said repeater.

10. In a transmission system, a pair of lines, a two way voice current repeater including amplifiers connecting said lines, a by-pass circuit for connecting said lines independent of said repeater, a thermionic tube in one of said amplifiers, a relay in the plate circuit of said tube responsive to a fall of current in said circuit to disconnect said repeater from said lines and connect the by-pass circuit between said lines, a ring control circuit connected to said lines, and means in said control circuit responsive to a ringing signal over one of said lines for also disconnecting said repeater from the lines, transmitting a ringing signal over the other line, and connecting said other line to the by-pass circuit.

11. In a transmission system, a pair of lines, a two way voice current repeater including am-

10

plifiers connecting said lines, a by-pass circuit for connecting said lines independent of said repeater, means in one of said amplifiers operative to disconnect said repeater from said lines and connect the by-pass circuit between said lines, a ring control circuit connected to said lines, a relay, a vacuum tube in said control circuit responsive to a ringing signal over one of said lines for operating said relay, a second relay operated by said first relay for disconnecting said repeater from the lines, transmitting a ringing signal over the other line, and connecting said other line to the by-pass circuit.

12. In a system as claimed in claim 11, means responsive to the operation of said first relay for balancing said lines.

ROSWELL H. HERRICK.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,697,933	Shackleton	Jan. 8, 1929
1,829,803	Korn	Nov. 3, 1931
2,414,795	Brandt	Jan. 28, 1947