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CIRCUIT MEANS FOR TELEPHONE REPEATERS

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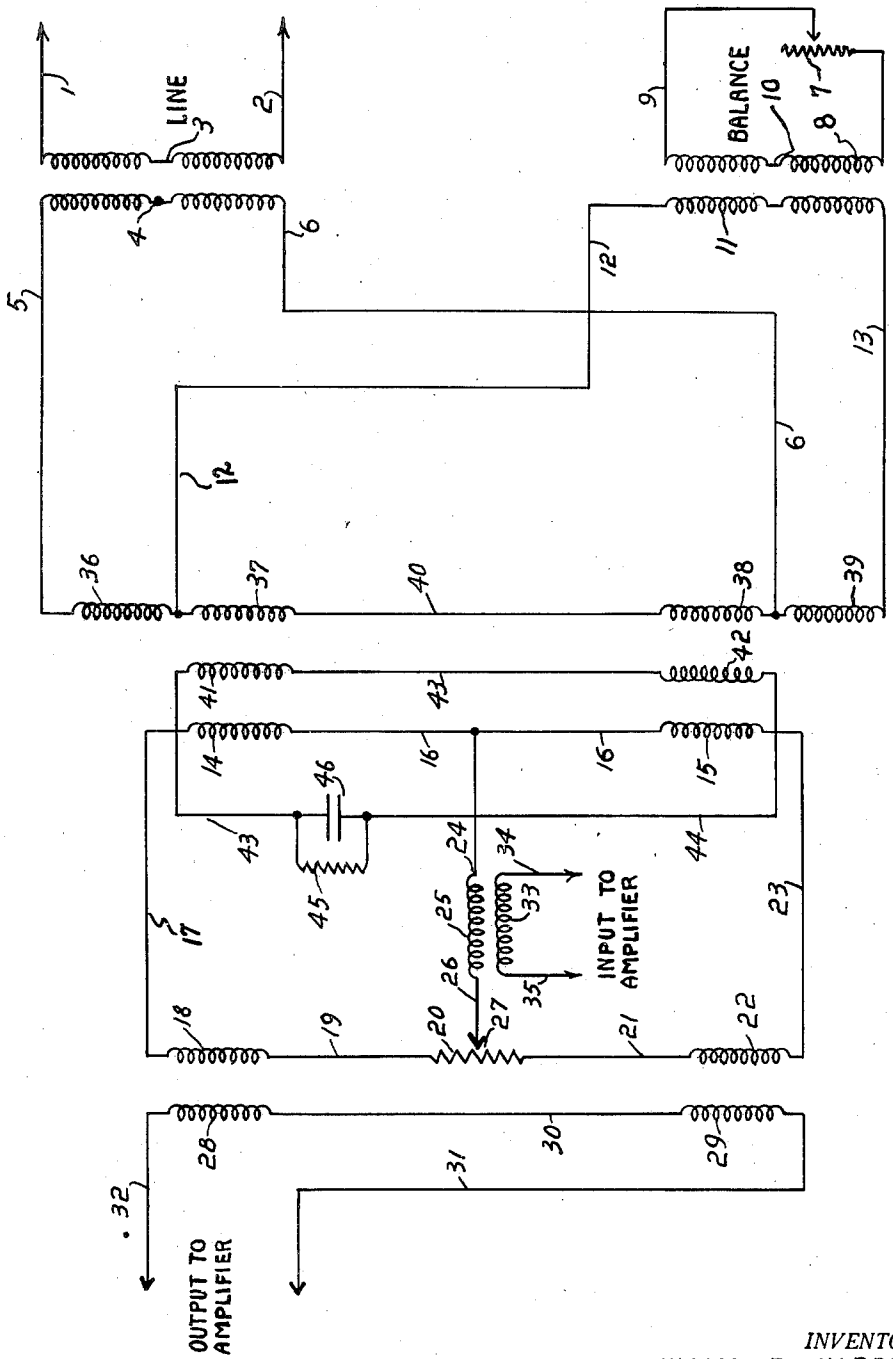

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CIRCUIT MEANS FOR TELEPHONE REPEATERS

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7 Claims. (Cl. 179—170)

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My invention relates to telephone repeater circuits, and in particular to means for balancing impedance fluctuations in the lines.

In my Patent 2,046,119, issued June 30, 1936, I described a universal telephone repeater of a type in which the two line circuits feed each other through independent amplifier networks coupled together by means of bridge circuits. The repeater described in my patent did not require the then conventional artificial line for attaining balance. Instead, balance was provided from a simple resistance impedance reflected into the bridge circuit by inductive means. My present invention provides improvements in the means shown in that patent as well as additional means, as will be described.

My objects include the provision of simple means for attaining a more perfect balance, and the provision of means for balancing greater variations in line impedance, to the end of securing a very substantially increased gain in decibels without feed back and oscillation. My objects also include the provision of a novel mode of compensating for line impedance fluctuations, involving a novel inductive coupling of line and balance circuits to a bridge circuit.

These and other objects of my invention, which will be set forth hereinafter or will be apparent to one skilled in the art upon reading these specifications, I accomplish by that construction and arrangement of parts of which I shall now describe an exemplary embodiment. Reference is made to the accompanying drawing wherein I have illustrated essential parts of my exemplary embodiment having to do with the line connection, the balance, the bridge circuit and the compensator. It will be understood that a similar arrangement is provided for each of the lines. The amplifiers and power connections are not shown. They may be the same as those illustrated in my patent, to which reference is made for a showing of the additional parts going to make up a complete repeater installation.

In the drawing, 1 and 2 indicate the leads of a line circuit connected to the primary 3 of a transformer. The secondary 4 of the transformer is provided with leads 5 and 6.

Balance means for the line impedance comprises, in my exemplary embodiment, an adjustable resistance 7 coupled by leads 8 and 9 to the primary 10 of another transformer. The secondary 11 of this transformer has leads 12 and 13.

The resistance 7 is adjusted so as to reflect

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into the circuit comprising leads 12 and 13 an impedance equal to the average impedance of the line 1, 2. The transformers 3, 4 and 10, 11 are of one-to-one ratio as employed by me; but they may be of other ratios. They have been shown as center tapped transformers, but they need not be of this type. The employment of center tapped transformers at these points is for a purpose not germane to the present invention, i. e., for telegraphy.

The problem is to couple the line circuit and the balance circuit to a bridge circuit in such a way that the line voltage fluctuations will be adequately reflected into the bridge circuit while fluctuations of line impedance (which in the less elaborate telephone systems may be very large) are compensated and balanced out.

The bridge circuit as illustrated comprises transformer windings 14 and 15, connected by a lead 16. The winding 14 is connected by a lead 17 to a transformer winding 18 and thence by a lead 19 to a potentiometer or variable bridge resistance 20, the other end of which is connected by a lead 21 to a winding 22 which in turn is connected by a lead 23 to the winding 15. The bridge is completed by a lead 24 coupled to lead 16 at one end and connected at the other to a winding 25 which in turn is connected by a lead 26 to the variable contact means 27 of the potentiometer.

Windings 28 (inductively coupled with winding 18) and 29 (inductively coupled to winding 22) are interconnected by a lead 30, and other leads 31 and 32 are used for coupling the bridge circuit to the output circuit of the No. 1 amplifier. Windings 18, 28, 22 and 29 may, if desired, be parts of the same transformer. A winding 33 (inductively coupled with winding 25) is provided with leads 34 and 35 by which it may be connected to the input circuit of amplifier No. 2 of the repeater, all as will be more fully understood by reference to my patent mentioned above.

In the circuit arrangement by means of which the illustrated line and balance circuits are coupled to the bridge circuit, I provide windings 36 and 37 inductively coupled with winding 14 of the bridge circuit. Also, I provide windings 38 and 39 inductively coupled with winding 15 of the bridge circuit. These pairs of windings are coupled in series, and also windings 37 and 38 are connected in series by a lead 40. It will be noted that the line transformer secondary 4 is coupled by lead 5 to the free end of winding 36, while it is coupled by lead 6 to the

connection between windings 38 and 39. The transformer secondary 11 of the balance circuit is coupled by lead 13 to the free end of winding 39, while lead 12 couples it to the connection between windings 36 and 37. Thus, I have a line circuit and a balance circuit each including three windings by means of which it is coupled to one or the other of the windings 14 and 15 in the bridge circuit. Two of the coupling windings, namely, windings 37 and 38, are common to the line and balance circuits; but winding 36 lies only in the line circuit while winding 39 lies only in the balance circuit. If all of the coupling windings are equal as to the number of turns, it will be seen that windings 36 and 37, acting together, cause the line impedance to reflect impedance into winding 14 of the bridge circuit in a 2:1 ratio, while coil 38 acting independently causes the line impedance to be reflected into winding 15 of the bridge circuit in a 1:1 ratio. Similarly, impedance in the balance circuit is reflected into winding 15 of the bridge circuit in a 2:1 ratio by windings 38 and 39 acting together, while winding 37 acting independently reflects the balance impedance into winding 14 of the bridge circuit in a 1:1 ratio.

Finally, I provide a compensator circuit comprising a winding 41 inductively coupled with windings 14, 36 and 37 and another winding 42 inductively coupled with windings 15, 38 and 39. These windings are interconnected by a lead 43 in such fashion, however, that unlike the remainder of the described windings, windings 41 and 42 are in electrical opposition. The compensator circuit is completed by leads 43 and 44 connecting the other ends of windings 41 and 42 with an impedance preferably comprising a resistance 45 shunted by a capacity 46. The resistance may be made variable, if desired.

Windings 14, 41, 36 and 37 are preferably comprised in a single transformer structure. Similarly, windings 15, 42, 38 and 39 are comprised in a single transformer structure.

As to the compensator circuit, it will be evident that when the impedances of the line and of the balance circuits are equal, the E. M. F. produced inductively in windings 41 and 42 will be the same and, since these windings are connected in opposition, will cancel. When a condition of unbalance exists, current will flow in the compensator circuit affecting the inductive coupling of the bridge circuit to the line and balance circuits, and tending to counteract the condition of unbalance. This, for situations where fluctuations of the line impedance are maintained within relatively narrow limits, may be sufficient for balancing purposes. But in the less elaborate telephone systems, very great fluctuations of line impedance are encountered; and the bare provision of a compensator circuit in connection with coupling means such as those illustrated in my patent may not be found sufficient to counteract unbalance, especially as respects all of the frequencies in a frequency range of desired extent.

I have found that the provision of the coupling means and the mode of operation hereinabove set forth, in combination with the other elements of the illustrated combination, does provide balance over the whole range of useful and desired frequencies and operates to do this in spite of extreme fluctuations of line impedance.

Modifications in my invention may be made without departing from the spirit of it. Having thus described my invention in an exemplary embodiment, what I claim as new and desire to secure by Letters Patent is:

1. In a telephone repeater or like apparatus having a bridge circuit whereby a line circuit and a balancing impedance circuit are coupled to incoming and outgoing amplifier networks, coupling means comprising a winding in each arm of the bridge circuit, and two pairs of windings inductively coupled respectively to each of the first mentioned windings, the said line circuit and balancing impedance circuit being connected respectively to said last mentioned four windings to include three of said last mentioned windings in each line circuit and balancing circuit, two of said last mentioned windings being common to each line and balancing circuit, both line and balancing circuits thus having inductive coupling to both arms of said bridge circuit.

2. In a telephone repeater or like apparatus having a bridge circuit whereby a line circuit and a balancing impedance circuit are coupled to incoming and outgoing amplifier networks, coupling means comprising a winding in each arm of the bridge circuit, and two pairs of windings inductively coupled respectively to each of the first mentioned windings, the said line circuit and balancing impedance circuit being connected respectively to said last mentioned four windings to include three of said last mentioned windings in each line circuit and balancing circuit, two of said last mentioned windings being common to each line and balancing circuit, both line and balancing circuits thus having inductive coupling to both arms of said bridge circuit, and the said last mentioned windings being connected in series, whereby the reflection of impedance from said line circuit into one of said bridge circuit windings is at a different ratio from the reflection of line impedance into the other of said bridge circuit windings, the same condition obtaining for the reflection of impedance from said balancing impedance circuit into said windings of said bridge circuit, but being of opposite hand.

3. In a telephone repeater or like apparatus having a bridge circuit whereby a line circuit and a balancing impedance circuit are coupled to incoming and outgoing amplifier networks, coupling means comprising a winding in each arm of the bridge circuit, and two pairs of windings inductively coupled respectively to each of the first mentioned windings, the said line circuit and balancing impedance circuit being connected respectively to said last mentioned four windings to include three of said last mentioned windings in each line circuit and balancing circuit, two of said last mentioned windings being common to each line and balancing circuit, both line and balancing circuits thus having inductive coupling to both arms of said bridge circuit, and the said last mentioned windings being connected in series, whereby the reflection of impedance from said line circuit into one of said bridge circuit windings is at a different ratio from the reflection of line impedance into the other of said bridge circuit windings, the same condition obtaining for the reflection of impedance from said balancing impedance circuit into said windings of said bridge circuit, but being of opposite hand, the said ratios being respectively 2:1 and 1:1.

4. In a telephone repeater or like apparatus having a bridge circuit whereby a line circuit and a balancing impedance circuit are coupled to incoming and outgoing amplifier networks, coupling means comprising a winding in each arm of the bridge circuit, and two pairs of windings

inductively coupled respectively to each of the first mentioned windings, the said line circuit and balancing impedance circuit being connected respectively to said last mentioned four windings to include three of said last mentioned windings in each line circuit and balancing circuit, two of said last mentioned windings being common to each line and balancing circuit, both line and balancing circuits thus having inductive coupling to both arms of said bridge circuit, and the said last mentioned windings being connected in series, whereby the reflection of impedance from said line circuit into one of said bridge circuit windings is at a different ratio from the reflection of line impedance into the other of said bridge circuit windings, the same condition obtaining for the reflection of impedance from said balancing impedance circuit into said windings of said bridge circuit, but being of opposite hand, and a compensating circuit comprising a pair of windings, one being inductively coupled with each of said bridge circuit windings, said compensating circuit windings being connected in series with each other and with an impedance to form a closed circuit, but said compensating circuit windings being connected in electrical opposition.

5. In a telephone repeater or like apparatus, a bridge circuit comprising a pair of windings, one located in each arm of the bridge, a coupling circuit comprising four windings connected in series, two of said last mentioned windings being inductively coupled with one of said bridge circuit windings and two with the other, a line circuit and a balance circuit, each connected to said coupling circuit windings in such a way as to include both windings inductively coupled to one of said bridge circuit windings but only one inductively coupled to the other of said bridge circuit windings, two only of said coupling circuit windings being common to said line and balance circuits, so that said line circuit impedance affects one arm of the bridge in a 2:1 ratio while the balance circuit affects the same bridge arm in a

1:1 ratio, this condition being reversed as respects the other arm of said bridge.

6. The structure of claim 5 in which said line circuit and said balance circuit each include a coupling transformer, the primary of the balance circuit transformer being shunted by a variable resistance.

7. In a telephone repeater or like apparatus, a bridge circuit comprising a pair of windings, one located in each arm of the bridge, a coupling circuit comprising four windings connected in series, two of said last mentioned windings being inductively coupled with one of said bridge circuit windings and two with the other, a line circuit and a balance circuit, each connected to said coupling circuit windings in such a way as to include both windings inductively coupled to one of said bridge circuit windings but only one inductively coupled to the other of said bridge circuit windings, two only of said coupling circuit windings being common to said line and balance circuits, so that said line circuit impedance affects one arm of the bridge in a 2:1 ratio while the balance circuit affects the same bridge arm in a 1:1 ratio, this condition being reversed as respects the other arm of said bridge, and a closed compensating circuit comprising an impedance and a pair of windings, each winding being inductively coupled with a bridge circuit winding, but the said compensating circuit windings being connected in electrical opposition to each other.

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