June 12, 1928. 1,672,977

F. E. FIELD

REPEATING COIL

Filed July 26, 1922

Fig. 1.

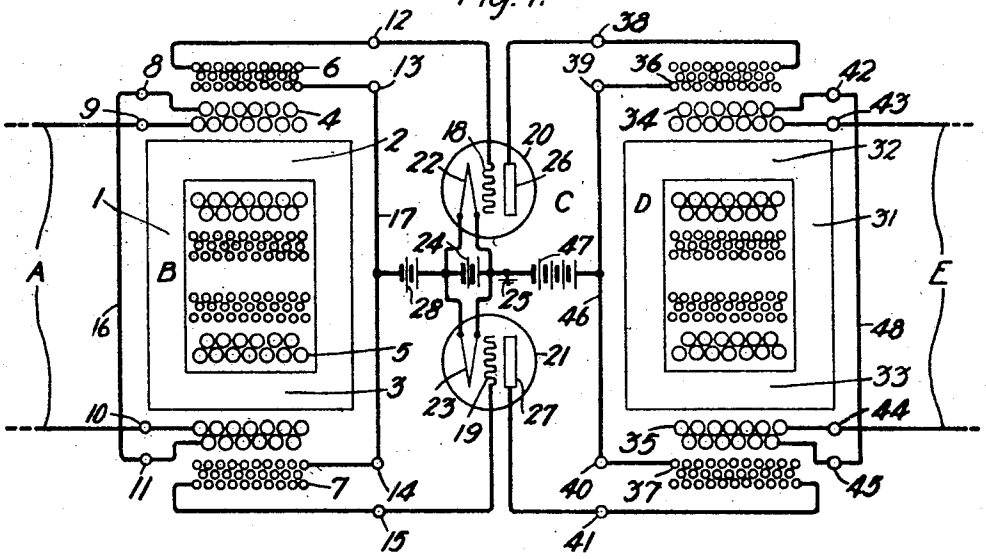
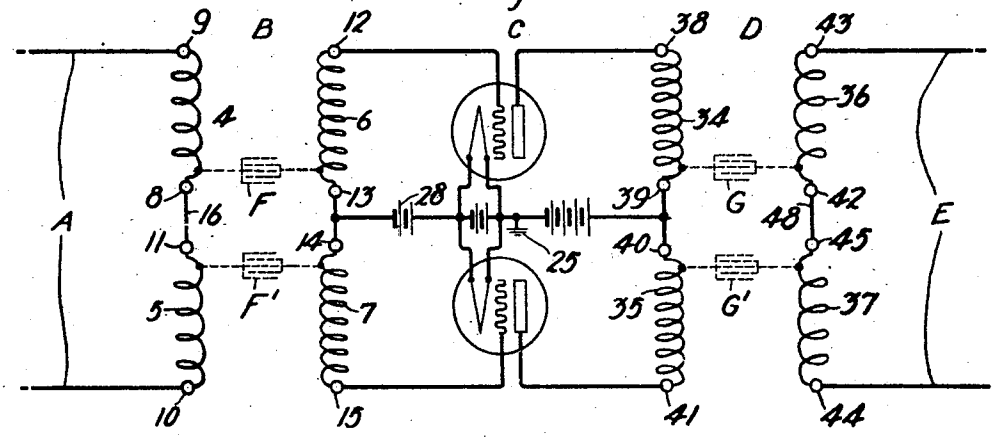


Fig. 2.



Inventor:
Frank E. Field.
by Joel C. Farmer Atty.

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UNITED STATES PATENT OFFICE.

FRANK E. FIELD, OF SOMERVILLE, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

REPEATING COIL.

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This invention relates to balanced translating circuits and pertains, especially to means for preventing unbalance and distortion in a speech transmission circuit in which transformers are employed for connecting a pair of vacuum tube repeaters in the so-called push-pull relation to the circuit.

The transformers ordinarily used in such circuits are composed of multi-layer coaxial coils which are so arranged that the capacities between the coils and the core, or between the cores and the casing are practically negligible whereas the capacities between the adjacent layers of the superposed coils have considerably larger values which cannot be neglected.

It is an object of this invention to materially reduce, in transformers of the above and similar types, the effect of the capacities between the primary and secondary windings.

Another object of the invention is to substantially eliminate the effect of the capacities between the primary and secondary windings of the input transformer.

These objects are attained in general by connecting the grids of the associated vacuum tubes to the layers of the secondary sections of the input transformer which are non-adjacent to the primary sections of the transformer and by connecting the cathodes of the tubes to the layers of the secondary sections which are adjacent the primary. The anodes of the tubes are connected to the non-adjacent layers of the primary sections of the output transformer and the cathodes to the adjacent layers of the primary through a battery. The outer layers of the primary of the input transformer are connected so as to be in the electrical center of the primary, and are therefore maintained at a substantially constant potential with respect to ground when the winding is connected to a balanced circuit such as an open wire line. The cathodes are grounded. The effect of this arrangement thus is to short-circuit the interlayer capacities through ground.

Referring now to the accompanying drawings, Fig. 1 discloses the winding of the transformers and their connections to the repeaters, and Fig. 2 is a diagrammatic representation thereof.

The circuit of this invention comprises a transformer B, the primary of which is connected to an incoming line A which is balanced with respect to ground and the secondary of which is included in the input circuit of a balanced vacuum tube repeater circuit C, the output circuit of which includes the primary of a transformer D, the secondary of which is connected to an outgoing line E.

The input transformer may comprise a substantially rectangular frame 1 around the ends 2 and 3 of which are wound multi-layer primary coils 4 and 5. Surrounding the coils 4 and 5 and having their inner layers adjacent the outer layers of said coils are multi-layer secondary coils 6 and 7 which cooperate with the coils 4 and 5 to form the primary and secondary of the transformer. Binding posts 8, 9, 10 and 11 are provided for the inner and outer layers of the primary coils 4 and 5. For the inner and outer layers of the secondary coils 6 and 7 are provided the binding posts 12, 13, 14 and 15. The binding posts 9 and 10 are connected to the incoming line and a conductor 16 connects the binding posts 8 and 11. The conductor 16 by virtue of its symmetrical position with respect to the incoming line of the circuit is maintained at effective ground potential because of the capacities to ground of the two members of the incoming line. The binding posts 13 and 14 of the secondary coils are connected by a conductor 17 and the binding posts 12 and 15 are connected, respectively, with the grids 18 and 19 of the repeater tubes 20 and 21. The cathodes 22 and 23 of the tubes 20 and 21 are in circuit with the battery 24 which supplies heating current to the cathode and are grounded at 25. The conductor 17 is connected to the negative pole of the battery 28.

The output transformer for this circuit may comprise a substantially rectangular frame 31 around the ends 32 and 33 of which are wound multi-layer secondary coils 34 and 35. Surrounding the coils 34 and 35 and having their inner layers adjacent the outer layers of said coils are multi-layer primary coils 36 and 37 which cooperate with the coils 34 and 35 to form the primary and secondary of a step down transformer. Binding posts 38, 39, 40 and 41 are provided for the inner and outer layers of the primary coils 36 and 37. For the inner and outer layers of the secondary coils 34 and 35 are provided the binding posts 42, 43, 44 and 45. The binding posts 39 and 40 are con-

nected by the conductor 46 to the cathodes 22 and 23 through a low impedance battery 47 of relatively small voltage. The binding posts 38 and 41 are connected, respectively, to the anodes 26 and 27 of the tubes 20 and 21. The binding posts 43 and 44 are connected to the outgoing line and the binding posts 42 and 45 are connected by conductor 48 which, because of its symmetrical position with respect to the outgoing line of the circuit, is maintained at effective ground potential by virtue of the capacities to ground of the two members of the outgoing line.

Fig. 2 discloses, diagrammatically, the effect of this method of connection upon the capacities between the adjacent layers of the primary and secondary coils of the input and output transformers. Those portions of the coils adjacent the binding posts 8, 11, 12 and 15 represent the outer layers of coils 4, 5, 6 and 7, respectively, and those portions adjacent the binding posts 9, 10, 13 and 14 represent the inner layers of said coils 4, 5, 6 and 7, respectively. The capacities F and F′ are therefore conveniently represented as being between the outer ends of coils 4 and 5 and the inner ends of coils 6 and 7, respectively. Since the terminals 8 and 13, and 11 and 14 of the capacities F and F′ are connected to the ground potential member 16 and to ground 25, respectively, the effect of these capacities is nullified to such an extent that they have no effect upon the transmission of speech waves.

In the output transformer, those portions of the coils adjacent the binding posts 38, 41, 42 and 45 represent the outer layers of the coils 34, 35, 36 and 37, respectively, and those portions adjacent the binding posts 39, 40, 43 and 44 represent the inner layers of said coils 34, 35, 36 and 37, respectively. The capacities G and G′ are therefore conveniently represented as being between the inner end of coil 34 and the outer end of coil 36, and between the inner end of coil 35 and the outer end of coil 37, respectively. Since the terminals 42 and 45 are connected to the ground potential member 48 and the terminals 39 and 40 are maintained at a potential in excess of ground equal only to the potential of the battery 47, the impedance of which is relatively small, the capacities G and G′ are eliminated to such an extent that they have no effect upon the transmission of speech through the circuit.

What is claimed is:

1. In a transmission circuit, a transformer having sections, each section comprising a multi-layer primary coil and a multi-layer secondary coil coaxial therewith, said secondary coil having its inner layers balanced with respect to ground and means including connections to a line having its two sides similarly capacitatively related to ground for keeping the adjacent layers of the primary coils of each section at a fixed potential with respect to ground.

2. In a transmission circuit, a transformer having a pair of sections, each section comprising a multi-layer primary coil and a multi-layer secondary coil surrounding said primary coil, a connection between the outer layers of the primary coils, connections from the inner layers of the primary coils to a line the two sides of which have like capacities to ground whereby said first mentioned connection is at a fixed potential with respect to ground, a pair of vacuum tubes, each having a cathode and a grid, connections between the outer layers of the secondary coils and the grids of said tubes, and connections between the inner layers of the secondary coils and the cathodes of said tubes, said last named connections being grounded.

3. In a transmission circuit, a transformer comprising coaxial multi-layer primary and secondary windings, means including connections from said windings to a line having like capacities between its two sides and ground for maintaining the layer of the primary adjacent the secondary substantially at ground potential, a pair of vacuum tubes each having a cathode, and connections between the cathodes of said tubes and the layers of the secondary adjacent said primary, said last mentioned connections being grounded.

4. In a transmission circuit, a transformer having sections, each section comprising a pair of multi-layer coaxial coils, connections respectively between the adjacent layers of the coils of one of said sections, and the corresponding adjacent layers of the coils of the other section, and means for maintaining said connections at fixed potentials with respect to ground, said means including a conductive path between one of said connections and ground, and electrical paths from the coils joined by the other connection to a line having its two sides similarly capacitatively related to ground.

5. In a transmission circuit, a transformer comprising a pair of multi-layer primary coils in series, means for keeping the terminals of the outer layers of each of said coils at substantially ground potential, said means including connections from the inner layers of said primary coils to a line having like capacities between its two sides and ground, a pair of multi-layer secondary coils surrounding said primary coils respectively, and connections between the terminals of the inner layers thereof and ground.

6. In a signaling circuit, a balanced transmission line, a transformer comprising a pair of multi-layer primary coils connected in series and a pair of multi-layer secondary coils coaxial with and surrounding said primary coils, said secondary coils being connected in series, connections from the inner

layers of each section of said primary coils to said transmission line and connections from the inner layer of each section of the secondary to an electrical device, said last named connections being grounded.

7. In a transmission circuit, a transformer comprising a pair of sections, each section comprising a primary and secondary coil arranged with the outer layer of one adjacent the inner layer of the other, a connection between the layers of said primary coils adjacent said secondary coils, means for maintaining said connection at substantially ground potential, said means including connections from the inner layers of said primary coils to a line having like capacities between its two sides and ground, a pair of vacuum tubes, each having a cathode and a grid, connections between the grids of said tubes and the non-adjacent layers of said secondary coils, and connections between the cathodes of said tubes and the layers of said secondary coils adjacent said primary coils, said last named connection being grounded.

8. In a transmission circuit, a line having terminals substantially balanced with respect to ground, a transformer comprising a pair of multi-layer primary coils, said coils having the terminals of their inner layers connected to the terminals of said line, a connection between the terminals of their outer layers, said last named connection being at a fixed potential with respect to ground, and a pair of secondary coils superposed on said primary coils, the inner layers of said secondary coils being connected to ground through a path of low impedance.

9. In a transmission circuit, in combination, an incoming line, a transformer comprisng a plurality of primary windings symmetrically arranged across the incoming line, connections between the outer layers of said primary windings, means including said line for maintaining said connections at substantially ground potential, a multi-layer secondary comprising a plurality of windings surrounding said primary windings, a plurality of vacuum tubes, each having a cathode and a grid, connections between the outer layers of said secondary windings and the grids of said vacuum tubes, and connections between the inner layers of said secondary windings and the cathodes of said tubes, said last named connections being grounded.

10. In a transmission circuit, a transformer having a plurality of sections, each section comprising a pair of multi-layer primary and secondary coils, the terminals of the primary non-adjacent said secondary being connected to an incoming line, and a connection beteween the terminals of the primary coils adjacent said secondary coils, said incoming line having like capacities between its two sides and ground whereby said connection is maintained at substantially ground potential, a pair of vacuum tubes, each having a cathode and a grid, connections from the layers of the secondary coils non-adjacent said primary coils to the grids of said tubes, and connections from the layers of the sections of said secondary adjacent said primary coils to the cathodes of said tubes, said last named connections being grounded.

11. In a balanced transmission circuit, an outgoing line, a transformer comprising a pair of multi-layer secondary coils, the terminals of the outer layers of said secondary coils being connected together, connections between the terminals of the inner layers of said secondary coils and said outgoing line, a pair of multi-layer primary coils surrounding said secondary coils, a pair of vacuum tubes, each having a cathode and an anode, connections between the terminals of the inner layers of said primary coils and the cathodes of said tubes, connections between the terminals of the outer layers of said primary coils and the anodes of said tubes and connections between the cathodes of said tubes and ground.

12. In a balanced transmission circuit, a pair of vacuum tubes, each having a cathode and an anode, an output transformer comprising a pair of multi-layer primary sections and a pair of multi-layer secondary sections, connections between the anodes of the tubes and the terminals of the layers of the primary sections non-adjacent the secondary sections, connections between the cathodes of said tubes and the terminals of the layers of the primary adjacent said secondary coils, a connection between the terminals of the layers of the secondary sections adjacent said primary sections, an outgoing line, and connections between the terminals of the layers of said secondary sections non-adjacent the primary layers and said outgoing line.

In witness whereof, I hereunto subscribe my name this 24th day of July, A. D. 1922.

FRANK E. FIELD.