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V. R. DE LONG

2,771,585

IMPEDANCE TRANSFORMER NETWORK

Original Filed April 26, 1951

2 Sheets-Sheet 1

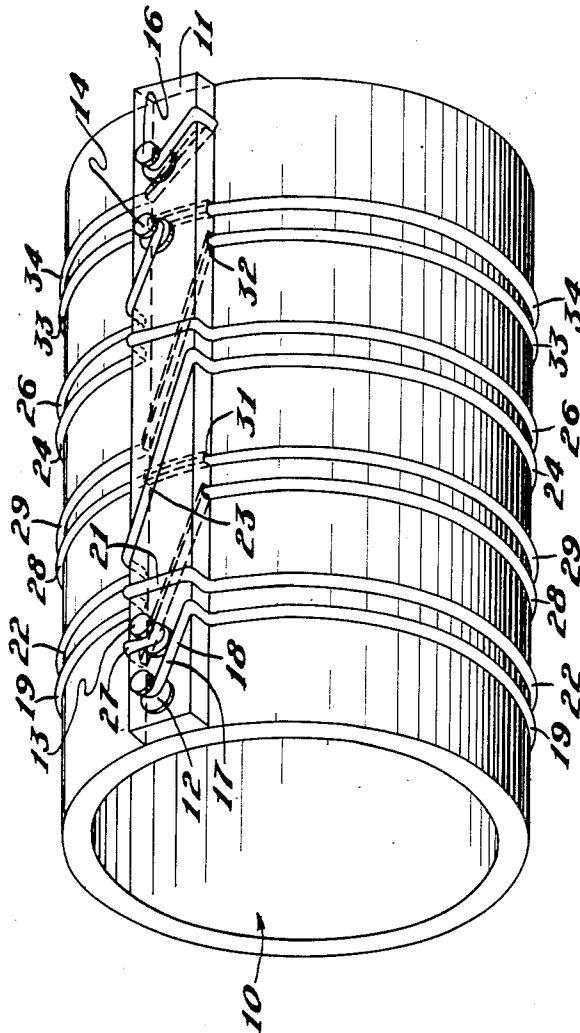


Fig. 1

INVENTOR.

VINCENT R. DELONG

BY

Merrin Moody

ATTORNEY

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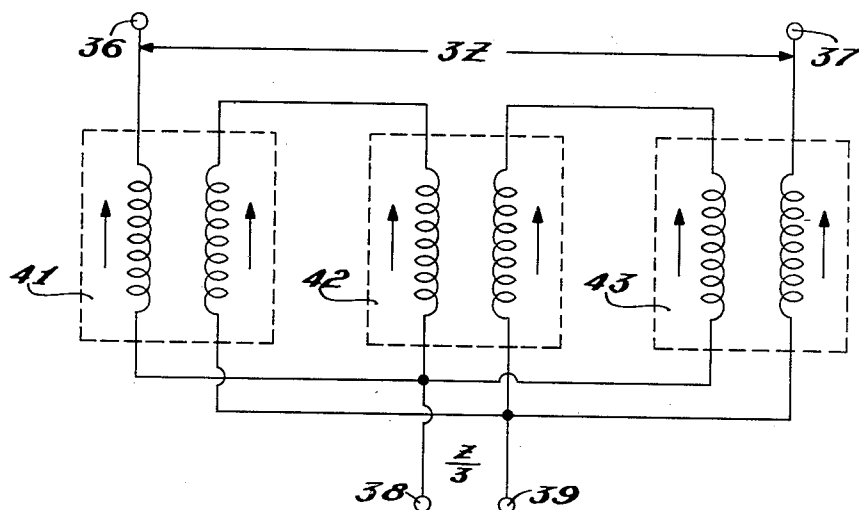


Fig 2

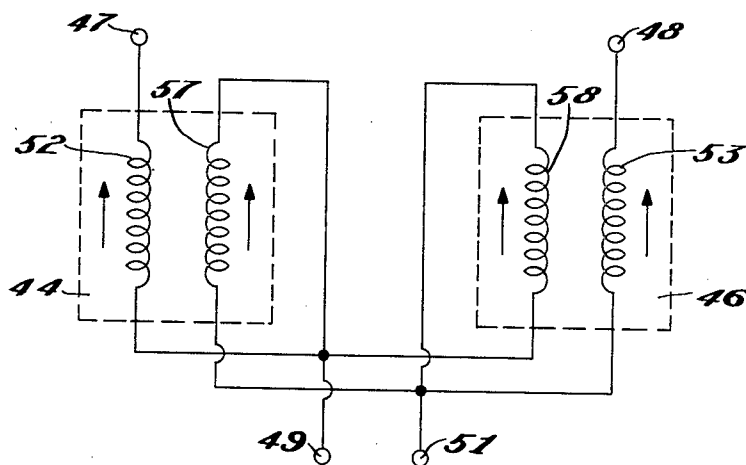


Fig 3

INVENTOR.
VINCENT R. DELONG
BY *Mam. Moody*
ATTORNEY

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Vincent R. De Long, Cedar Rapids, Iowa, assignor to Collins Radio Company, Cedar Rapids, Iowa, a corporation of Iowa

Original application April 26, 1951, Serial No. 223,090, now Patent No. 2,669,698, dated February 16, 1954. Divided and this application October 6, 1952, Serial No. 313,243

3 Claims. (Cl. 333—32)

This invention relates in general to impedance transformers and in particular to inductance coils wound and connected so as to obtain a desired impedance transformation. This case is a division of Serial Number 223,090, filed April 26, 1951, now Patent No. 2,669,698, issued Feb. 16, 1954.

In the electrical field it is oftentimes desirable to make an impedance transformation so that an output at one impedance may be connected to an input with a different impedance. In order to prevent a discontinuity occurring when such a connection is made, it is desirable to place in the line an impedance transformer which will eliminate the discontinuity. For a more complete discussion of the theory of matching transformers reference may be made to Patent 2,470,307, issued to Guanella on May 17, 1949, entitled High Frequency Matching Transformer.

Applicant's invention constitutes an improvement in the manner of winding the coil and a new manner of connecting coils so as to obtain different impedance ratios has been developed.

It is an object of this invention to provide an impedance transformer by utilizing two or more inductance coils of this invention.

Another object of this invention is to provide a coil with high surge impedance which has opposite sides of the line wound in the same direction about a coil form while maintaining a relatively large distance between the turns of one side of the line and the turns of the opposite side of the line.

Yet another object of this invention is to provide an improved high impedance coil which has opposite sides of the line wound about it in the same direction with relatively large spacing between turns of the opposite sides of the lines and with more than one turn of each side made between turns of the opposite line.

A feature of this invention is found in the provision for a new and novel coil which may be connected in various manners to obtain different impedance transformations.

Further objects, features and advantages of this invention will become apparent from the following description and claims when read in view of the drawings, in which:

Figure 1 is an air view drawing of the coil of this invention;

Figure 2 illustrates a connection for making a 9-1 impedance transformation; and,

Figure 3 illustrates a connection developed by applicant for making a 9-1 impedance transformation.

With reference to Figure 1 a coil form, designated generally as 10, may be made of ceramic material, for example, and has attached a longitudinal insulating strip 11 which might be formed of polystyrene, for example.

A pair of input terminals 12 and 13, respectively, pass through one end of the insulating strip 11 and fasten to the form 10 to hold the insulating strip rigidly to it.

Output terminals 14 and 16, respectively, pass through the opposite end of strip 11 and attach to the coil form 10.

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One side 17 of a line is attached to terminal 12. Conductor 17 passes through a diagonal slot 18 formed in the insulating strip 11 and is wound about the coil form to make a first turn 19, passes over the insulating strip 11 in a slot 21 and makes a second turn 22 about the form 10.

After the second turn 22 the conductor is received in a slot 23 formed in the insulating strip 11 and passes diagonally across the strip for a substantial longitudinal distance from the second turn 22 and is wound about the form to make a third turn 24. A fourth turn 26 is made about the form 10 by crossing over the insulating strip 11.

After the fourth turn the conductor to output terminal 14 passes diagonally along the strip 11.

The other side 27 of the line is connected to input terminal 13 and passes under the insulating strip 11 through a diagonal slot formed therein to emerge for a first turn 28. A second turn 29 is made by allowing the conductor to pass under the insulating strip 11 through a slot 31 formed therein. After turn 29 the conductor passes through a transverse slot 32 formed in the under side of the strip 11 and passes a substantial distance down the strip 11 to emerge and make turn 33 which is the third turn for the second conductor. A fourth turn 34 is made by the second conductor. After the last turn 34 the second conductor is connected to the output terminal 16.

The longitudinal spacing between opposite sides of the line increases the surge impedance of the coil and a practical size coil may be obtained. In other words, in order to get a relatively high surge impedance, a much smaller coil will be needed when wound as shown in Figure 1 than when the opposite sides of the line are spaced relatively close together.

An advantage obtained by spacing two turns of the same side of the line close together is to increase the surge impedance by increasing the mutual inductance between adjoining turns of the same line.

A coil wound such as shown in Figure 1 has the characteristic that it offers no impedance to balanced current flowing through the coil, but a high impedance to any unbalanced current. This is true because with a balanced current opposite sides of the line will carry equal and opposite current and the total inductance will be substantially cancelled for the reason that the conductors are wound in the same direction.

Unbalanced currents, however, flow in the same direction through both sides of the line and the inductances would add and thus form a high impedance path. As shown in the patent to Guanella, previously referenced, impedance transformations may be made by connecting two or more coils in the line. For example, Guanella's Figure 6 illustrates a connection for two coils to obtain a 4-1 impedance transformation.

Applicant's Figure 2 illustrates means for obtaining a 9-1 impedance transformation between input terminals 36 and 37 and output terminals 38 and 39. If the impedance of each coil is Z, the total impedance between the terminals 36 and 37 is 3Z. The rectangles 41, 42 and 43 each represent coils with two coil sides or windings such as shown in Figure 1 and are connected as shown in applicant's Figure 2 which is the same as the right part of Figure 7 of the Guanella patent. Applicant has discovered, however, that an impedance transformation of 9-1 may be made with the connection as shown in Figure 3 with two coils 44 and 46. This may be shown by considering the unbalance currents represented by arrows placed adjacent the coils in Figure 2. It is to be seen that the unbalance current flowing in the middle coil 42 will be cancelled and therefore, the coil 42 has no effect on the unbalanced currents.

This suggested to applicant that the coil 42 might be eliminated and the connections made as shown in Figure 3.

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In this case input terminals 47 and 48 are connected to windings 52 and 53, respectively, of coils 44 and 46. The opposite ends of windings 52 and 53 are connected to output terminals 49 and 51. The second winding 57 of coil 44 has its end adjacent the input terminal 47 connected to output terminal 49 and its opposite end connected to output terminal 51. The second winding 58 of coil 46 has its end adjacent the input terminal 48 connected to the output terminal 51 and its opposite end connected to the output terminal 49. With this connection the impedance transformation is 9-1 but only two coils 44 and 46 are used instead of the three coils shown in Figure 2.

It is seen that this invention provides a new and novel way of winding a coil so as to obtain a high surge impedance and also provides a new connection for two coils to obtain a 9-1 impedance transformation.

Although this invention has been described with respect to a preferred embodiment thereof, it is not to be so limited as changes and modifications may be made therein which are within the full intended scope of the invention as defined by the appended claims.

I claim:

1. An impedance transformer for obtaining a nine-to-one impedance transformation at high impedance levels comprising first and second inductance coils, each coil including first and second input terminals and first and second output terminals, each coil also having a pair of separate windings, with one of said windings being connected between the first input and output terminals, and the other of said windings being connected between the second input and output terminals of the respective coil, each of said windings having two groups of turns wound in the same direction, two closely-wound turns forming each of said groups, with said groups being spaced widely apart relative to the spacing of the turns within a group, each coil having the groups of one winding interleaved with the groups of its other winding in spaced relationship, said transformer having first and second input points, with one input point connected to the first input terminal and the second output terminal of said first coil and to the first input terminal of said second coil, the second input point being connected to the second input terminal of said first coil and to the second input terminal and the first output terminal of said second coil, and output points for said transformer being provided by the first output terminal of said first coil and the second output terminal of said second coil.

2. An impedance transformer for obtaining a nine-to-one impedance transformation at relatively high imped-

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ance levels, comprising first and second coils, each of said coils including first and second input terminals and first and second output terminals, each coil having first and second windings, with each coil having its first winding connected between its first input and first output terminals, and with each coil having its second winding connected between its second input and second output terminals, each winding formed with a plurality of groups of turns wound in the same direction, with each group including at least two closely-spaced turns, the respective groups of the first and second windings of each of said coils being axially interleaved, a pair of input points for said transformer, with one input point connected to the first input terminal and second output terminal of said first coil and to the first input terminal of said second coil, the other transformer input point being connected to the second input terminal of said first coil and to the second input terminal and the first output terminal of said second coil, a pair of output points for said transformer being provided by the first output terminal of said first coil and the second output terminal of said second coil.

3. A radio-frequency impedance-matching transformer providing a nine-to-one ratio between a pair of input points and a pair of output points comprising first and second coils, each of said coils having first and second input terminals and first and second output terminals, each coil having a first winding connected between its first input terminal and its first output terminal, and each coil also having a second winding connected between its second input terminal and its second output terminal, with each winding formed with a plurality of groups of closely-spaced turns wound in the same direction, with said groups of each winding being widely spaced from each other, and each coil having the groups of its first winding interleaved between the groups of its second winding, one transformer input point being connected to the first input terminal of said second coil and to the first input terminal and the second output terminal of said first coil, with the second transformer input point being connected to the second input terminal of said first coil and to the first output terminal and second input terminal of said second coil, and said transformer output points being provided by the first output terminal of said first coil and the second output terminal of said second coil.

References Cited in the file of this patent

UNITED STATES PATENTS

2,470,307 Guanella ----- May 17, 1949