United States Patent

[11] **3,629,761**

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[54] **BROADBAND HIGH-FREQUENCY TRANSFORMER**
6 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **336/192,** 336/205, 336/223
[51] **Int. Cl.** **H01f 27/28**
[50] **Field of Search** 336/192, 221, 222, 223, 205, 220; 333/77, 78

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ABSTRACT: Transformer for use in the 25- to 50-megahertz frequency band for coupling from a 50-ohm source impedance to the low-input impedance of a transistor power amplifier. The transformer includes a single-layer primary winding on a ferrite rod core, with a wide-strip secondary winding about the primary winding. The primary winding may have 15 turns and the secondary winding two turns, with the secondary winding covering substantially the entire outer surface of the primary winding. The frequency of self-resonance of the transformer is above 50 megahertz so that the transformer can be used over a complete octave of frequencies (25 to 50 megahertz). The windings and terminations have low-leakage inductance to hold the LC ratio low for broadband operation.

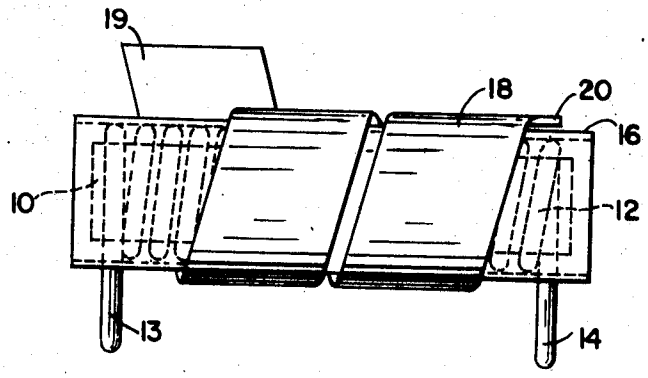


FIG. 1

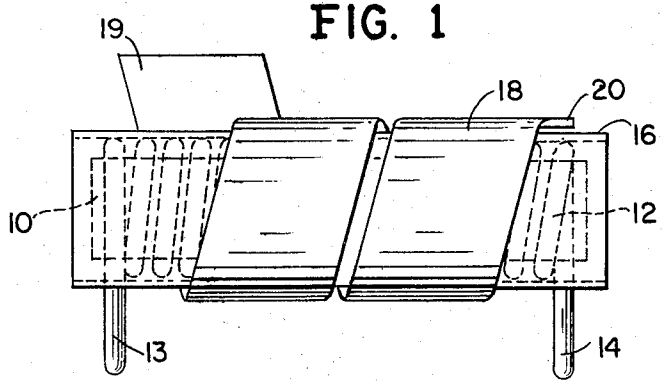


FIG. 2

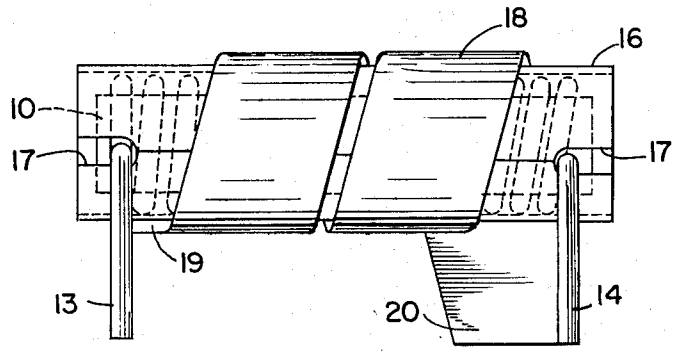
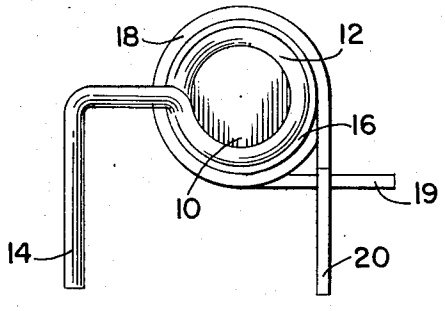


FIG. 3



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BROADBAND HIGH-FREQUENCY TRANSFORMER

BACKGROUND OF THE INVENTION

There are many applications in which a transformer is required for operating in the very high-frequency range, wherein it is desired to provide operation over a wide band of frequencies. One example is to provide coupling from a supply having an impedance of the order of 50 ohms to the input of the transistor amplifier which may have an impedance of the order of 1 ohm. In such an application, it is difficult to obtain the low-leakage inductance required for wide-band operation. It is also difficult to hold the winding capacitance low so that the self-resonant frequency of the transformer is above the range of operation. In order to have the required low-output impedance, the secondary winding must have very few turns, and this makes it difficult to obtain the close coupling required for good efficiency. There is also a problem in constructing the secondary winding so that the connections thereto do not provide objectionable inductance and resistive loss.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a broadband high-frequency transformer which is of simple construction.

A further object of the invention is to provide a transformer having a low-impedance secondary winding closely coupled to a primary winding which has a substantially greater impedance.

Another object of the invention is to provide a transformer for matching a 50-ohm source impedance to the low (1 ohm) input impedance of a transistor power amplifier, which provides effective coupling over a wide band such as from 25 to 50 megahertz and which has a self-resonant frequency above the band of interest.

A feature of the invention is the provision of a transformer having a primary winding wound in a single layer about a ferrite rod core, and a secondary winding formed by a flat conducting strip wound about and insulated from the primary winding, and which covers substantially the entire surface of the primary winding.

The transformer of the invention, as described in the preceding paragraph, provides close coupling between the primary and secondary windings for efficient signal transfer. The secondary winding and the terminals thereof are constructed to have very low-leakage inductance and resistive loss. The transformer can be used over a wide band of frequencies, such as over the octave from 25 to 50 megahertz, with the self-resonant frequency being above this frequency band as required for satisfactory operations.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of the transformer of the invention;
FIG. 2 is a side view of the transformer of FIG. 1; and
FIG. 3 is an end view of the transformer of FIG. 1.

DETAILED DESCRIPTION

The transformer of the invention is illustrated in the drawings wherein a rod core **10** is provided on which the primary winding **12** is wound. The ends of the winding **12** extend from the core **10** to form terminals **13** and **14**, which may also be used to support the transformer. Positioned about the primary winding **12** is a tubular insulator **16** which completely surrounds the primary winding and the core. The insulator can be formed from a flat sheet which is curved into a tubular shape. Slots **17** are provided in the tubular insulator for passage of the terminals **13** and **14** formed by the ends of the primary winding **12**. About the insulator **16** a flat strip conductor secondary winding **18** is provided which has ends **19** and **20** extending therefrom for making connections to the secondary winding, and for supporting the transformer. The ends **19** and **20** of winding **18** extend at substantially right angles to each other.

The transformer shown may be constructed for use in the frequency band extending between 25 and 50 megahertz, and for such use the primary winding **12** may have 15 turns for matching an input impedance of 50 ohms. The secondary winding **18** may be formed of a flat copper strip provided as about two turns about the tubular insulator **16**, with the secondary winding covering substantially the entire outer surface of the primary winding **12**. This construction provides close spacing between the primary and secondary windings for a high coupling coefficient to insure low-leakage inductance. The secondary winding provided as a copper strip has low inductance, and the ends **19** and **20** thereof form low-inductance terminations, so that the overall LC ratio is low and the transformer provides a very broadband response. The turns of the primary winding are spaced to minimize the capacitance between adjacent turns and this results in a transformer having a high self-resonant frequency, which is above 50 megahertz in the example given. This places the self-resonant frequency outside the operating band, as is required for proper operation.

The transformer of the invention can be constructed in very compact form, with the unit described having a core 1 inch long and one-fourth inch in diameter. The core is made of nickel-zinc ferrite which is commercially available from the Indiana General Corporation, Keasbey, N.J., as type Q–2. The primary winding is formed of No. 20 heavy polyurethane-coated copper wire, and the secondary winding is formed of a copper strip 0.280 inch wide and 0.01 inch thick. The insulator between the windings can be a sheet of varnished craft paper. The entire assembly may be coated with an adhesive to secure the primary winding to the core and to secure both windings to the insulator.

The transformer described has operated satisfactorily in actual use to couple signals from a 50-ohm source to an amplifier having an input impedance of the order of 1 ohm. It has been used to couple a transistor power amplifier to the output of a radio transmitter, with the primary winding connected to the 50-ohm output and the secondary winding connected to the input of the transistor amplifier.

It is obvious that the transformer can also be used as a step-up transformer with the flat low-impedance winding used as the primary winding and the higher impedance winding having a greater number of turns used as the secondary winding. The transformer will, in such an application, have the broadband characteristics described and will provide efficient coupling of signals from a low-impedance output to a higher impedance input. For example, the transformer can be used to couple the output of a transistor amplifier to an antenna.

We claim:

1. A broadband, high-frequency transformer including in combination, an elongated ferrite rod core, a first winding having a plurality of turns spaced from each other and wound in a single layer on said core, an insulating layer about said first winding, a second winding formed by a flat conductive strip wound about said insulating layer, said second winding having substantially less turns than said first winding and covering a large portion of the area of said first winding, and adhesive means securing said first winding to said core and securing said first and second windings to said insulating layer, said windings having integral extensions for making electrical connections thereto and for supporting the transformer.

2. A transformer in accordance with claim 1 wherein said core has a length of the order of 1 inch, said first winding is the transformer primary winding and said second winding is the transformer secondary winding, and said primary winding has at least five times as many turns as said secondary winding.

3. A transformer in accordance with claim 1 for use in the frequency range from 25 to 50 megahertz wherein said first winding is the transformer primary winding and has about 15 turns and said second winding is the transformer secondary winding and has about two turns, and said transformer has an impedance ratio of the order of 50 ohms to 1 ohm.

4. A transformer in accordance with claim 3 wherein the turns of said first winding are so spaced, and said windings are so constructed that the self-resonant frequency of the transformer is above 50 megahertz.

5. A transformer in accordance with claim 1 wherein said second winding is the primary winding of the transformer and said first winding is the secondary winding of the transformer.

6. A transformer in accordance with claim 5 wherein said secondary winding has at least five times as many turns as said primary winding, and said transformer has an impedance ratio of the order of 1 ohm to 50 ohms.

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