United States Patent

Brown

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[54] ELECTRICAL TRANSFORMERS

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **336/182**, 336/183, 336/192, 336/229

[51] **Int. Cl.** **H01f 27/28**

[58] **Field of Search** 336/180, 182, 183, 192, 229

[56] **References Cited**

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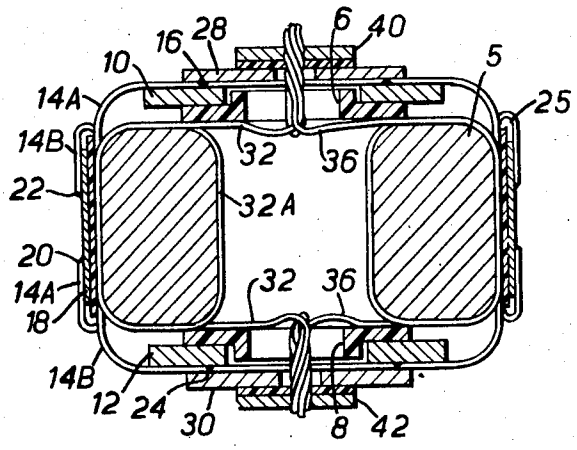
[57] **ABSTRACT**

A wideband transformer, particularly suitable for use in transistor high-frequency amplifiers, is disclosed. The transformer has a toroidal core mounted between first and second electrically conductive, apertured disks. A conductive band encircles the outer periphery of the core. The single-layer primary consists of several parallel-connected windings each having two bi-filar turns one of which is connected to one of the disks and passes round the core and is connected to the encircling band, and the second of which is connected to the encircling band and passes round the core and terminates on the other disk. The secondary, also single-layer, comprises several parallel-connected windings each having a number of turns, the ends of the secondary windings passing through the apertures of the conductive disks and terminating on further, insulated conductive washers.

8 Claims, 2 Drawing Figures



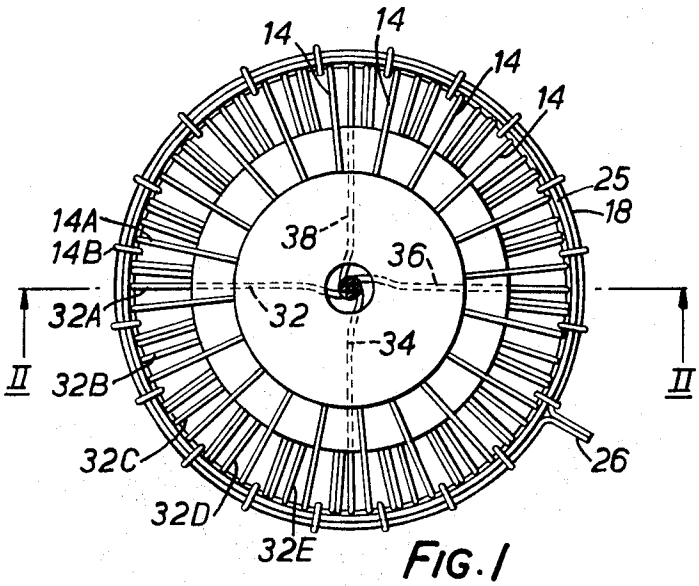


FIG. 1

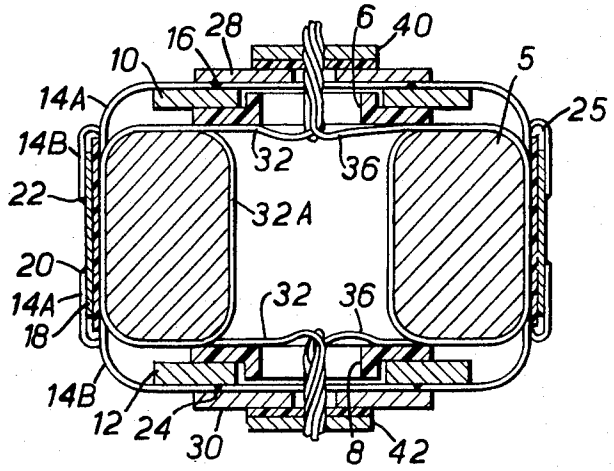


FIG. 2

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ELECTRICAL TRANSFORMERS

BACKGROUND OF THE INVENTION

The invention relates to electrical transformers, such as wideband transformers particularly suitable for use in transistor high-frequency amplifiers for example.

Transformers have been previously proposed with a magnetic core providing a closed magnetic circuit and carrying multiple windings arranged in parallel. With such transformers operating at very low impedances, a problem is to reduce the leakage inductance while maintaining a reasonable value of coupling inductance.

It is an object of the invention to provide an improved transformer.

It is a more specific object of the invention to provide a transformer in which the windings are terminated with very low additional inductance and facilitating the use of very low inductance connecting leads.

According to the invention, there is provided an electrical transformer, comprising a magnetic core providing a closed magnetic circuit around an aperture, first and second conductors providing relatively large electrically conductive areas and arranged to extend across the aperture with the core between them, a plurality of primary windings wound on the core all in a single-layer and extending through the core aperture and terminating on the conductors so as to be connected in parallel thereby, third and fourth conductors providing relatively large electrically conductive areas and respectively arranged adjacent to but insulated from the first and second conductors, and a plurality of secondary windings wound on the core all in a single-layer and extending through the core aperture and terminating on the third and fourth conductors so as to be connected in parallel thereby.

DESCRIPTION OF THE DRAWINGS

A wideband transformer embodying the invention will now be described, by way of example only, with reference to the accompanying drawing in which:

FIG. 1 is a plan view of the transformer; and

FIG. 2 is a section on the line II—II of FIG. 1.

DESCRIPTION OF PREFERRED EMBODIMENT

The transformer comprises a ferrite toroid **5** on which are mounted upper and lower stepped insulating rings **6** and **8**. A conductive washer or centrally apertured disk **10, 12**, made of copper for example, is mounted on each insulating ring **6, 8**. The primary of the transformer consists of 20 (in this example) parallel-connected center-tapped windings **14** (only some being referenced on the drawing), each winding having two bifilar turns. FIG. **2** shows one of the windings **14** in greater detail. This winding consists of two turns **14A** and **14B**. The turn **14A** is soldered to the conductive disk **10** at a point **16** and is led therefrom down the outside surface of the toroid **5**, then round the toroid in an anti-clockwise direction as viewed in FIG. **2** so as to pass down the outside surface of the toroid **5** again until it is finally curved round the lowest edge of a copper band **19** and soldered thereto at a point **20**. The other turn **14B** of the winding in question is soldered to the band **18** at a point **22**, then looped round the top edge of the band and passes down the outer surface of the toroid **5**, around the toroid in an anti-clockwise direction and is finally terminated by soldering to the lower conductive disk **12** at a point **24**. The other primary windings are arranged similarly and each consists of two wires.

The band **18** completely encircles the outside of the toroid **5** and is insulated from the windings thereon by a liner **25** of p.t.f.e. or similar material. The two ends of the band are bent outwardly of the toroid **5**, as shown in FIG. **1**, to form the primary winding center-tap terminal **26**.

Large conductive washers or centrally apertured disks **28, 30**, are soldered onto the disks **10, 12** and make electrical connection with the points **16** and **24** and the corresponding points of the other primary windings.

The secondary of the transformer has a higher impedance and consists of four (in this example) windings **32** to **38**. Each winding comprises five turns, made of p.t.f.e. insulated wire for example, interwound with the primary windings. Thus, the winding **32** has five turns **32A** to **32E** (FIG.1). As shown in FIG. **2**, one end of the winding **32** passes through an aperture in the upper conductive disk **28**, where it is electrically connected in parallel with the corresponding end of the other three secondary windings, and the other end of the winding **32** passes through an aperture in the lower conductive disk **30** where it is connected in parallel with the other ends of the secondary windings. The two ends of the secondary windings are connected to respective conductive washers or centrally apertured disks **40, 42** (omitted from FIG. 1) which are insulated from and have a smaller diameter than the disks **28** and **30**.

Therefore, in use, electrical connections are made to the two ends of the primary by means of the disks **28** and **30**, and to the two ends of the secondary by means of the disks **40** and **42**. The terminal **26** is a center-tap terminal of the primary.

It will be seen that all the terminations are of large area which facilitate connection by low inductance copper strips. The transformer described has very low leakage inductance, and yet maintains a reasonable value of coupling inductance between the primary and secondary windings. Furthermore, the circumferential band **18** and the single-layer and uniform nature of the windings minimize problems caused by heating. The described transformer is particularly suitable for use in transistor h.f. power amplifiers.

In a modification, the disks **28** and **30** can be formed with integral and projecting connecting tags. In addition, a U-shaped band may be arranged to partially encompass the circular band **18** and to be in electrical contact therewith to provide a center-tap termination to replace the terminal **26** of FIG. **1**. Such modified arrangement is particularly suitable for printed circuit board mounting.

It will be appreciated that many modifications can be made to the transformer described without departing from the scope of the invention as defined in the claims. For example, the number of windings in the primary and/or secondary and the number of turns in each winding can be altered from that described, and in one particular embodiment the primary has six windings (each of two turns) and the secondary has two windings (each of 10 turns).

What is claimed is:

1. An electrical transformer, comprising

a magnetic core providing a closed magnetic circuit extending around and defining an aperture,

first and second electrical conductors each providing relatively large electrically conductive area,

means mounting the first and second conductors on the core so that they extend across the aperture therein with the core between them,

a plurality of primary windings wound on the core all in a single-layer and extending through the said aperture with the ends of each winding being respectively electrically connected to the first and second conductors so that the windings are electrically connected in parallel thereby,

third and fourth conductors each providing relatively large electrically conductive area,

means respectively mounting the third and fourth conductors adjacent to but electrically insulated from the first and second conductors, and

a plurality of secondary windings wound on the core all in a single-layer and extending through the aperture thereof with the ends of each secondary winding being respectively electrically connected to the third and fourth conductors so that the secondary windings are electrically connected in parallel thereby.

2. A transformer according to claim **1**, in which each of the first and second conductors defines a through hole, in which the third and fourth conductors are respectively mounted outside of the first and second conductors, and in which the ends

of the secondary windings extend with electrically insulating clearance through the holes in the first and second conductors to the third and fourth conductors.

3. A transformer according to claim 1, in which each of the primary and secondary windings comprises a plurality of turns and the turns of the primary windings are arranged in bi-filar form.

4. A transformer according to claim 1, including an electrically conductive band at least partially encircling the outer periphery of the core, and in which each primary winding comprises a first turn connected at one end to the first conductor and wound round the core and terminating at an electrical connection on the said band, and a second turn electrically connected to the said band and wound round the core and terminating at an electrical connection on the second conductor.

5. A transformer according to claim 1, in which the core is a toroidal core.

6. A high frequency, wideband electrical transformer, comprising

a toroidal core,

first and second planar, apertured electrical conductors mounted on opposite sides of the core with their apertures coaxial with the core,

an electrically conductive band encircling the outer periphery of the core,

a plurality of primary windings wound on the core all in single-layer form, each primary winding having two bi-filar turns one of which is electrically connected at one end to the first conductor and winds round the core and is electrically connected at the other end to the said band, and the other of which is electrically connected at one end to the said band and winds round the core and is electrically connected at the other end to the second conductor, such that the said band provides a center-tap terminal for the transformer,

third and fourth planar electrical conductors respectively arranged outside of and adjacent to but electrically insulated from the first and second conductors, and

a plurality of secondary windings wound on the core and in single-layer form and each winding comprising a plurality of turns round the core with one end of each winding extending with electrically insulating clearance through the aperture in the first conductor to an electrical connection on the third conductor and the other end of each winding extending with electrically insulating clearance through the aperture in the second conductor to an electrical connection on the fourth conductor.

7. A transformer according to claim 6, in which each turn of the secondary winding is made of p.t.f.e. insulated wire.

8. A transformer according to claim 6, including respective terminal means on each of the first, second, third and fourth conductors and on the said conductive band, for making external connections to the transformer.

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