19	Europäisches Patentamt European Patent Office Office européen des brevets	(1)	Publication number:	0 343 A2	886	
EUROPEAN PATENT APPLICATION						
2) (2)						
(3) (3) (8)	29.11.89 Bulletin 89/48		Applicant: EEV LIMITED 106 Waterhouse Lane Chelmsford Essex CM1 20 Inventor: Iskander, Stephen "Heavitree" Moulsham Stru Chelmsford Essex CM2 0J	n Mark eet		
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Generation Circuit arrangements.

(7) A circuit arrangement includes a transformer 12 having a core 13 about which is wound a primary winding 14 and a secondary winding 15 which is connected to a load, such as a magnetron. The secondary winding 15 comprises two windings 17 and 18 which are wound in opposite senses and arranged adjacent one another.



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CIRCUIT ARRANGEMENTS

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This invention relates to circuit arrangements and more particularly, but not exclusively, to arrangements including a transformer in which current passed through a primary winding is used to drive a load, such as a magenetron, connected across a secondary winding.

A circuit arrangement which is conventionally used for driving a magnetron is illustrated in Figure 1. It includes a pulse transformer 1 having a core 2 about which is wound a primary winding 3 and a secondary winding 4. The primary winding 3 is connected to a d.c. charging circuit indicated generally at 5 which includes a switch 6 for controlling transmission of current pulses through the primary winding 3. The secondary winding 4 is bifilar, that is, it consists of two wires wound together in parallel such that the adjacent turns carry current in opposite directions. The secondary winding 4 is connected to the supply of the magnetron heater element 7. The proximity of the two wires produces only a surface effect within the core 2 and magnetic fields generated by the heater current passing along the secondary winding 4 tend to cancel each other out. The magnetron cathode is connected to one of the heater element terminals 8, the other terminal being shown at 9.

The B-H curve of the core 2, showing the flux density B as a function of magnetic field strength H is illustrated in Figure 2. The smaller curve, YY1, is the hysterisis loop at low magnetising force and the other loop, ZZ¹, is the largest, at which saturation occurs if H_2 is exceeded. The curves OXY and OXZ show the curve taken on the first half of the cycle for each loop when the core material is unmagnetised. The part of the hysteris loop at which operation occurs may be by applying biasing to the core 2. The curves WW1 and VV1 are selected by using positive and negative biasing respectively. When a pulse is passed through the primary winding 3, the transformer core becomes magnetised. After transmission of the current pulse, and thus removal of the magnetic field, the remanence R remains, decaying in a time depending on the core material, the conditions existing in the core and other external conditions. It is desirable to reset the transformer core between pulses to permit a larger range of the B-H curve to be used, thus maximising the power which can be handled for a given core volume. By producing a relatively large change in B as it decreases, the capability of the core to pass longer pulse widths is enhanced. To reset the transformer core 2, an additional auxillary winding 10 is required which is connected to a power supply 11. After a pulse has been transmitted through the primary winding 3, producing magnetisation, a pulse is transmitted through the auxiliary winding 10. This causes a magnetic field to be applied which opposes the effects produced by the pulse through the primary winding 3, resetting the transformer core.

The present invention seeks to provide an improved circuit arrangement which includes a transformer core.

According to a first aspect of the invention there is provided a circuit arrangement comprising 10 a transformer having a substantially toroidal core and a winding about the core which comprises two wires, one being wound in the opposite sense to the other and at least some of the turns of one wire being wound on a different part of the core to those 15 of the other. The core is typically, but not necessarily of circular cross-section. The use of such a winding enhances the operation of the transformer as it enables a greater change in the B field to be achieved. It is believed that this is because each of 20 the wires produces a magnetic field within the core material, rather than the surface effect produced by the conventional bifilar winding, as at least some of the turns of one wire are spaced apart from those 25 of the other. The fields produced are equal and opposite and thus completely cancel one another. The dipole elements of the core material are acted on by the fields which, although their resultant force is zero, cause the mobility of the dipole elements to be increased as they are in a state of 30 dynamic equilibrium. Due to microscopic variations in dipole strength, size and orientation, changes in the applied field produce a faster response. This enables the core to pass longer pulse widths than is possible using a conventional arrangement. 35

The winding may be arranged such that only part of each of the wires is spaced from the other, but preferably each wire is wound on a different part, so there is no overlap between them. The winding may be separate from others on the core but in a particularly advantageous embodiment, the winding is a secondary winding across which a load is connected.

According to a second aspect of the invention there is provided a circuit arrangement comprising a transformer having a secondary winding across which a load is connected and means arranged to pass a current through the secondary winding to reset the transformer core after transmission of current through its primary winding. By the term "resetting" it is meant that the flux density is reduced from what it would otherwise be, and not necessarily only that negative saturation or remanence is achieved. By arranging that the secondary winding is used in resetting the transformer

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core, the additional power supply, auxiliary winding and other circuit elements needed in a conventional arrangement are not required. The invention is particularly applicable to arrangements in which the load is a magnetron, the current used to reset the core also being the heater current for the magnetron. This may be achieved by employing a secondary winding which comprises two windings which are arranged adjacent one another and wound in opposite senses.

One way in which the invention may be performed is now described by way of example with reference to Figure 3 of the accompanying drawings which schematically illustrates a circuit arrangement in accordance with the invention.

With reference to Figure 3, a circuit arrangement in accordance with the invention includes a transformer 12 having a transformer core 13 about which are wound primary and secondary windings 14 and 15. The primary winding 14 is connected to a d.c. charging circuit 16 similar to that shown in the circuit arrangement of Figure 1. The secondary winding 17 is connected to a load, which in this embodiment is a magnetron. The secondary winding comprises two wires 18 and 19 which are arranged adjacent one another and wound in opposite senses. The secondary winding 17 includes four terminals 20, 21, 22 and 23. The magnetron heater element is connected across two of the terminals 21 and 22 which are arranged between the two parts 18 and 19 of the secondary winding 17. The terminal 21 is also connected to the magnetron cathode. The terminal 20 is the input terminal of the heater supply to which the heater current is applied and the terminal 23 is connected to earth.

Claims

1. A circuit arrangement comprising a transformer having a substantially toroidal core and a winding about the core which comprises two wires, one being wound in the opposite sense to the other and at least some of the turns of one wire being wound on a different part of the core to those of the other.

2. An arrangement as claimed in claim 1 wherein one wire is wound on one part of the core and the other on another part of the core.

3. An arrangement as claimed in claim 1 or 2 and including means for passing a direct current through the winding.

4. An arrangement as claimed in claim 1, 2 or 3 wherein the winding is a secondary winding across which a load is connected. 5. A circuit arrangement comprising a transformer having a secondary winding across which a load is connected and means arranged to pass a current through the secondary winding to reset the transformer core after transmission of current through its primary winding.

6. An arrangement as claimed in claim 5 wherein the secondary winding comprises two windings which are arranged adjacent one another and which are wound in opposite senses.

7. An arrangement as claimed in claim 4, 5 or 6 wherein the load is a magnetron and current passed through the secondary winding is heater current for the magnetron.

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