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Other: **EPODOC, WPI, TXTE**
updated as appropriate

(72) Inventor(s):
George Young

(73) Proprietor(s):
Eisergy Limited
(Incorporated in the United Kingdom)
No.1 Grant's Row, Second Floor, Lower Mount Street, Dublin D2, Ireland

(74) Agent and/or Address for Service:
Hanna, Moore + Curley
13 Lower Lad Lane, Dublin 2, D02 T668, Ireland

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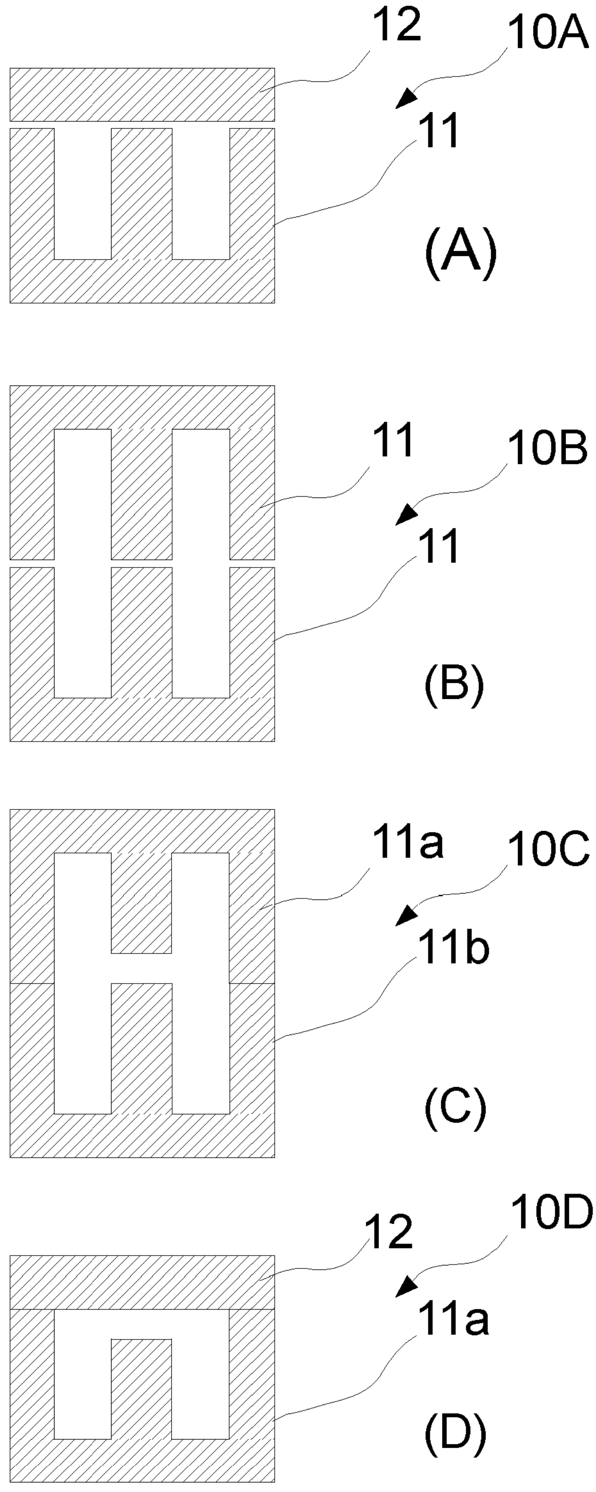
Figure 1



PRIOR ART

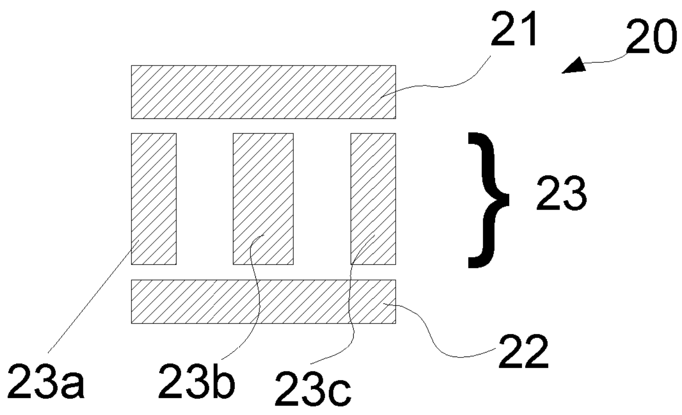


Figure 2

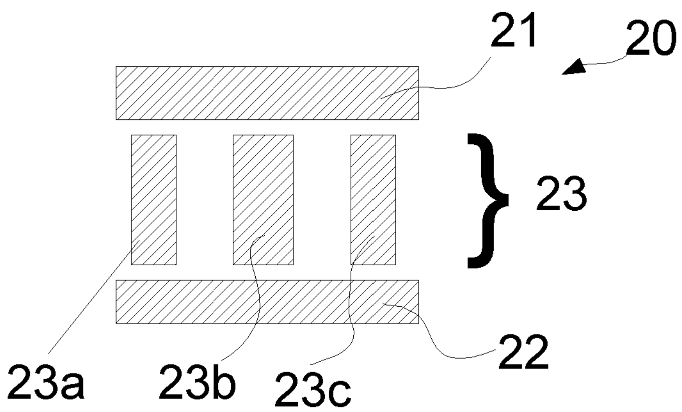


Figure 3

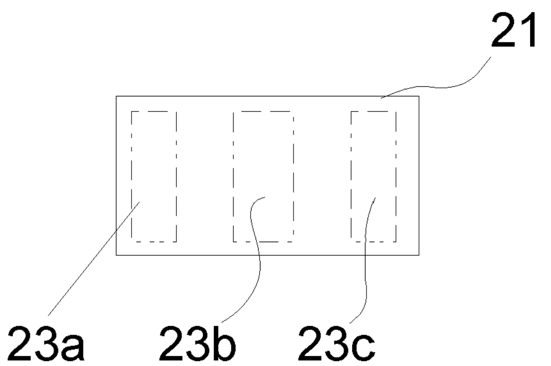
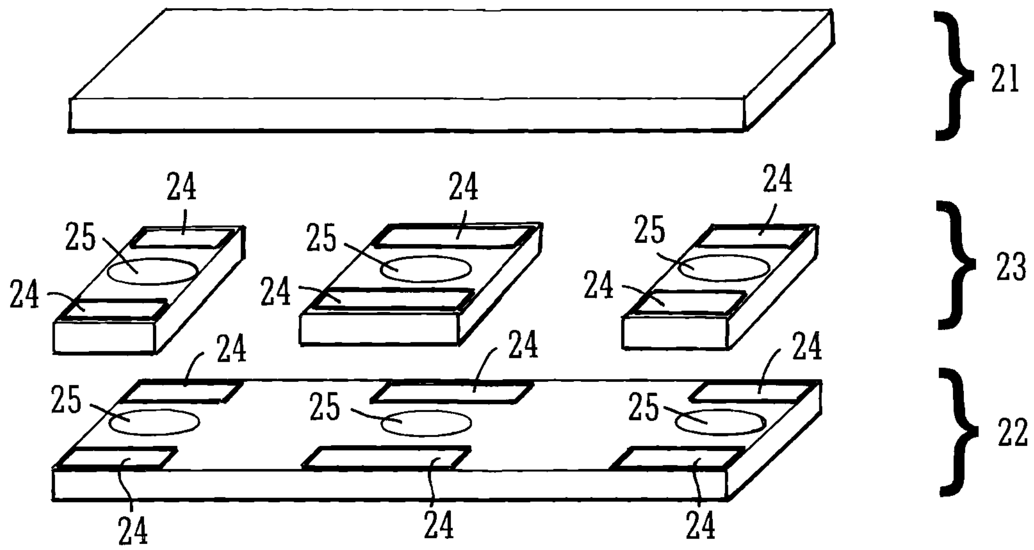


Figure 4


21
23
22
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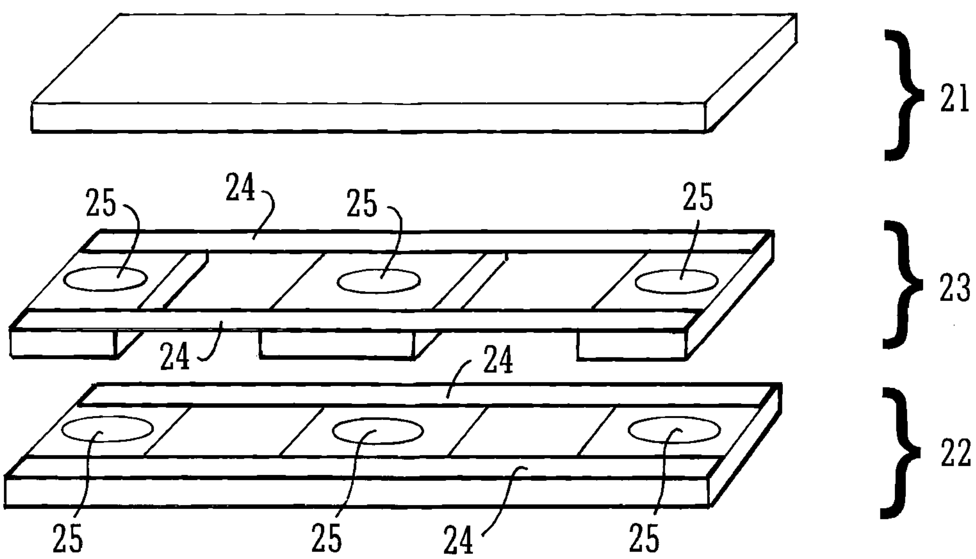
24

FIG. 5


21
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22
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24
25

FIG. 6

30

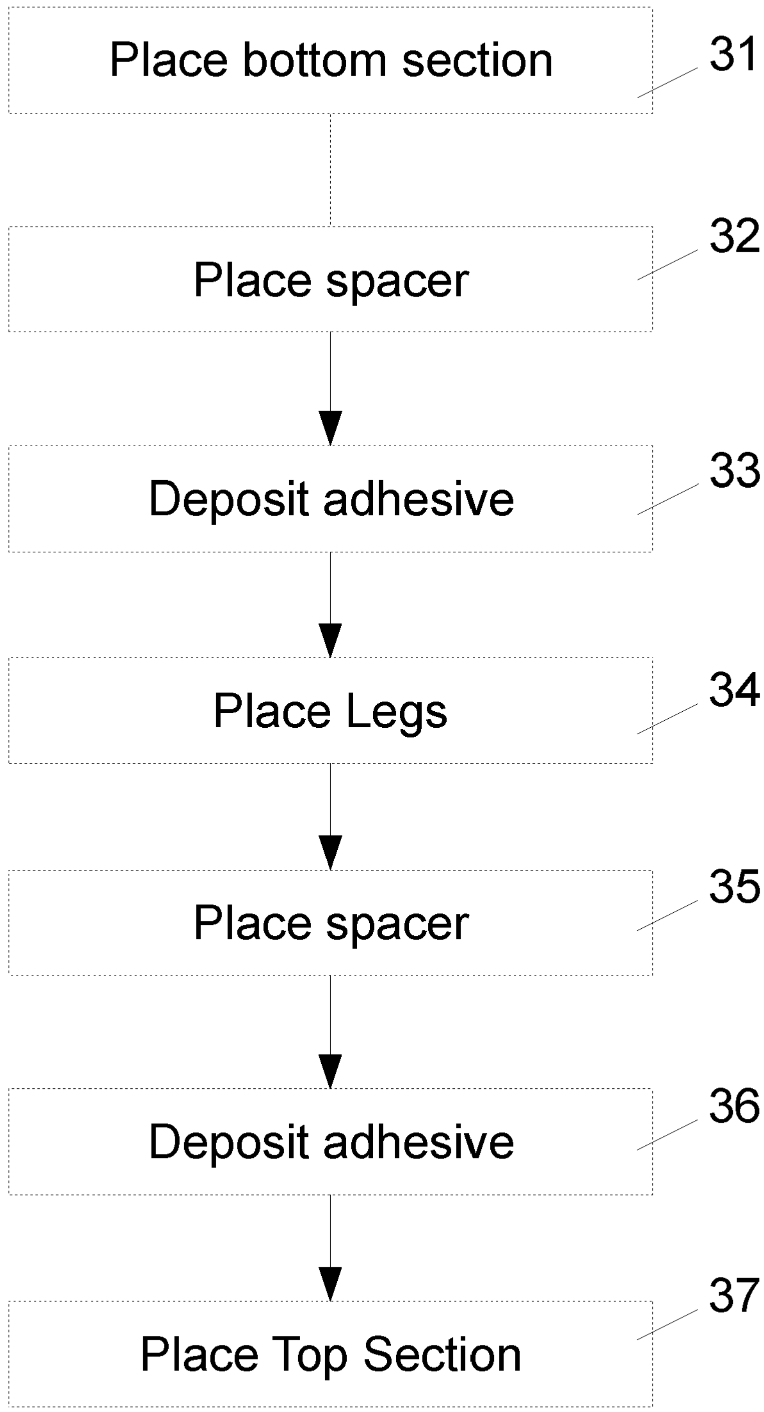

Place bottom section
31
Place spacer
32
Deposit adhesive
33
Place Legs
34
Place spacer
35
Deposit adhesive
36
Place Top Section
37

Figure 7

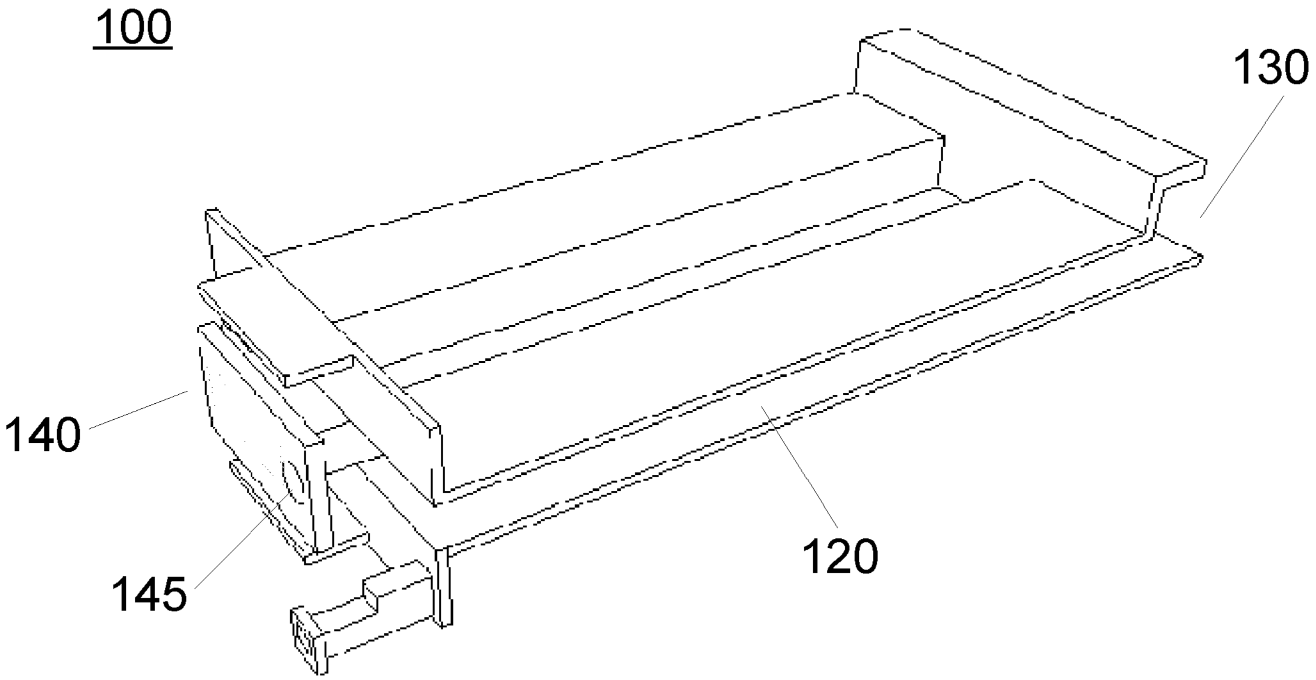


Figure 8

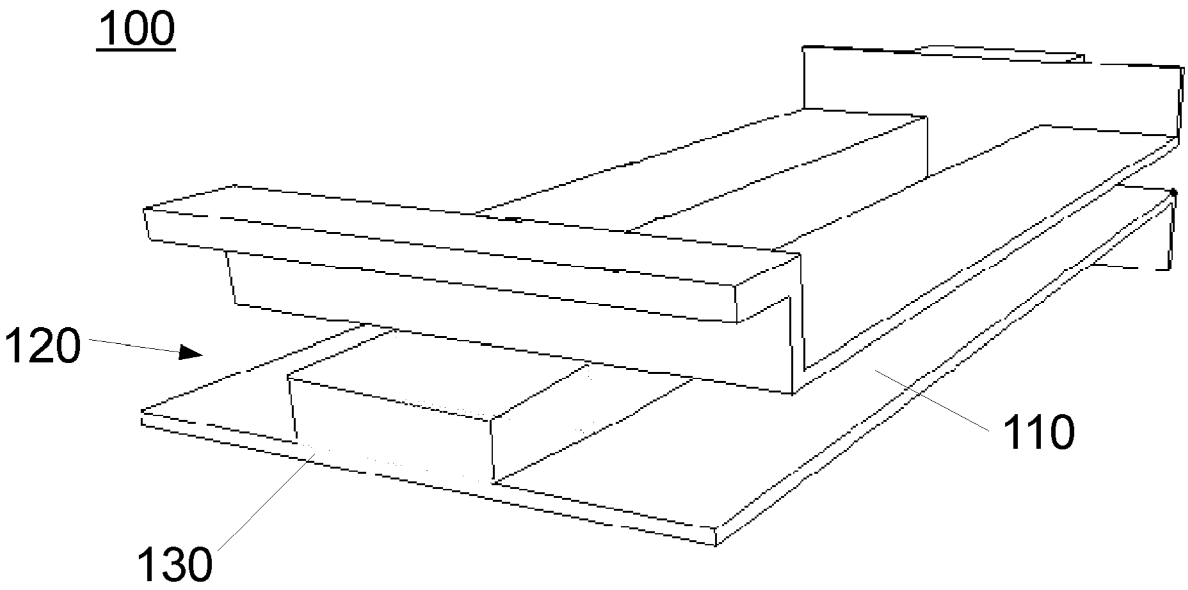


Figure 9

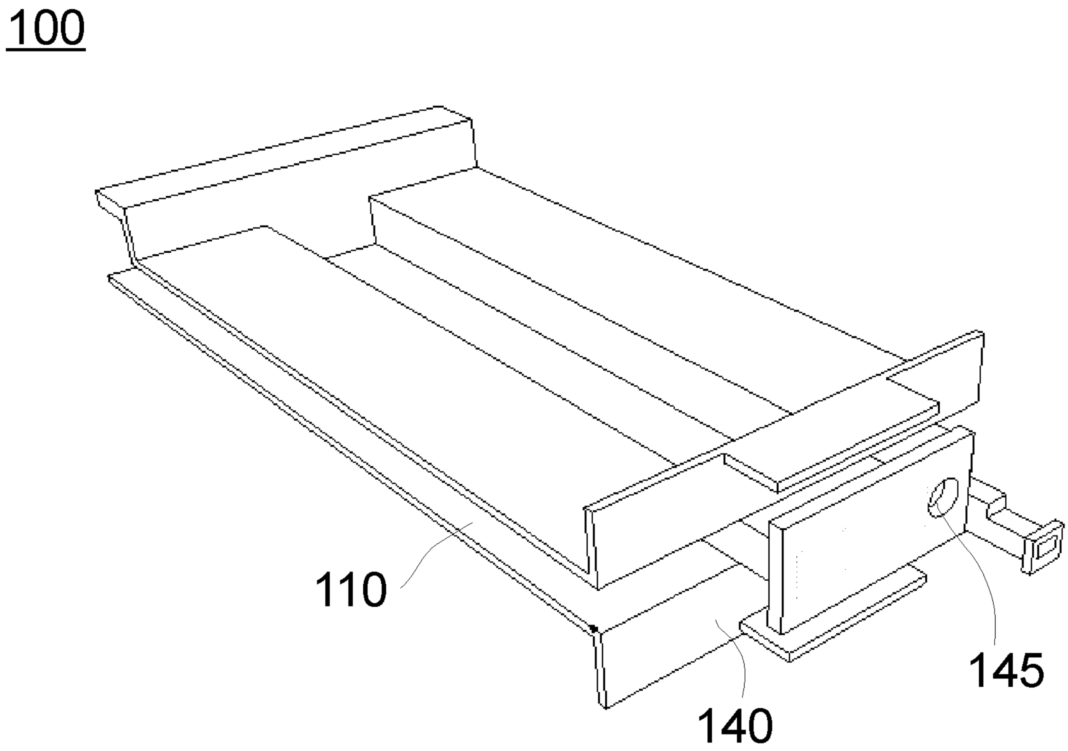


Figure 10

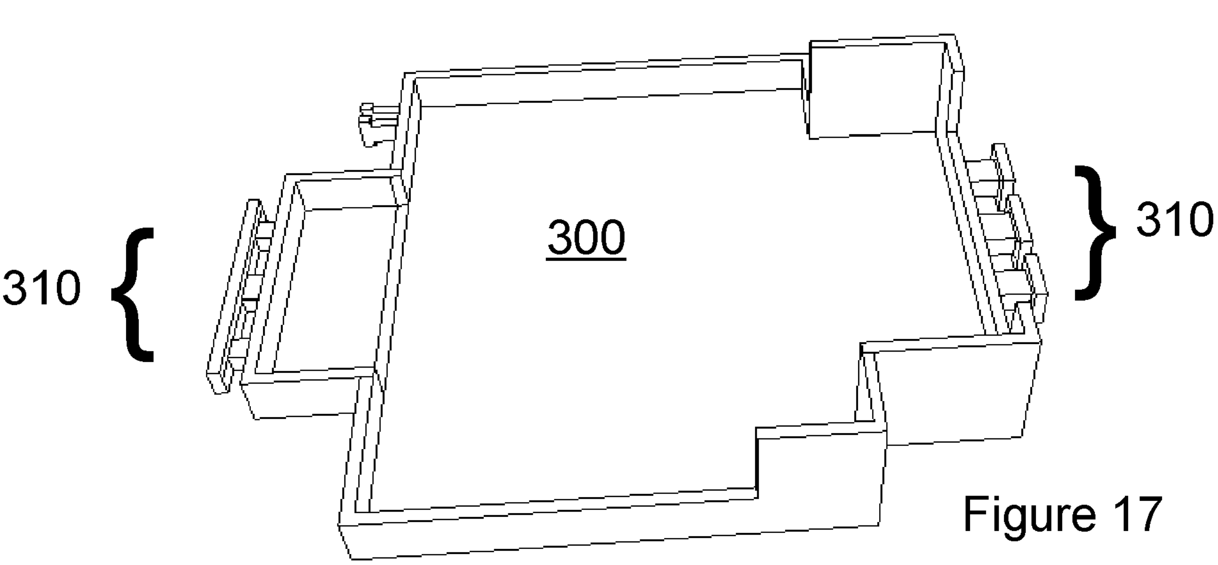


Figure 17

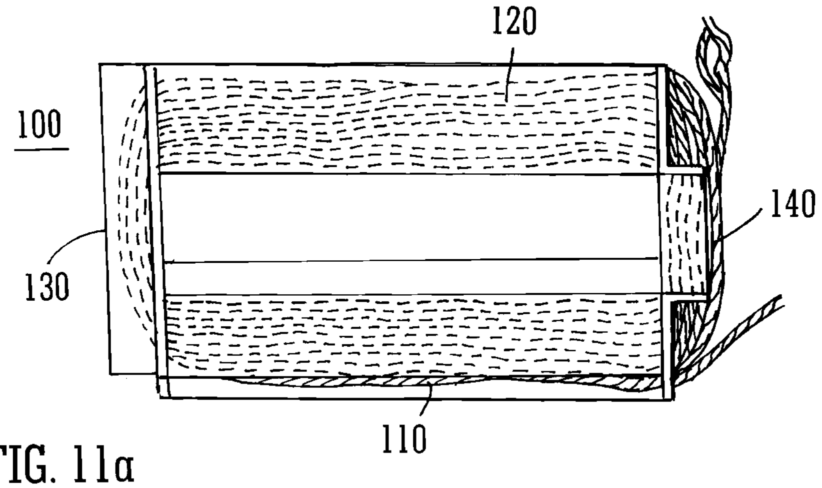


FIG. 11a

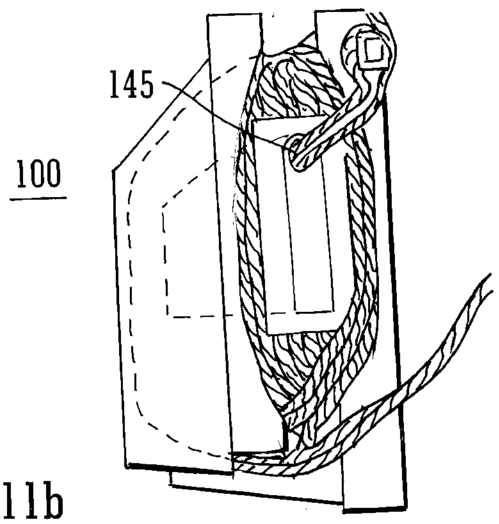


FIG. 11b

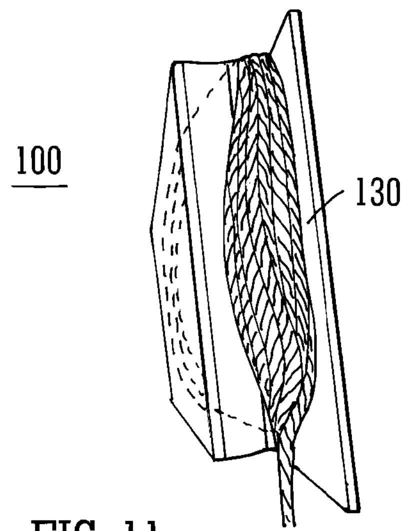
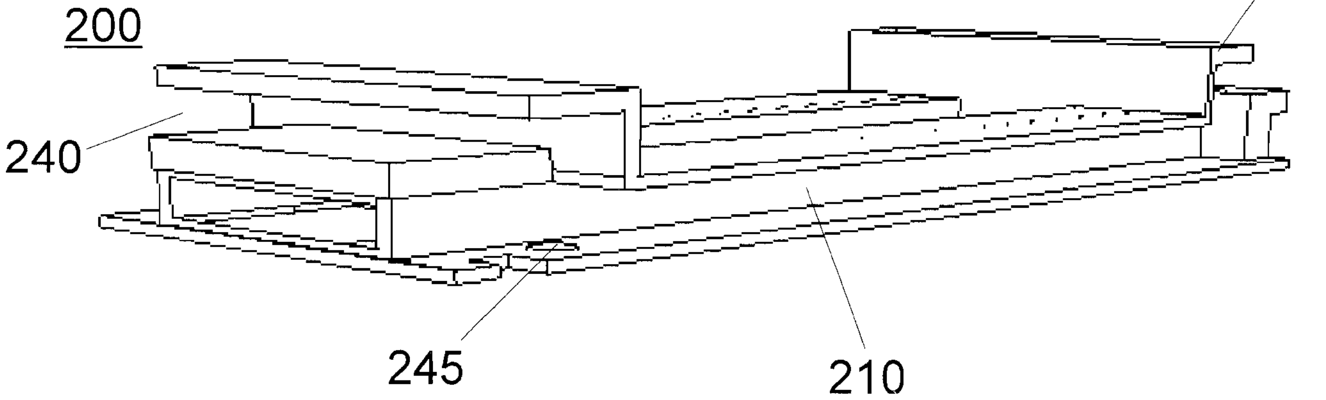


FIG. 11c

Figure 12



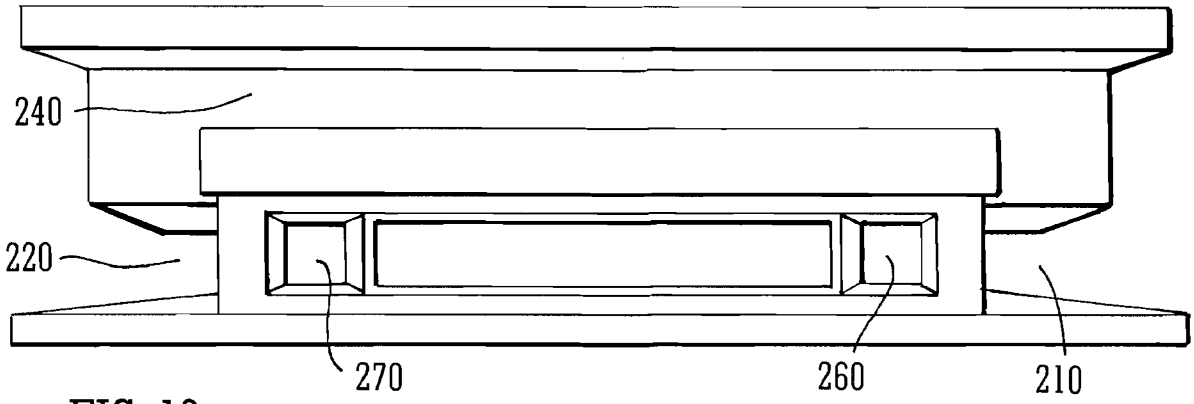


FIG. 13

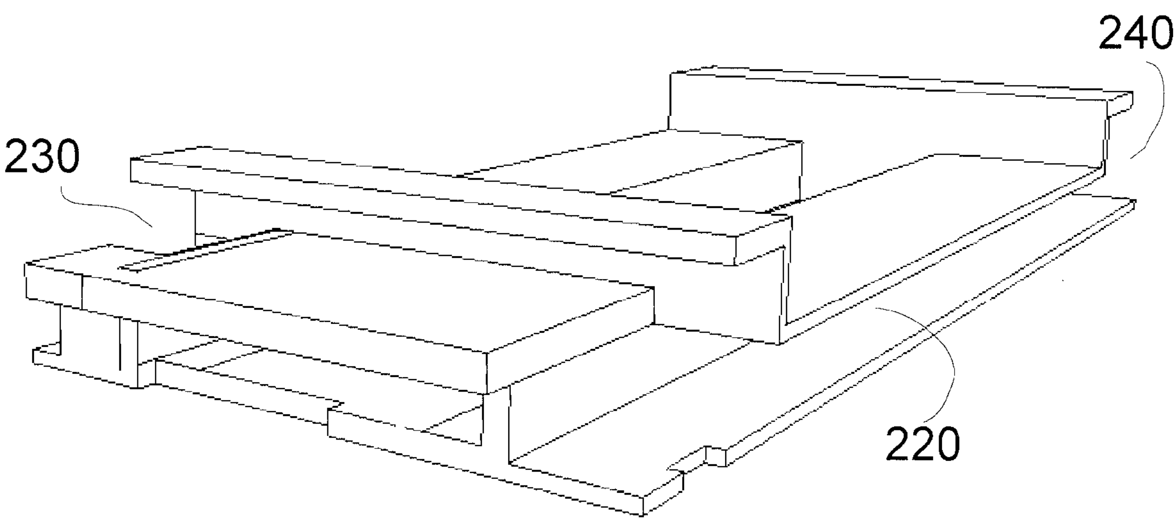


Figure 14

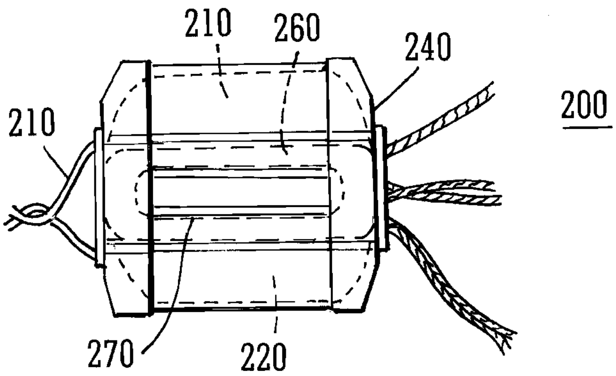


FIG. 15a

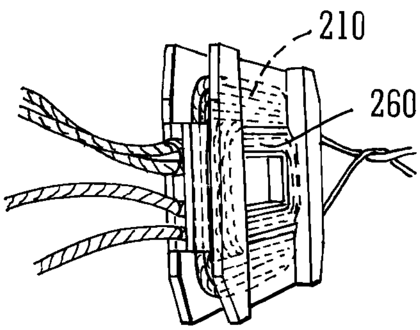


FIG. 15b

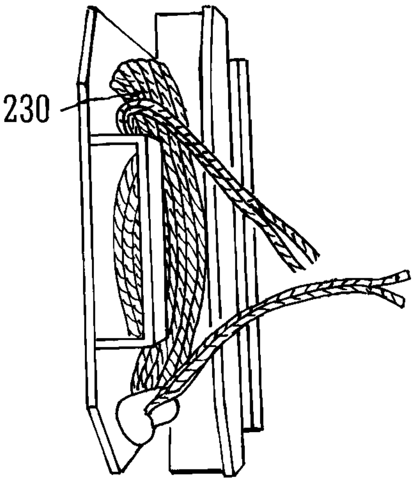


FIG. 15c

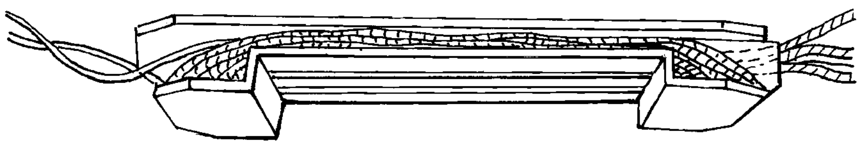


FIG. 15d

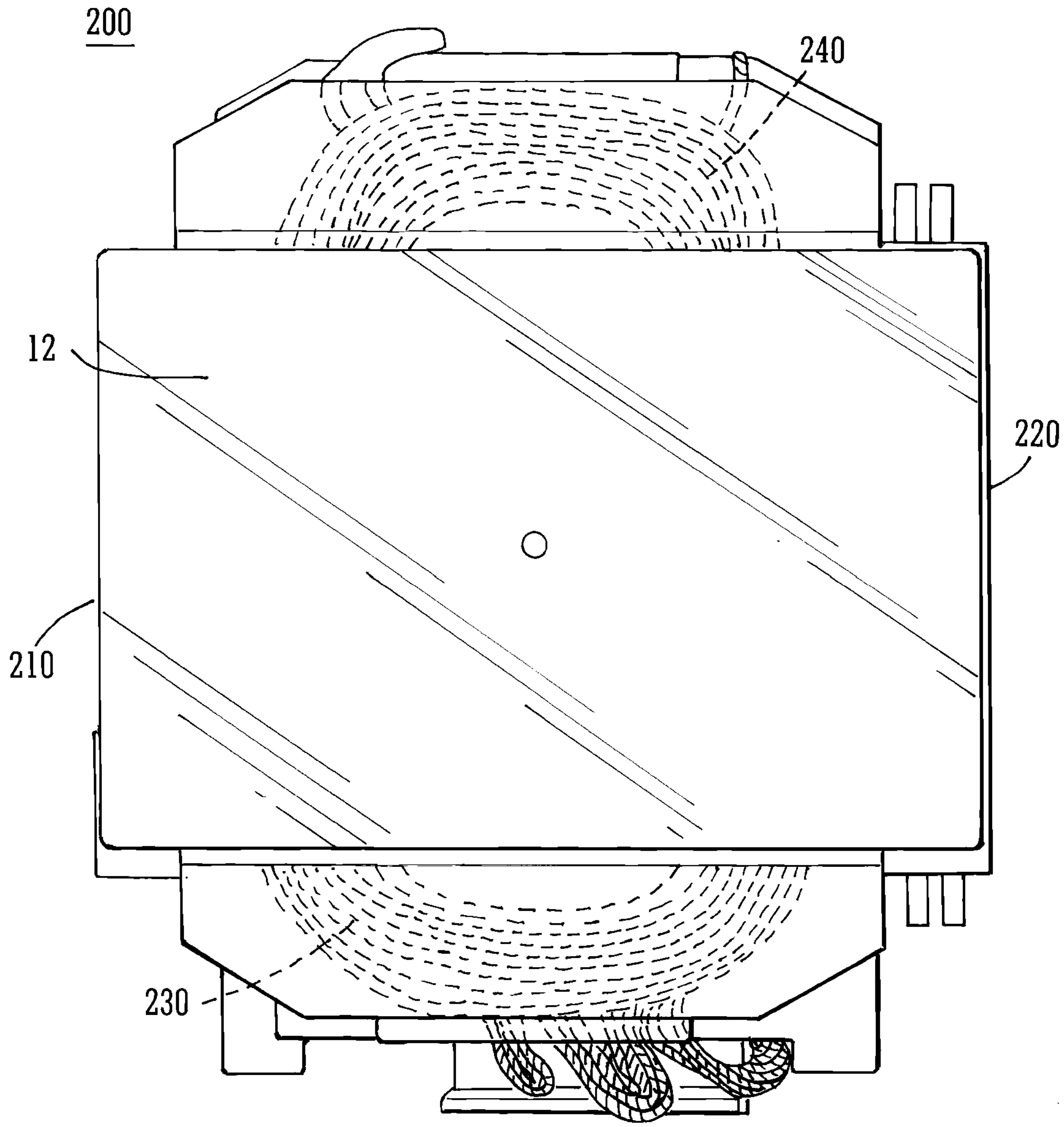


FIG. 16

Title

A MAGNETIC COMPONENT FOR A SWITCHING POWER SUPPLY AND A METHOD OF MANUFACTURING A MAGNETIC COMPONENT

Field

The present application relates to magnetic components employed in switching power supplies.

Background

Magnetic components are used in switching power supplies for the storage of electrical energy in a magnetic field. Magnetic components comprise an electrical part (windings) and a magnetic core.

A magnetic core is a piece of magnetic material with a high permeability used to confine and guide magnetic fields in electromagnetic devices such as transformers and inductors. Magnetic cores are typically made from a ferromagnetic such as ferrites. The high permeability, relative to the surrounding air, causes the magnetic field lines to be concentrated in the core material. The magnetic field is created by a coil of wire around the core that carries a current. The presence of the core can increase the magnetic field of a coil by a factor of several thousand over what it would be without the core.

The use of a magnetic core can enormously concentrate the strength and increase the effect of magnetic fields produced by electric currents. The properties of a device will depend on a number of factors including for example the geometry of the magnetic core, the amount of air gap in the magnetic circuit and the properties of the core material.

Depending on the application, a variety of different magnetic core shapes are available. One or more electrical windings are wound around one or more sections of the core. A bobbin may be used to form and retain the windings. Bobbins are typically formed from an insulating material such as plastic. There are a variety of different core shapes known, for example: open core shapes, including “I”, “C” “E” and “U” cores which are so called because of their corresponding cross sectional shape; and closed core shapes, which may be formed by combining such open core shapes together.

E-shaped sections are generally selected to form a closed magnetic core using either a second “E” shaped section or an “I” shaped section with the electric circuit wound around the resulting center leg. The E-section core tends to be the most common type of core employed due to its shielding properties and the ability to support the structure mechanically.

A number of variations on the general E shaped cores are known including pot cores and EFD, ER and EP cores. For example, a pot core may be viewed as having a generally “E” shaped cross section albeit that it has been rotated somewhat to further enclose the center leg between the outer legs.

Whilst the magnetic core is one part of the magnetic component, an equally important part is the electrical part. The electrical part provides conductive elements which form turns around the magnetic material referred to generally as windings. These windings may be in the form of stampings, rigid or flexible printed circuit boards or wound wire (on bobbins, or self-supporting). Optimising the winding structure is important in the context of getting best performance from the magnetic component. It will be appreciated that the definition of best performance will vary depending on the application and will generally involve a trade-off between different characteristics. For example, depending on the application, it may be desirable to minimise leakage inductance. Equally in other applications it may be desirable to have increased leakage inductance. For example, with switching power supplies it is generally desirable to have compact magnetic components and low losses. At the same time there can be conflicting demands. For example, for a transformer employed in a mains powered switching power supply it is essential that sufficient isolation be provided between primary and secondary windings. It will be appreciated that magnetic components employed in switching power supplies are not generally comparable with those used for general AC conversion, i.e. mains frequencies of 50/60Hz. Switching power supplies generally operate at frequencies above audio frequencies, i.e. above 20kHz and so would have entirely different design characteristics. Thus, whilst iron laminate cores may be common in mains (non-switched) transformers, similar iron laminate cores (i.e. laminate cores having a thickness suited for use in mains transformers) would be considered entirely unsuitable in a switched power supply.

Thus in switching power supplies, the cores selected for magnetic components are generally formed from a suitable ferrite material. Most ferrites used for cores in switching power supply deployments have a relative permeability (μ_r) in the order of 500 or more. Low effective permeability is desired in many magnetic components, and accordingly in the case of ferrite materials, it is usual to introduce a gap in the magnetic path through the ferrite material.

There is a number of ways of forming air gaps with three legged cores using “E” shaped cores. For example, in Figure 1 (a) a magnetic component 10A is provided with three air gaps formed by assembling an “E” core 11 and an “I” core 12 with a gap therebetween, thereby leaving air gaps between the “I” core and each leg of the “E” core 11, or as shown in Figure 1(b) by assembling two “E” cores 11 with a gap therebetween to provide the core 10B.

However, the conventional solution in providing an “air” gap, as shown in the core 10C of Figure 1(c) is to shorten the centre leg of a first "E" core 11a and to assemble this in combination with a second “E” core 11b. In this manner, the air gap sits in the middle of the coil which in turn would typically is wound around the center leg, i.e. there is no gap in the outer legs. This is done so as to minimise fringing and reduce electromagnetic interference. The term “air” gap is generally used to refer to any gapped core as such even though the gap may not be filled by air but by nylon or some other non-saturable material (non-saturable being relative to the magnetic material used in the core).

Less conventionally, an “E” core 11a with a shortened leg might be combined with an “I” core 12 to provide a core 10D as shown in Figure 1(d). Magnetic cores are however fragile and grinding operations to shorten a leg can produce an unreliable gap length, whilst at the same time introducing a step in the manufacturing process. Although cores prefabricated with a shortened leg are known, it will be appreciated that this limits the component designer's freedom to meet particular design objectives.

A further problem with the conventional approach of Figure 1(c) is that a large fringe-field area exists which can cause significant loss in the conductive materials. This effect may be ameliorated somewhat using Litz-wire in windings, or by techniques involving the interchange of strands in printed-wire conductors. However, Litz windings whilst desirable for losses introduce other problems, for example the limited availability of adequate insulation to ensure isolation between primary and secondary windings. Nonetheless, even where Litz wire is employed considerable increases in AC-resistance can still occur due to presence of the air-gap. Recommended industry practice can be to keep wiring away from the gap, with the distance typically being several times the gap length. This creates difficulties and requires careful arrangement of the windings, which it will be appreciated, can complicate the designing of the winding arrangements.

The present application seeks to address one or more of the shortcomings set forth above.

Summary

The application further provides a transformer comprising a bobbin having an opening, a three legged magnetic core having a middle leg passing through the bobbin opening, a first winding provided in a first concentric path to the middle leg of the magnetic core, a second winding provided in a second concentric path to the middle leg of the magnetic core, where the first and second concentric paths are isolated from each other by the structure of the bobbin, wherein the first concentric path comprises two longitudinal passages enclosed by the structure of the bobbin, wherein the first winding exits the bobbin through a first opening to the longitudinal passages at a first end and where a second opening is provided at a second end opposing the first opening, where the second opening allowed feeding of the first winding about the first concentric path as detailed in claim 1.

Further advantageous features are provided in the dependent claims.

Brief Description Of The Drawings

The present application will now be described with reference to the accompanying drawings in which:

Figure 1 illustrates examples of prior art gapped magnetic components;

Figure 2 illustrates a side view of a gapped core for a magnetic component according to a first aspect of the present application;

Figure 3 is a side view of a gapped core according to a second aspect of the present application;

Figure 4 is a top view of the gapped core of Figure 3;

Figure 5 illustrates a first method of assembling a gapped core of the type shown generally in Figures 2 to 4;

Figure 6 illustrates a second method of assembling a gapped core of the type shown generally in Figures 2 to 4;

Figure 7 is a process flow corresponding to the method of assembly of figure 5 or figure 6;

Figure 8 is a first perspective view from the top left hand side of a bobbin for a magnetic component according to another aspect of the present application;

Figure 9 is perspective view from the opposite end of Figure 8;

Figure 10 is another perspective view of the bobbin of Figure 8;

Figure 11 is series of views of the bobbin of Figures 8 to 10 with a winding in place;

Figure 12 is a first view of a bobbin for a magnetic component according to a further aspect of the present application;

Figure 13 is another view of the bobbin of Figure 12;

Figure 14 is another view of the bobbin of Figure 12;

Figure 15 illustrates a series of views of the bobbin of Figures 12 to 14 with windings in situ;

Figure 16 illustrates an assembled bobbin and core; and

Figure 17 illustrates an exemplary tray which may be employed with a bobbin or core according to a further aspect.

Detailed Description Of The Drawings

The present application provides a magnetic component which is suitable for use in a switching power supply. The type of magnetic component may be a transformer. The magnetic component is intended for use in a switching power supply having a switching frequency of at least 20 kHz. The magnetic component has a core comprising a plurality of legs. The core is gapped. The gap is distributed such that at least two of the legs are individually gapped. Each of the gapped legs has multiple gaps.

Referring to the exemplary structure of Figure 2 in which a three legged gapped magnetic core 20 is provided which may be used in the structure of claim 1. The core 20 may be used in combination electrical windings to provide a magnetic component, for example an inductor or a transformer. The gapped magnetic core 20 comprises a top section 21 and a bottom section 22 separated by legs 23 comprising three individual leg sections 23a, 23b, 23c. The top 21 and bottom 22 sections may be plates.

The gap in the core 20 is provided by a combination of six individual gaps. More particularly, there are two gaps provided in each of the legs 23 of the three legged magnetic core 20. The first gap is provided between an individual leg 23 and the top section 21 and a second gap provided between the individual leg 23 and the bottom section 22. It will be appreciated that this structure means that the effective gap length of the core is four times the individual gap lengths (since the outer legs 23a and 23c are effectively in parallel magnetic paths). Thus the gap length requirement is a quarter that of the conventional structure of Figure 1(c). At the same time, the structure is particularly well suited to lower-profile designs as typically required in switched power supplies.

By reducing the gap by a factor of four, the fringe flux is reduced materially and likewise the “keepout zone” for wiring is reduced, typically to a level which is comparable to that generally presented by normal bobbin material thicknesses. Positioning the regions in proximity to the gaps in the corners also ensures that these are aligned perforce with regions where bobbin wall thickness is likely to be greatest thus ensuring maximum gap-winding separation. Whilst the exemplary structure employs six gaps that more may be provided by providing further gaps in the legs. For example, at least one further gap might be introduced in each leg 23, preferably mid-way along each leg 23.

Where the magnetic component is intended for a switching power supply with a relatively high switching frequency, e.g. above 100 kHz, the necessity for large numbers of turns is significantly reduced and as a result, the height of the leg may correspondingly be reduced. An advantage of this is that the gapped core 20 may be formed from a number of separate laminar sections 21, 23, 22 as illustrated in Figures 5 and 6. Thus the laminar thickness of the top 21 section, bottom section 22 and legs 23 may all be the same.

It will be appreciated that having the outside surfaces of the legs 23 flush with those of the top 21 and bottom 22 sections may allow excessive magnetic flux to be present outside the magnetic structure about the gaps. This problem may be reduced, as shown in Figures 3 and 4, by oversizing the top 21 and bottom 22 sections relative to the legs. In this manner the footprint of the top 21 and bottom 22 sections extends beyond that of the legs 23.

The sides of the core 20 may be wrapped with a ferrite polymer composite to reduce stray flux from the gaps if improved magnetic shielding is required. This is particularly useful for wrapping the core in the overlap instance presented between the legs and the top and bottom sections in Figure 3 to constrain flux about the air gaps. .

It will be appreciated that a plurality of gaps in the magnetic path greater than four may be used, and the number chosen will be a function of manufacturing issues as well as of the desire to maintain a uniform flux intersecting the winding. Operating at high frequencies, it is desirable that a reliable method of construction be employed to ensure the gap lengths are consistent and so as to ensure mechanical strength. The present application provides for a method of assembly 30, illustrated generally in Figures 5 and 6 and in the process flow of figure 7, which is simpler and generally suitable for mass production. For ease of illustration, the inclusion of an electrical part to the magnetic component has been omitted from the figures.

The core 20 is assembled using a plurality of individual sections 21, 22, 34. Suitably, the height of an assembled core 20 is less than 20mm and desirably less than 10mm. The sections 21, 22, 34 are formed from a suitable magnetic material. The magnetic material is suitably a ferrite. Exemplary materials include by way of example N49 from TDK-EPCOS and 3F35 from Ferroxcube. These materials are available in standard sizes having a length of 25mm, a width of 18mm and thickness of 2mm. These pieces may be used for the individual sections or cut to size for individual sections where smaller pieces are required. It will be appreciated that other dimensions may be employed.

The method begins at step 31 with the placement of a bottom section 22. The bottom section is suitably laminar, with one commercially available section having a length of 25mm and a width of 18mm with a thickness of 2 mm.

One or more spacer elements 24 are then placed upon the bottom section 22 in step 32. The purpose of the spacer element 24 is to define the gap length and thus the spacer thickness is selected to correspond to a desired gap length. The spacer element 24 is suitably a non saturable insulating material, for example a plastic for example nylon. In the arrangement of Figure 5, two individual spacers are placed down on the bottom section for each leg. In this arrangement, the spacers are positioned on opposite sides leaving a space between them. In Figure 6, two individual spacers are employed for all of the legs. More particularly, each of the spacers extends the length of the bottom section.

In one method of assembly, adhesive 25 is deposited is step 33 on the bottom section in regions where legs are to be placed but not where the spacers 25 have been placed. The individual legs 23 are then placed on top of the bottom section 22 in step 34. The legs 23 may comprise several layers. Thus if a leg length of 4mm is required, two layers of 2mm material may be employed on top of the other (spacers may or may not be employed between the layers).

A further set of spacers 24 are then placed on top of each the legs 23 in step 35. As before, adhesive 25 may be applied in step 36. The top section 21 is then placed on top of the legs 23 in step 37. By appropriate selection of the position and amount of adhesive 25, the legs 23 may be adhered to the top 21 and bottom sections 22. More particularly, if the adhesive 25 is applied in a layer which is thicker than the spacers 24, pressing the top 21 and bottom 22 sections together before the adhesive 25 has cured allows the adhesive 25 to spread reducing its thickness to that of the spacers 24. Epoxy adhesives would be examples of suitable adhesives 25. This method assembly 30 of a gapped magnetic component from sections of magnetic material whereby the adhesive 25 is applied to a different area of surface than the spacers 24 allows for a reliable mechanical assembly held together by the adhesive 25 but where the thickness of the adhesive 25 is limited to be the thickness of the spacer material 24.

Whilst adhesive 25 may be employed on top of the spacers 24, the desired gap size is typically relatively thin and accordingly to ensure a consistent gap thickness, the gap is best set solely by the spacer material. The gap length is typically of the order of 10μm to 200 μm and more preferably 20μm to 100 μm which in turn is defined by the spacer thickness. Accordingly, it desirable that the regions on which spacers 24 are placed are distinct from those where adhesive 25 is placed. Where a spacer material is too thin, multiple layers of spacer material may be employed in a laminar fashion to obtain a thicker spacer 24.

An alternative method of construction is to employ the spacers as discussed above but without adhesive and to hold the sections together using a clamp or similar restraint for example by wrapping the structure in tape.

It will be appreciated by those skilled in the art that the electrical part of the magnetic component is also required to be assembled on a core. Whilst this may be achieved after assembly of the core, it is easily accommodated during the process of assembling the core. Thus, in the case where a bobbin is employed to hold the one or more electrical windings, the bobbin might be placed on the bottom section after/before the placement of the spacers and used to act as a guide for the placement of the legs on top of the bottom section.

Thus the bobbin may be employed to align the magnetic components and to minimise the adverse build-up of mechanical tolerances which might otherwise reduce the effective winding window width available.

Prior art approaches to bobbin design have generally been relatively limited with the primary function of the bobbin being viewed as mere support onto which the windings may conveniently be wound for subsequent assembly with a core. The present application provides a novel approach to bobbin design which may be employed with the above described core constructions or indeed with any other core construction. In one form, the bobbin construction provides for an effective reduction in circuit footprint for the magnetic component by allowing the positioning of components below parts of the bobbin as will now be explained. Other advantages will become apparent from the more detailed description which follows below, including for example the provision of isolation without the need for tape or triply-insulated wire. At the same time, the design of the bobbin allows limitation of parasitic capacitive coupling and allow for design of a determined or low value of leakage inductance by modification of bobbin dimensions.

An exemplary bobbin 100 will now be described which is suitable for use with the previously described three legged cores 20. The exemplary bobbin 100, shown in Figures 8 through 10, is intended to provide an inductor, i.e. a magnetic component with a single winding as illustrated in the views of Figure 11 (it will be appreciated that a reference to a single winding does not mean a single turn and that a winding may have one or more turns). The bobbin 100 provides an inner wall which defines an opening for receiving the leg of a magnetic component. The bobbin 100 has six sides: a first side which in use faces the top section; a second side, opposed to the first side, which in use faces the bottom section; two opposed longitudinal sides; and two opposed transvers sides. In the exemplary bobbin 100, the wall comprises four inner walls defining a rectangular opening to correspond to a rectangular leg. It will be appreciated that the inner walls are suitably selected to conform to the shape of and accommodate a leg of a core. Thus other shapes are possible. A first longitudinal channel 110 is provided to the outside of the inner wall on a first longitudinal side. The first longitudinal channel 110 is defined by the exterior of the inner wall, a top surface and a bottom surface. The top and bottom surfaces are substantially perpendicular to the inner wall and extend therefrom. The first longitudinal channel 110 is dimensioned to accommodate a section of a winding. A second corresponding longitudinal channel 120 is provided on the opposite longitudinal side of the rectangular opening and accommodates a further section of the winding.

The first longitudinal channel 110 and the second longitudinal channel 120 are coplanar as would be found generally in the art, i.e. windings are generally wound concentrically around a bobbin and a section of winding on one side of a core is matched by a section of winding on the opposite side of the core.

However, in contrast to the art, the bobbin 100 of the present application provides a first transverse path 130 extending from the first longitudinal channel 110 to the second longitudinal channel 120 along a first transverse side which is not coplanar with the channels 110, 120. This first transverse path 130 comprises the inner wall and a top and bottom surface. The bottom and top surface of the transverse path 130 are raised up relative to the top and bottom surfaces of the longitudinal channels 110, 120. In the exemplary bobbin illustrated 100, the bottom surface of the transverse path is level with the top surfaces of the longitudinal channels. Thus the winding is raised up and falls back down as it crosses over from side to the other. This raising or splaying of the windings means that the space required by the windings at either end is reduced since the windings are bent/splayed either up or down thus spreading the windings in the vertical as well as horizontal planes. Thus, where 4mm of space might be required in a conventional bobbin for the windings, in the exemplary bobbin 100 this figure might be reduced to closer to 2mm. As a result the overall footprint of the bobbin/magnetic component is reduced. In the exemplary construction illustrated, the first transverse path 130 may be considered to be split with the first path as previously described and in effect providing a raised transverse path, whilst at the same time a lowered transverse path 140 is provided below the first path. Splitting the transverse path 130 into an upper 131 and a lower 132 transverse path effectively provides for a further reduction in size.

At the opposite transverse side to the first transverse path 130, a second transverse path 140 may be provided. It will be appreciated that if the winding comprises a single turn there is no requirement as such for the second transverse path 140. Equally, the second transverse path 140 need not be raised as the terminations of the windings may be made here. However, there is benefit by raising the winding at both ends. In particular, the second transverse path 140 is defined as with the first transverse path 130 by an exterior side of the inner wall a top surface and a bottom surface and an outer wall. An aperture

145 is provided in the outer wall which provides a feed point for the inner part of the winding which as will be appreciated by those skilled in the art generally has to be accommodated as a winding generally wraps around itself. However by splaying the coil, a space is created. Whilst the inner wall accommodates the leg of a core, the wall may extend upwards and downwards at the first 130 and second 140 transverse to accommodate top 22 and bottom 23 sections of the core 20. Isolation walls may be provided as part of the bobbin 100 to isolate the winding from other parts of the circuit. Similarly, one or more features may be provided on the bobbin to facilitate easy termination of the winding. These features may be formed as part of one piece bobbin construction for example using a plastics material or they may be additional pieces formed with the plastics material for example metal pins for terminating the winding and facilitating placement on a circuit board as a PTH or SMT component.

A further exemplary bobbin construction 200, shown in Figures 12 to 14 provides a former for first and second windings (as shown in Figure 15) with isolation between the windings provided by the bobbin structure. This further bobbin construction 200 is similar to the first 100 but additionally provides a first longitudinal passage 260 positioned between the inner wall and the first longitudinal channel 210. A second longitudinal passage 270 is positioned provided between the inner wall and the second longitudinal channel 220. The passages are enclosed by the bobbin material so that an isolation barrier is provided between the longitudinal passages 260, 270 and the longitudinal channels 210, 220. At the same time the space created by raising the transverse paths (as discussed above with reference to the first bobbin construction) is used in this construction to provide openings allowing access to the longitudinal passages 260, 270. In this way a winding (or a turn thereof) may be fed through a first opening at a first transverse end and through the first longitudinal passage 260 and out an opening at the opposite transverse end. Once out, the winding may be passed back through the second longitudinal passage 270 via an isolated transverse passage and out the first transverse end thus effecting a turn. The isolated transverse passage is isolated from the transverse path at the opposite transverse end. Once the turn is completed, the opposite (closed) end of the turn may be pulled back into the bobbin until it meets the inner wall, thereby providing an isolation gap to the outside of the bobbin. The process may be repeated if multiple turns are required. It will be appreciated that the winding passing within the longitudinal channels (typically the primary winding of the transformer) may be readily terminated at an opposing transverse end of the bobbin 200 to that of the winding passing within the longitudinal passages (typically the secondary winding of the transformer) thereby ensuring isolation is maintained. It will be appreciated that there is no need for special insulation on the windings to isolate the secondary from the primary as the bobbin walls provide inherent isolation. Walls may be added as required to improve creepage distances to meet particular design or safety requirements.

As shown in figure 15, a plurality of windings can be provided within the longitudinal channels. This allows for these windings of the transformer to be tapped, as the windings longitudinal channels can be connected together to allow a user to select between different numbers of turns. Similarly, a plurality of windings can be provided within the longitudinal passages. This allows for these windings of the transformer to be tapped, as the windings can be connected together to allow a user to select between different numbers of turns. This means the transformer has a variable turns ratio, enabling voltage regulation of the output.

Additionally, because a significant number of the coil parameters are defined by the dimensions of the bobbin, it is possible to produce more predictable magnetic components. Thus a component designer may choose to alter wall thicknesses (for example that of the inner wall) to meet a particular requirement. Equally, whilst the previously described passageways are suitably dimensioned to receive a primary winding comfortably such that there is limited difficulty in feeding the winding through, the component designer may oversize these passageways to provide for greater leakage inductance by increasing the spacing. For example, the diameters of first and second longitudinal passages may be at least 20% more than the diameter of the second winding.

Where this is employed, one or more spacers such as hollow beads or a filler may be employed to restrict movement of the winding and to keep it in a predefined position within the passageways. For example, the winding can be kept centrally positioned in the passageways.

Thus it will be appreciated that a bobbin for a magnetic component is provided for two windings. The bobbin provides first and second concentric paths for the first and second windings respectively about a leg of a core. The bobbin provides openings at opposing ends of the bobbin to allow feeding of the first winding about the first concentric path. The second concentric path is around the first in one direction and above the first in a second direction transverse to the first.

A further feature which may be employed with either the bobbins 100, 200 or cores 20 or both is a tray for receiving a magnetic component. An exemplary tray is shown in Figure 17. The tray 300 is formed from an insulating material such as a plastic. The tray is sized to accept the core 20 and provides a barrier between the magnetic core 20 and the underlying circuit board on which the tray 300 is placed. One or more wiring termination posts 310 may be provided on the tray to facilitate termination of windings from the transformer. A termination post may provide a metal contact which may be employed as a SMT or PTH lead. The tray 300 may be fixed to the magnetic component by an adhesive or the magnetic component may be held in place by a snap fit or similar locking feature.

The above bobbins 100, 200 have been described as a single piece construction formed using a suitable insulating material, for example a plastics material. However, the bobbins 100, 200 are not limited to such a single piece construction and several different methods of construction are possible. For example, the previously described longitudinal channels may be formed in a separate piece to the longitudinal passageways and subsequently assembled together. In this respect, the windings may be wound on the separate sections of the bobbin prior to assembly. In another variation, the winding and longitudinal passageways may be integrally formed by moulding the winding in a suitable material.

The bobbin and core constructions are ideally suited to use in higher frequency switching converters of the type where the switching frequency is over 100 kHz.

The words comprises/comprising when used in this specification are to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

Claims

1. A transformer comprising

a bobbin having an opening;

a three legged magnetic core having a middle leg passing through the bobbin opening;

a first winding provided in a first concentric path to the middle leg of the magnetic core;

a second winding provided in a second concentric path to the middle leg of the magnetic core; where the first and second concentric paths are isolated from each other by the structure of the bobbin, wherein the first concentric path comprises two longitudinal passages enclosed by the structure of the bobbin, wherein the first winding exits the bobbin through a first opening to the longitudinal passages at a first end and where a second opening is provided at a second end opposing the first opening, where the second opening allowed feeding of the first winding about the first concentric path.

2. A transformer according to claim 1, wherein the second winding comprises a single turn.

3. A transformer according to claim 1 or claim 2, wherein a spacer is provided to maintain the second winding in a predefined position in one of the passages.

4. A transformer according to any preceding claim, wherein the three legged magnetic core further comprises:

a top section;

a bottom section;

with two further legs in addition to the middle leg;

wherein there is a gap provided between each leg and the top section and a gap provided between each leg and the bottom section.

5. A transformer according to claim 4, wherein the thickness of each gap has a gap length of between 10µm and 200µm.

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6. A transformer according to claim 4 or 5, wherein a spacer is provided in each gap.

7. A transformer according to any one of claims 4 to 6, wherein adhesive is provided in the gaps.