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(54) **METHOD FOR PRODUCING A COIL DEVICE, AN END RING ELEMENT AND A COIL DEVICE
HAVING AN END RING ELEMENT**

VERFAHREN ZUR HERSTELLUNG EINES ENDRINGES EINER SPULENVORRICHTUNG, EIN
ENDRINGELEMENT UND SPULENVORRICHTUNG MIT ENDRINGELEMENT

PROCÉDÉ DE FABRICATION D'UN ÉLÉMENT DE BAGUE D'EXTÉMITÉ POUR DISPOSITIF DE
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EP 3 014 636 B1

Description

Technical field

[0001] The present invention relates to the field of producing coil devices e.g. for high-voltage/high-power applications. Particularly, the present invention relates to a production process for coil devices, wherein the windings are compacted after the coil wire is spooled.

Related art

[0002] In the production of coil devices, e.g. for high-voltage/high-power applications, the coil wires are wound on a cylindrical coil core layer by layer. Each layer may be separated by an insulating/spacing sheet on which the next layer windings are coiled. The windings are formed spirally in an axial direction, so that the end face of each winding layer is not plane with respect to the end face of the entire coil device.

[0003] In order to be able to apply pressure on the coil windings after the process of spooling up the windings on the coil core in an axial direction, the end face, however, has to form a flat plane, so that pressure can be applied homogeneously on the windings in an axial direction. Therefore, end rings are usually provided which are shaped to correspond to the uneven end face of each winding, so that an even end face is formed which is perpendicular to the axial direction. This allows for homogeneously applying a force for compacting the windings.

[0004] In case the coil device is used in a transformer unit, the end ring further serves to center the windings in order to minimize forces applied thereto in case of a short circuit.

[0005] Conventionally, such end rings are cut from a cylinder having the same inner diameter as the winding layer the end ring has to be applied to and having a thickness substantially corresponding to the thickness of the winding layer. This manufacturing process for the end ring is very expensive since for each different diameter of end rings a respective cylinder is required. Hence, when cutting the cylinders to end rings a large fraction of the cylinder material is scrap. Furthermore, cutting directly into a cylinder requires special and expensive tools and equipment.

[0006] Document CN 201584277-U discloses an insulating end ring for a transformer coil. The end ring has an inner paper plate cylinder arranged in a lamination cushion block and an outer paper plate cylinder arranged outside the lamination cushion block.

[0007] Document CN 202102865 discloses a transformer insulation ring with an insulating cushion block that is provided between an inner paper cylinder and an outer paper cylinder. An insulating rivet is connected between the inner paper cylinder and the outer paper cylinder.

[0008] Document CN 201549344-U discloses a trans-

former-insulated end ring device having a hollow ring body sleeve between upper and lower parts of rings in a transformer and being adapted to a coil. The cross-section of the hollow ring body is shaped rectangularly.

[0009] Document US3657808A discloses a collar with a width changing in trapezoidal manner, which forms an end ring disposed each end of an electrical coil. The collar is made of a plurality of insulating plies which are stacked to form a layered structure of constant thickness.

[0010] Document US 5 717 373 A discloses a collar of constant thickness wrapped over the top and the bottom of a cylindrical core. In this way sharp edges of the core are smoothed and a coil can be wound over the wrapped core without damage.

[0011] It is an object of the present invention to provide an end ring element, an end ring, and a method for producing such an end ring element for use in the production of coil devices. In particular, it is an object that the end ring element can be produced with less scrap.

Summary of the invention

[0012] The above objects have been achieved by the end ring element for forming an end ring for a coil device according to claim 1 and 2 as well as by the end ring, the method for producing an end ring, the set of end ring elements, the set of end rings, the coil device and the method for producing a coil device according to the further independent claims.

[0013] Preferred embodiments of the present invention are indicated in the dependent subclaims.

[0014] According to a first aspect, an end ring element for forming an end ring for a coil device is provided, wherein the end ring element is formed by a plane band which extends along a longitudinal direction and a width direction, wherein the band provides a constant global thickness to allow a constant spacing over its full length in a longitudinal direction, a higher stiffness in the width direction than the in longitudinal direction, and a shape of the plane band with a straight longitudinal edge. The plane band has a cross-section along the longitudinal direction having flexible portions which allow a bending to a ring along the longitudinal direction and having spacing portions between the flexible portions providing the constant spacing capability. According to an alternative embodiment the plane band can have a cross-section along the longitudinal direction having a corrugated structure, wherein the corrugated structure has corrugation elements extending along the width direction, thereby providing stiffness along the width direction, wherein the corrugation elements provide a depth of corrugation corresponding to the constant global thickness.

[0015] According to a further aspect, an end ring formed by the above end ring element is provided, wherein the end ring element is formed into a circular cylinder, so that the straight longitudinal edge defines a plane perpendicular to the cylinder axis.

[0016] One idea of the present invention is to provide

end rings that can be made from sheet material for the production of a coil device. This allows for producing less scrap and the use of simpler cutting tools.

[0017] The end ring elements used for forming end rings are designed to be formed/bent into cylindrical shapes. Particularly the end ring elements may, at least in part, made of a flexible material. The end ring elements provide a spacing capability for a thickness which, at least partially, corresponds to the thickness of the winding layer that is to be applied in the production process of the coil device. The length of the end ring element in a longitudinal direction is substantially adapted to the inner diameter of the corresponding winding layer, so that the length is substantially equal to or slightly shorter than the inner diameter. The end ring element has one straight longitudinal edge in a longitudinal direction and an opposite straight longitudinal edge which may be sloped with respect to the longitudinal direction. Both straight longitudinal edges extend between opposite end edges of the end ring elements extending in a width direction. The overall shape formed by the end ring element is a trapezoid.

[0018] By manufacturing the end ring element such that it can be flexibly bent in a ring shape, so that the longitudinal direction corresponds to the circumferential direction, an end ring for a winding layer of a coil device can be formed. The end ring has to be made of a material and provided with a structure allowing the end ring element to be bent in a ring shape while still providing a stiffness required for performing a compacting in axial direction after the production of the coil device. Hence, the end ring element needs to have a suitable flexibility for being bent to a ring in a longitudinal direction while it needs to provide a sufficient stiffness for receiving pressure in the width direction (corresponding to the axial direction of the coil device), in particular a compacting pressure sufficient to compact the windings of the winding layer when formed to an end ring.

[0019] End rings formed by the above end ring elements have the advantage that a flat and strong mechanical interface can be created to protect the windings of a winding layer at their axial ends when pressure forces are applied in an axial direction. Furthermore, the end ring elements have the advantage that while producing the coil device tolerances in winding diameters can easily be compensated as the distance between the longitudinal ends of the end ring elements formed to an end ring may vary over a broad range without having negative effects on the functionality of the end ring and the coil device. In case of use in a transformer, different widths of end ring elements can be used for high-voltage primary winding layers and low-voltage secondary winding layers, respectively, which allows to center them, thus minimizing axial forces applied to the primary and secondary windings in case of a short circuit.

[0020] As the thickness of the end ring element has to correspond to the thickness of the winding layer, the required flexibility can be achieved by reducing the thick-

ness by providing grooves extending along the width direction of the end ring element. Substantially, it can be provided that the thickness of the end ring element varies along the longitudinal direction thereof, providing portions of low thickness distanced from one another, so that the end ring element can be bent along a circumferential direction of the coil device. The constant spacing capability is provided by a constant global thickness to allow a constant spacing over its full length in the longitudinal direction; According to an embodiment the band may have a shape with a straight longitudinal edge. Furthermore, the band has a cross section along the longitudinal direction having flexible portions which allow a bending to a ring along the longitudinal direction and having spacing portions between the flexible portions which may extend over the full width of the band, thereby providing stiffness along the width direction.

[0021] It may be provided that the band is formed by a sheet material provided with grooves to form the flexible portions, wherein the grooves are formed by separate spacing portions each attached with a spacing along the longitudinal direction and/or by grooves cut into the sheet material.

[0022] Moreover, the band may have a thickness which allows a substantial bending along the longitudinal direction.

[0023] It may be provided that the plane band has a further longitudinal edge opposing the straight longitudinal edge, so that the plane band has a varying width, wherein particularly the further longitudinal edge may be straight and sloped with respect to the longitudinal direction.

[0024] According to a further aspect, a set of above end ring elements is provided, wherein at least two of the end ring elements have different lengths for forming end rings with different diameters.

[0025] According to a further aspect, a method for producing an end ring is provided, wherein the above end ring element is formed into a circular cylinder, particularly on a core of a coil device or on another end ring, so that the straight longitudinal edge defines a plane perpendicular to the cylinder axis.

[0026] According to a further aspect, a cylindrical coil device is provided, comprising:

- one or more cylindrical winding layers; and
- at least one above end ring, wherein the end ring at least partially abuts the end face of the winding layer in the axial direction and wherein the straight longitudinal edge is substantially flush with an end face of the cylindrical coil device.

[0027] Moreover, each winding layer may have one end ring on one end face or two end rings on both end faces.

[0028] It may be provided that at least one winding layer has a winding that is spirally wound with a spiral offset, wherein the end ring is formed by the end ring element

which has a further longitudinal edge opposite to the straight longitudinal edge, wherein the further longitudinal edge is straight and extends from a first end of the end ring element having a first width to a second end of the end ring element having a second width, wherein the difference between the second and first width is adapted to the spiral offset.

[0029] According to a further aspect, a method for producing a coil device is provided, comprising the steps of:

- providing one or more cylindrical winding layers; and
- after a winding layer is formed, bending the above end ring element to abut to an end face of the winding layer in the axial direction, so that the straight longitudinal edge is substantially flush with an end face of the cylindrical coil device.

Brief description of the drawings

[0030] Preferred embodiments are described in more detail in the following description in conjunction with the accompanying drawings, in which:

- Figure 1 shows a perspective view of a part of a coil device having winding layers and end rings;
- Figure 2 shows a top view of an end ring element;
- Figure 3 shows a perspective view of the end ring element;
- Figure 4 shows a lateral view of the end ring formed by the end ring element of Figures 2 and 3;
- Figure 5 shows an illustration of an end portion of the end ring element;
- Figure 6 shows a cutting scheme for cutting the end ring elements from a sheet material;
- Figure 7 shows an illustration of a different kind of end ring element; and
- Figure 8 shows an illustration of a further different kind of end ring element.

Description of embodiments

[0031] Figure 1 shows a perspective view of a part of a coil device 1. Coil devices are generally needed for producing single-phase transformers, three-phase transformers for distribution purposes, insulation transformers for traction, auxiliary and double insulation purposes, transformers for power electronic converters as well as coil devices for inductors, chokes and reactors as well as for electrical machines.

[0032] The coil device 1 is built around a coil core 2. The coil device 1 has winding layers 3 which are formed

by one or more winding wires 4, in the present embodiment three separate parallel winding wires 4, are spirally wound, so that the winding wires 4 are neighbored. The winding wires 4 can be wound as single or bundles of several winding wires 4 neighboring one another in the axial direction of the coil device 1. The width of the bundle of one or more neighboring winding wires 4 defines the offset of the spiral formed by the winding wires 4 in one winding layer 3 around the coil core 2.

[0033] At both ends of each winding layer 3, close to the end faces of the coil device 1 to be produced, an end ring 5 is attached to render the end face of the coil device 1 plane. Each end ring 5 generally has a shape suitable to compensate for the irregular end plane formed by the axial ends of the winding layers 3. Specifically, the end ring 5 has a varying axial width, so that the edge directed towards the end face of the coil device 1 is flush with the end face while the opposite edge abuts the winding wire 4 of the first winding of the respective winding layer 3. In particular, the end ring compensates for the offset of the spiral formed by the winding wires 4.

[0034] The end ring 5 provides a flat and strong mechanical interface in order to protect the winding layers 3 from local force variations, e. g. when pressing forces are applied for compacting the winding wires 4. When the coil device 1 is provided with several winding layers 3 for use in a transformer, different dimensions of the end ring 5 for high-voltage winding layers 3 and low-voltage winding layers 3 can be centered with respect to the axial direction, thus minimizing forces applied thereto in case of a short circuit.

[0035] Figure 2 shows a top view of the end ring element 10 used to form an end ring 5 as shown in Figure 1. The end ring element 10 is formed from a sheet material, e.g. by processes such as cutting, punching and the like. The end ring element 10 has a longitudinal direction L and a width direction W. In the longitudinal direction L, the end ring element 10 has to provide flexibility, so that it can easily be bent to an end ring 5 with both opposing ends, a first longitudinal end 13 and an opposing second longitudinal end 14, abutting or coming close to one another in the longitudinal direction L without a noticeable tension forcing the ends 13, 14 away from the annular shape.

[0036] In the width direction W, the end ring element 10 needs to provide a stiffness sufficient to absorb forces in the axial direction, such as pressure applied to the end faces for compacting the winding wires 4 after being wound on the coil core 2, without a noticeable deformation.

[0037] Furthermore, the end ring element 10 has a first longitudinal edge 11 and a second longitudinal edge 12 which are substantially straight between both longitudinal ends 13, 14 while the end ring element 10 forms a trapezoid. In other words, in the longitudinal direction L the end ring element 10 has an increasing width, i. e. a first width W1 at the first longitudinal end 13 in the longitudinal direction L and a second larger width W2 at the opposite

second longitudinal end 14 in the longitudinal direction L. The difference between the first width W1 and the second width W2 substantially corresponds to the offset of the spiral of the winding wires 4 being spirally wound along the axial direction, so that when formed as a ring, the second longitudinal edge 12 of the end ring element 10 abuts a corresponding edge of the end loop of the windings in the respective winding layer 3 while the first longitudinal edge 11 is flush with the end face of the coil device 1.

[0038] Figure 3 shows a perspective view of an embodiment of the end ring element 10 which provides the required flexibility in the longitudinal direction L and the required stiffness in the width direction W. The end ring element 10 is formed as a band having flexible portions 21 with reduced thickness which are formed by grooves on one surface while the opposite surface may be flat. At the grooves, the material of the end ring element 10 has a decreased thickness to provide the required flexibility in the longitudinal direction L. Between the flexible portions 21, spacing portions 22 such as spacing members with a higher thickness (in thickness direction D) may be provided, wherein the thickness of the spacing portions 22 or spacing members substantially correspond to the radial thickness of a winding layer 3 to provide a required radial spacing between the winding layers 3. Furthermore, the spacing portions 22 may provide the stiffness required in the width (axial) direction W.

[0039] The widths of the flexible portions 21 and of the spacing portions 22 along the longitudinal direction L can be selected in a broad range. It is preferred that the spacing portions (members) 22 are wider than the flexible portions in the longitudinal direction L. For instance, a spacing member 22 may have a width which is 1.5 to 4 times longer than the width of the grooves 21.

[0040] In the present embodiment, the flexible portions 21 and the spacing portions 22 form a step pattern. However, other patterns can also be used, which:

1. provide the thickness required for the spacing of the winding layers 3;
2. provide the stiffness in the width direction W required to absorb axial forces; and
3. provide the flexibility required along the longitudinal direction L to bend the end ring element annularly.

[0041] In case of a step pattern, the edges along the width direction W can be smoothed or rounded.

[0042] The end ring element 10 can be made of a single sheet of material which is cut to form the flexible portions 21. In other embodiments, the sheet can be made of a flexible layer of a first material, such as a fabric or the like, on which spacing members 22 are attached, e. g. by an adhesive.

[0043] Figure 4 shows the end ring element 10 formed to an end ring 5 while the protruding spacing members 22 are directed inwardly.

[0044] Figure 5 shows a more detailed view of an end portion of the end ring element 10. It can be seen that the first end 13 in the longitudinal direction L is flattened to have a continuously decreasing thickness, so that an angle between the opposing surfaces in the thickness direction D is formed. This angle can be within a range of 30° to 75°.

[0045] As shown in Figure 6, the end ring element 10 is formed by cutting pieces of a trapezoid shape from a standard plate 30, e.g. of EPGC 308 (epoxy laminate), which is provided with spacing members 22 extending in one direction and separated by grooves. The cutting of the plate 30 is performed such that the longitudinal direction L of the end ring elements 10 is substantially perpendicular to the extension of the spacing portions (spacing members) 22 / flexible portions (grooves) 21 of the plate 30.

[0046] Figure 6 shows an example of how a number of end ring elements 10 having different lengths can be cut from such a standard plate 30. Due to the trapezoid shape of each of the end ring elements 10 and due to the fact that for each end ring element 10 two identical pieces are required for the opposing sides of a winding layer 3 of the coil device 1, the scrap can be reduced when the two pieces of the same length are cut from a rectangular area 31 of the plate 30. The sloped second longitudinal edge 12 of the respective end ring elements 10 can be cut along the same cutting line 31.

[0047] According to another embodiment, which is also shown in Figure 7, the thickness variation of the end ring element 10 can also be achieved using a low-thickness plate 17 to which the spacing members 22 extending into the width direction W are attached, e. g. glued. In this embodiment, the material of the low-thickness plate 17 can provide a high flexibility while the spacing members 22 can be made of an material identical to or different from the material of the plate 17 and providing the required thickness and stiffness. The spacing members 22 can be made of a high temperature-resistant and a dielectric-resistant composite material, such as EPGC, EPGM or UPGM.

[0048] Figure 8 shows a further embodiment of an end ring element 10 and an end ring 5 made thereof having a corrugated structure which has been cut from a corrugated plate 30 made of a high temperature-resistant and a dielectric-resistant composite material, such as described above. The corrugated plate 30 can provide structures having, e. g., a sinusoidal, triangular or rectangular shape (in the cross-sectional view) in the longitudinal direction L and extending along the width direction W, thereby providing a stiffness as required for absorbing forces in the width direction W. The sheet material of the corrugated plate 30 is relatively thin to provide a sufficient flexibility for bending the end ring element 10 to a ring shape along the longitudinal direction L. Constituted by the corrugation structures, the corrugated plate 30 also has a global thickness which provides the spacing required when wrapped around the winding layers 3 of the

coil device 1.

Reference list

[0049]

- 1 coil device
- 2 coil core
- 3 winding layer
- 4 winding wire
- 5 end ring
- 10 end ring element
- 11 first longitudinal edge
- 12 second longitudinal edge
- 13 first longitudinal end
- 14 second longitudinal end
- 17 low-thickness plate
- 21 flexible portion
- 22 spacing portion
- 30 plate
- 31 cutting line

Claims

1. End ring element (10) for forming an end ring (5) for a coil device (1), wherein the end ring element (10) is formed by a plane and trapezoid band which extends along a longitudinal direction (L) and a width direction (W), wherein the band provides

- a constant spacing capability over its length along the longitudinal direction (L);
- a higher stiffness in the width direction (W) than in the longitudinal direction (L);
- **characterized in that** the plane band has a cross-section along the longitudinal direction (L) having flexible portions (21) with reduced thickness which allow a bending to a ring along the longitudinal direction (L) and having spacing portions (22) with a higher thickness between the flexible portions (21) and providing the constant spacing capability, and wherein the band has a shape with a straight longitudinal edge (11).

2. End ring element (10) for forming an end ring (5) for a coil device (1), wherein the end ring element (10) is formed by a plane and trapezoid band which extends along a longitudinal direction (L) and a width direction (W), wherein the band provides

- a constant spacing capability over its length along the longitudinal direction (L);
- a higher stiffness in the width direction (W) than in the longitudinal direction (L),

- **characterized in that** the plane band has a cross-section along the longitudinal direction (L) having a corrugated structure, wherein the corrugated structure has corrugation elements extending along the width direction (W), thereby providing stiffness along the width direction W, wherein the corrugation elements provide a depth of corrugation corresponding to the constant global thickness,

wherein the plane band has a thickness which allows a substantial bending along the longitudinal direction L, and wherein the band has a shape with a straight longitudinal edge (11).

3. End ring element (10) according to claim 1, wherein the constant spacing capability is provided by a constant global thickness to allow a constant spacing over its full length in the longitudinal direction (L);

4. End ring element (10) according to claim 1, wherein the spacing portions (21) extend over the full width of the band, thereby providing stiffness along the width direction (W).

5. End ring element (10) according to claim 1 or 4, wherein the plane band is formed by a sheet material provided with grooves to form the flexible portions (21), wherein the flexible portions (21) are formed by spacing portions (22) each being attached with a spacing along the longitudinal direction L and/or by grooves cut into the sheet material.

6. End ring element (10) according to any one of claims 1 to 6, wherein the plane band has a further longitudinal edge (12) opposing the straight longitudinal edge (11), so that the plane band has a varying width, wherein particularly the further longitudinal edge (12) is straight and sloped with respect to the longitudinal direction (L).

7. End ring (5) formed by the end ring element (10) according to any one of claims 1 to 6, wherein the end ring element (10) is shaped into a particularly circular cylinder, so that the straight longitudinal edge (11) defines a plane perpendicular to the cylinder axis.

8. Set of end ring elements (10) according to any one of claims 1 to 6, wherein at least two of the end ring elements (10) have different lengths for forming end rings (5) with different diameters.

9. Set of end rings (10) according to claim 7, wherein at least two of the end rings (5) have different diameters.

10. Method for producing an end ring (5), wherein an end ring element (10) according to any one of claims 1 to 6 is formed into a circular cylinder, particularly on a core (2) of a coil device (1) or on another end ring (5), so that the straight longitudinal edge (11) defines a plane perpendicular to the cylinder axis. 5
11. Cylindrical coil device (1) comprising:
- one or more cylindrical winding layers (3); and
 - at least one end ring (5) according to claim 7, wherein the end ring (5) at least partially abuts the end face of the winding layer (3) in the axial direction and wherein the straight longitudinal edge (11) is substantially flush with an end face of the cylindrical coil device (1). 10
12. Coil device (1) according to claim 11, wherein each winding layer (3) has one end ring (5) on one end face or two end rings (5) on both end faces of the winding layer (3). 15
13. Coil device (1) according to claim 11 or 12, wherein at least one winding layer (3) has a winding spirally wound with a spiral offset, wherein the end ring (5) is formed by the end ring element (10) which has a further longitudinal edge (12) opposite to the straight longitudinal edge (11), wherein the further longitudinal edge (12) is straight and extends from a first end of the end ring element (10) having a first width to a second end of the end ring element (10) having a second width, wherein the difference between the second and first width is adapted to the spiral offset. 20
14. Coil device (1) according to any of the claims 11 to 13 wherein one of the at least one end ring (5) is coaxial to at least one of the winding layers (3). 25
15. Method for producing a coil device (1), comprising the steps of: 30
- providing one or more cylindrical winding layers (3); and
 - installing a first end ring element (10) according to any one of claims 1 to 6 to abut an end face of the winding layer (3) in the axial direction, so that the straight longitudinal edge (11) is substantially flush with an end face of the cylindrical coil device (1). 35
16. Method according to claim 15, wherein the first end ring element (10) is installed before a corresponding one of the winding layers (3) is wound the face of which abuts the respective installed first end ring element (10). 40
17. Method according to claim 16, wherein after the corresponding winding layer (3) has been wound, a sec-

ond end ring is installed to abut another end face of the winding layer (3) in the axial direction, so that the straight longitudinal edge (11) is substantially flush with a respective end face of the cylindrical coil device (1).

Patentansprüche

1. Endringelement (10) zum Bilden eines Endrings (5) für eine Spulenvorrichtung (1), wobei das Endringelement (10) von einem planen und trapezförmigen Band gebildet wird, das sich entlang einer Längsrichtung (L) und einer Breitenrichtung (W) erstreckt, wobei das Band bereitstellt
- eine konstante Abstandsbildungsfähigkeit über seine gesamte Länge entlang der Längsrichtung (L);
 - eine größere Steifigkeit in der Breitenrichtung (W) als in der Längsrichtung (L);
 - **dadurch gekennzeichnet, dass** das plane Band einen Querschnitt entlang der Längsrichtung (L) mit flexiblen Teilen (21) mit geringerer Stärke, was ein Biegen eines Rings entlang der Längsrichtung (L) ermöglicht, und mit Abstandsbildungsteilen (22) mit einer größeren Stärke zwischen den flexiblen Teilen (21) und zum Bereitstellen der konstanten Abstandsbildungsfähigkeit aufweist, und wobei das Band eine Form mit einer geraden Längskante (11) aufweist. 45
2. Endringelement (10) zum Bilden eines Endrings (5) für eine Spulenvorrichtung (1), wobei das Endringelement (10) von einem planen und trapezförmigen Band gebildet wird, das sich entlang einer Längsrichtung (L) und einer Breitenrichtung (W) erstreckt, wobei das Band bereitstellt
- eine konstante Abstandsbildungsfähigkeit über seine gesamte Länge entlang der Längsrichtung (L);
 - eine größere Steifigkeit in der Breitenrichtung (W) als in der Längsrichtung (L);
 - **dadurch gekennzeichnet, dass** das plane Band einen Querschnitt entlang der Längsrichtung (L) mit einer gewellten Struktur aufweist, wobei die gewellte Struktur sich entlang der Breitenrichtung (W) erstreckende Wellungselemente aufweist, wodurch Steifigkeit entlang der Breitenrichtung (W) bereitgestellt wird, wobei die Wellungselemente eine Wellungstiefe entsprechend der konstanten gesamten Stärke bereitstellen, 50
- wobei das plane Band eine Stärke aufweist, die ein beträchtliches Biegen entlang der Längsrichtung (L) ermöglicht, und 55

wobei das Band eine Form mit einer geraden Längskante (11) aufweist.

3. Endringelement (10) nach Anspruch 1, wobei die konstante Abstandbildungsfähigkeit von einer konstanten gesamten Stärke bereitgestellt wird, um einen konstanten Abstand über die gesamte Länge in der Längsrichtung (L) zu ermöglichen. 5
4. Endringelement (10) nach Anspruch 1, wobei sich die Abstandbildungsteile (21) über die gesamte Breite des Bandes erstrecken, wodurch Steifigkeit entlang der Breitenrichtung (W) bereitgestellt wird. 10
5. Endringelement (10) nach Anspruch 1 oder 4, wobei das plane Band von einem mit Nuten ausgestatteten Blechmaterial zum Bilden der flexiblen Teile (21) gebildet wird, wobei die flexiblen Teile (21) von jeweils mit einem Abstand entlang der Längsrichtung L und/oder durch in das Blechmaterial geschnittenen Nuten befestigten Abstandbildungsteilen (22) gebildet werden. 15 20
6. Endringelement (10) nach einem der Ansprüche 1 bis 6, wobei das plane Band eine weitere Längskante (12) gegenüber der geraden Längskante (11) aufweist, so dass das plane Band eine variierende Breite aufweist, wobei insbesondere die weitere Längskante (12) gerade und schräg in Bezug auf die Längsrichtung (L) ist. 25 30
7. Endring (5), der durch das Endringelement (10) gebildet wird, nach einem der Ansprüche 1 bis 6, wobei das Endringelement (10) zu einem insbesondere runden Zylinder ausgebildet ist, so dass die gerade Längskante (11) eine Ebene senkrecht zur Zylinderachse definiert. 35
8. Menge von Endringelementen (10) nach einem der Ansprüche 1 bis 6, wobei wenigstens zwei der Endringelemente (10) unterschiedliche Längen zum Bilden von Endringen (5) mit verschiedenen Durchmessern aufweisen. 40
9. Menge von Endringen (10) nach Anspruch 7, wobei wenigstens zwei der Endringe (5) verschiedene Durchmesser aufweisen. 45
10. Verfahren zum Erzeugen eines Endrings (5), wobei ein Endringelement (10) nach einem der Ansprüche 1 bis 6 zu einem runden Zylinder, insbesondere auf einem Kern (2) einer Spulenvorrichtung (1) oder auf einem anderen Endring (5), ausgebildet ist, so dass die gerade Längskante (11) eine Ebene senkrecht zur Zylinderachse definiert. 50 55
11. Zylindrische Spulenvorrichtung (1) umfassend:

- eine oder mehrere zylindrische Wicklungsschichten (3); und

- wenigstens einen Endring (5) nach Anspruch 7, wobei der Endring (5) wenigstens teilweise an der Endfläche der Wicklungsschicht (3) in der axialen Richtung anstößt und wobei die gerade Längskante (11) im Wesentlichen bündig mit einer Endfläche der zylindrischen Spulenvorrichtung (1) ist.

12. Spulenvorrichtung (1) nach Anspruch 11, wobei jede Wicklungsschicht (3) einen Endring (5) an einer Endfläche oder zwei Endringe (5) an beiden Endflächen der Wicklungsschicht (3) aufweist.

13. Spulenvorrichtung (1) nach Anspruch 11 oder 12, wobei wenigstens eine Wicklungsschicht (3) eine spiralförmig mit einem Spiralversatz gewickelte Wicklung aufweist, wobei der Endring (5) vom Endringelement (10) gebildet wird, das eine weitere Längskante (12) gegenüber der geraden Längskante (11) aufweist, wobei die weitere Längskante (12) gerade ist und sich von einem ersten Ende des Endringelements (10) mit einer ersten Breite zu einem zweiten Ende des Endringelements (10) mit einer zweiten Breite erstreckt, wobei der Unterschied zwischen zweiter und erster Breite an den Spiralversatz angepasst ist.

14. Spulenvorrichtung (1) nach einem der Ansprüche 11 bis 13, wobei einer der wenigstens einen Endrings (5) koaxial zu wenigstens einer der Wicklungsschichten (3) ist.

15. Verfahren zum Erzeugen einer Spulenvorrichtung (1), umfassend die Schritte zum:

- Bereitstellen von einer oder mehreren Wicklungsschichten (3); und

- Installieren eines ersten Ringelements (10) nach einem der Ansprüche 1 bis 6 zum Anstoßen an einer Endfläche der Wicklungsschicht (3) in der axialen Richtung, so dass die gerade Längskante (11) im Wesentlichen bündig mit einer Endfläche der zylindrischen Spulenvorrichtung (1) ist.

16. Verfahren nach Anspruch 15, wobei das erste Endringelement (10) installiert wird, bevor eine entsprechende der Wicklungsschichten (3) gewickelt wird, deren Fläche am entsprechenden installierten ersten Endringelement (10) anstößt.

17. Verfahren nach Anspruch 16, wobei nach dem Wickeln der entsprechenden Wicklungsschicht (3) ein zweiter Endring zum Anstoßen an einer anderen Endfläche der Wicklungsschicht (3) in der axialen Richtung installiert wird, so dass die gerade Längs-

kante (11) im Wesentlichen bündig mit einer entsprechenden Endfläche der zylindrischen Spulenvorrichtung (1) ist.

Revendications

1. Élément (10) de bague d'extrémité pour former une bague d'extrémité (5) pour un dispositif de bobine (1), dans lequel l'élément (10) de bague d'extrémité est constitué par une bande plane et trapézoïdale qui s'étend suivant une direction longitudinale (L) et une direction transversale (W), dans lequel la bande procure :

- une capacité d'espacement constant sur sa longueur suivant la direction longitudinale (L) ;
- une rigidité plus élevée dans le sens (W) de la largeur que dans le sens (L) de la longueur,

caractérisé en ce que la bande plane présente une section suivant la direction longitudinale (L) comportant des parties flexibles (21) ayant une épaisseur réduite qui permettent une courbure sur une bague suivant la direction longitudinale (L) et comportant des parties d'espacement (22) ayant une épaisseur plus élevée entre les parties flexibles (21) et procurant la capacité d'espacement constant, et dans lequel la bande a une forme avec un bord longitudinal (11) droit.

2. Élément (10) de bague d'extrémité pour former une bague d'extrémité (5) pour un dispositif de bobine (1), dans lequel l'élément (10) de bague d'extrémité est constitué par une bande plane et trapézoïdale qui s'étend suivant une direction longitudinale (L) et une direction transversale (W), dans lequel la bande procure :

- une capacité d'espacement constant sur sa longueur suivant la direction longitudinale (L) ;
- une rigidité plus élevée dans le sens (W) de la largeur que dans le sens (L) de la longueur, **caractérisé en ce que** la bande plane présente une section suivant la direction longitudinale (L) comportant une structure ondulée,

dans lequel la structure ondulée comporte des éléments d'ondulation s'étendant dans le sens (W) de la largeur, assurant de ce fait une rigidité dans le sens (W) de la largeur,

dans lequel les éléments d'ondulation procurent une profondeur d'ondulation correspondant à l'épaisseur globale constante,

dans lequel la bande plane a une épaisseur qui permet une courbure importante suivant la direction longitudinale (L), et

dans lequel la bande a une forme avec un bord lon-

gitudinal (11) droit.

3. Élément (10) de bague d'extrémité selon la revendication 1, dans lequel la capacité d'espacement constant est assurée par une épaisseur globale constante pour permettre un espacement constant sur toute sa longueur dans le sens (L) de la longueur.
4. Élément (10) de bague d'extrémité selon la revendication 1, dans lequel les parties d'espacement (21) s'étendent sur toute la largeur de la bande, assurant de ce fait une rigidité dans le sens (W) de la largeur.
5. Élément (10) de bague d'extrémité selon la revendication 1 ou 4, dans lequel la bande plane est constituée par une tôle pourvue de rainures pour former les parties flexibles (21), dans lequel les parties flexibles (21) sont constituées par des parties d'espacement (22), chacune étant fixée avec un espacement suivant la direction longitudinale (L) et/ou par des rainures découpées dans la tôle.
6. Élément (10) de bague d'extrémité selon l'une quelconque des revendications 1 à 6, dans lequel la bande plane comporte un autre bord longitudinal (12) à l'opposé du bord longitudinal (11) droit, si bien que la bande plane a une largeur variable, dans lequel, en particulier, l'autre bord longitudinal (12) est rectiligne et incliné par rapport à la direction longitudinale (L).
7. Bague d'extrémité (5) constituée par l'élément (10) de bague d'extrémité selon l'une quelconque des revendications 1 à 6, dans laquelle l'élément (10) de bague d'extrémité est façonné en un cylindre en particulier circulaire, si bien que le bord longitudinal (11) droit définit un plan perpendiculaire à l'axe du cylindre.
8. Jeu d'éléments (10) de bague d'extrémité selon l'une quelconque des revendications 1 à 6, dans lequel au moins deux des éléments (10) de bague d'extrémité ont des longueurs différentes pour constituer des bagues d'extrémité (5) ayant des diamètres différents.
9. Jeu d'éléments (10) de bague d'extrémité selon la revendication 7, dans lequel au moins deux des bagues d'extrémité (5) ont des diamètres différents.
10. Procédé de production d'une bague d'extrémité (5), dans lequel un élément (10) de bague d'extrémité selon l'une quelconque des revendications 1 à 6 est formé en un cylindre circulaire, en particulier sur le noyau (2) d'un dispositif de bobine (1) ou sur une autre bague d'extrémité (5), de façon à ce que le bord longitudinal (11) droit définisse un plan perpen-

diculaire à l'axe du cylindre.

11. Dispositif de bobine (1) cylindrique comprenant :

- une ou plusieurs couches d'enroulement (3) cylindriques ; et
- au moins une bague d'extrémité (5) selon la revendication 7,

dans lequel la bague d'extrémité (5) est au moins partiellement en appui sur la face terminale de la couche d'enroulement (3) dans la direction axiale et dans lequel le bord longitudinal (11) droit est sensiblement dans l'alignement de la face terminale du dispositif de bobine (1) cylindrique.

12. Dispositif de bobine (1) selon la revendication 11, dans lequel chaque couche d'enroulement (3) comporte une bague d'extrémité (5) sur une face terminale ou deux bagues d'extrémité (5) sur les deux faces terminales de la couche d'enroulement (3).

13. Dispositif de bobine (1) selon la revendication 11 ou 12, dans lequel au moins une couche d'enroulement (3) comporte un enroulement enroulé en spirale avec un décalage en spirale, dans lequel la bague d'extrémité (5) est constituée par l'élément (10) de bague d'extrémité qui comporte un autre bord longitudinal (12) à l'opposé du bord longitudinal (11) droit, dans lequel l'autre bord longitudinal (12) est rectiligne et s'étend d'une première extrémité de l'élément (10) de bague d'extrémité ayant une première largeur à la seconde extrémité de l'élément (10) de bague d'extrémité ayant une seconde largeur, dans lequel la différence entre la seconde et la première largeur est apte à créer le décalage en spirale.

14. Dispositif de bobine (1) selon l'une quelconque des revendications 11 à 13, dans lequel l'une desdites bagues d'extrémité (5) est coaxiale avec au moins une des couches d'enroulement (3).

15. Procédé de production d'un dispositif de bobine (1), comprenant les étapes consistant à :

- utiliser une ou plusieurs couches d'enroulement (3) cylindriques ; et
- installer un premier élément (10) de bague d'extrémité selon l'une quelconque des revendications 1 à 6 pour qu'il soit en appui sur la face terminale de la couche d'enroulement (3) dans la direction axiale, de façon à ce que le bord longitudinal (11) droit soit sensiblement dans l'alignement de la face terminale du dispositif de bobine (1) cylindrique.

16. Procédé selon la revendication 15, dans lequel le

premier élément (10) de bague d'extrémité est installé avant que ne soit enroulée une des couches d'enroulement (3) correspondante, dont la face est en appui respectivement sur le premier élément (10) de bague d'extrémité installé.

17. Procédé selon la revendication 16, dans lequel, après que la couche d'enroulement (3) correspondante a été enroulée, on installe une seconde bague d'extrémité pour qu'elle soit en appui sur l'autre face terminale de la couche d'enroulement (3) dans la direction axiale, de façon à ce que le bord longitudinal (11) droit soit sensiblement dans l'alignement de la face terminale correspondante du dispositif de bobine (1) cylindrique.

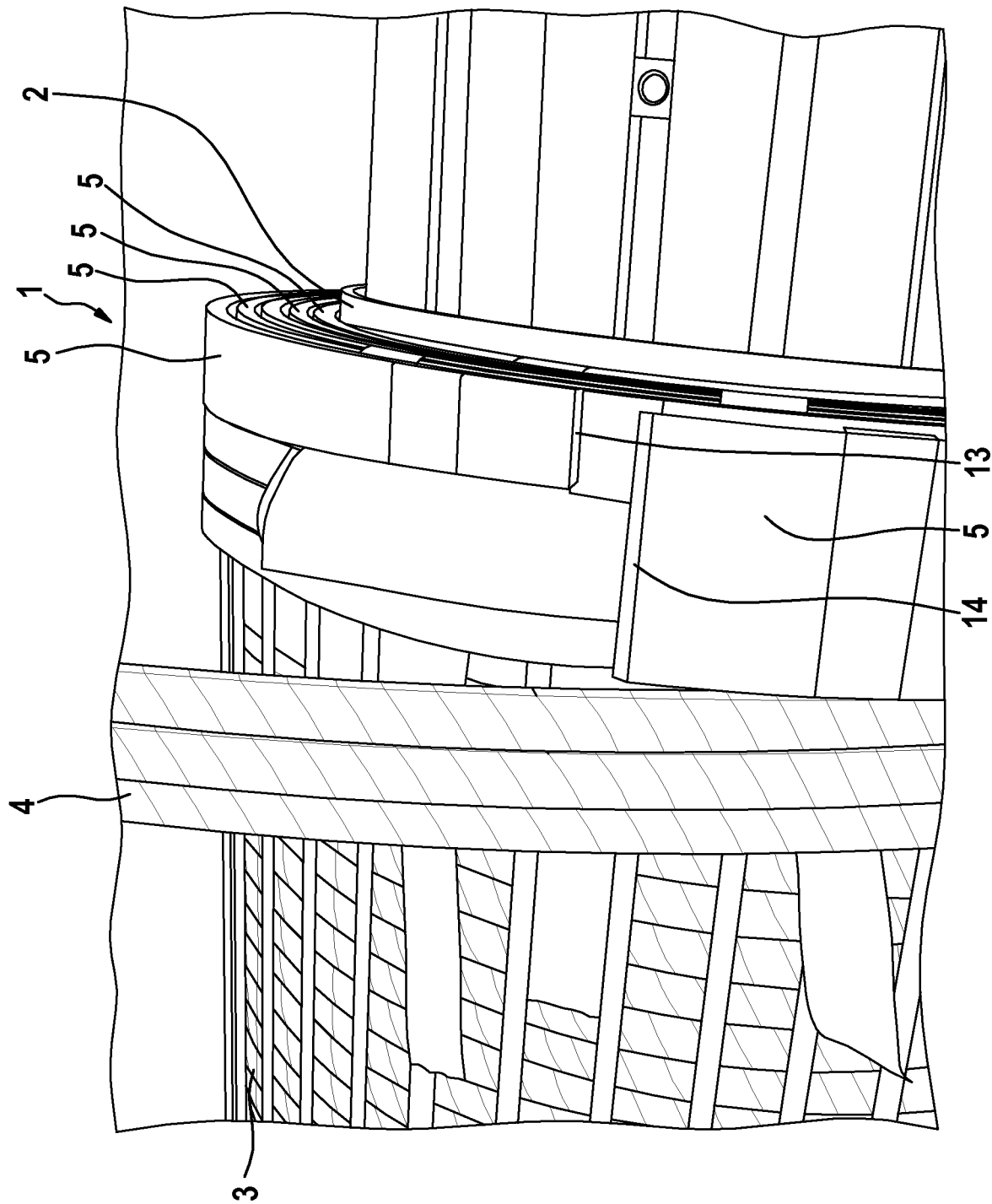


Fig. 1

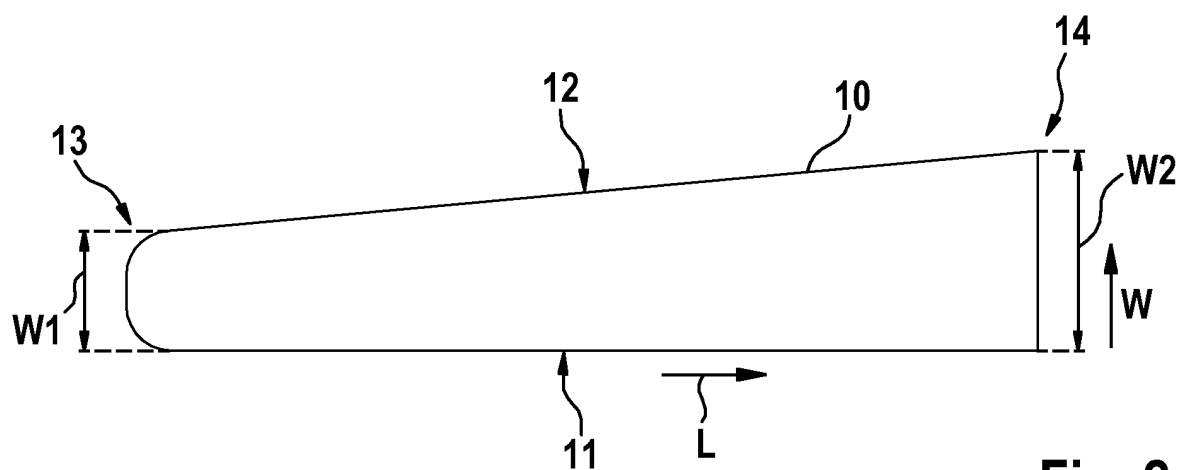


Fig. 2

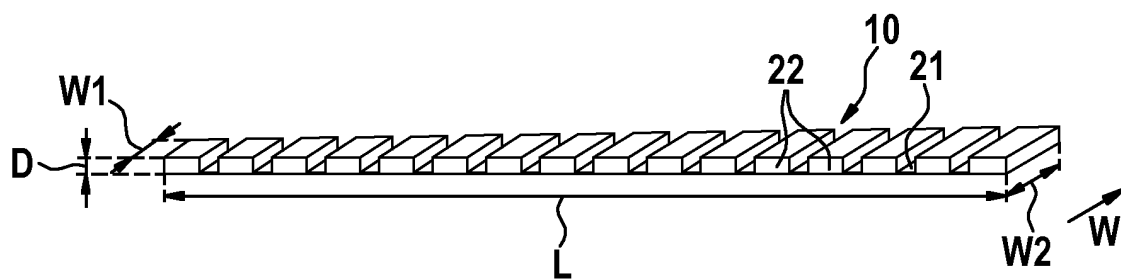


Fig. 3

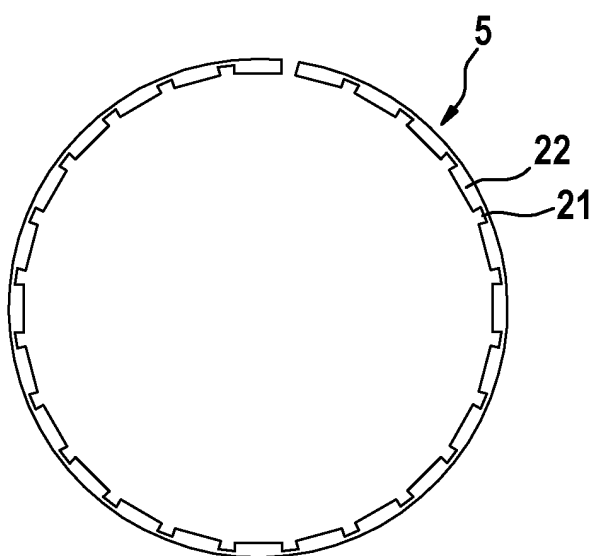


Fig. 4

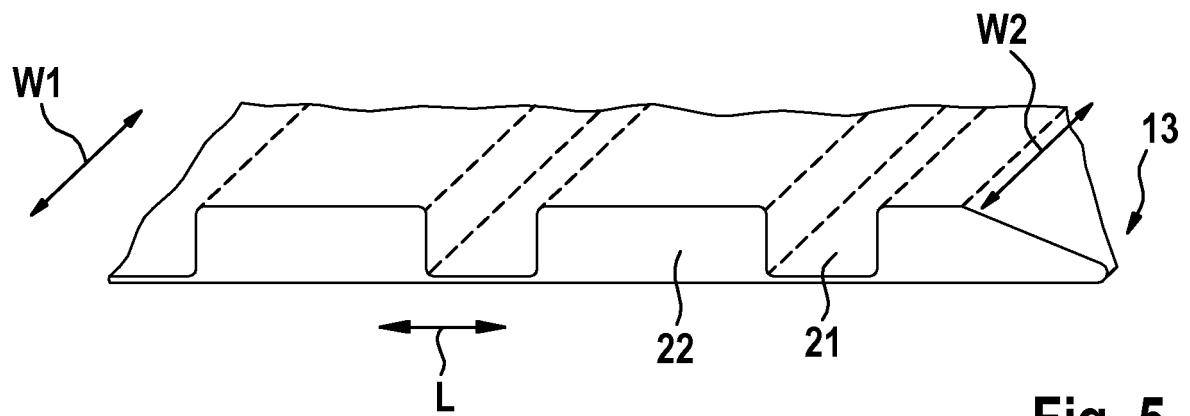


Fig. 5

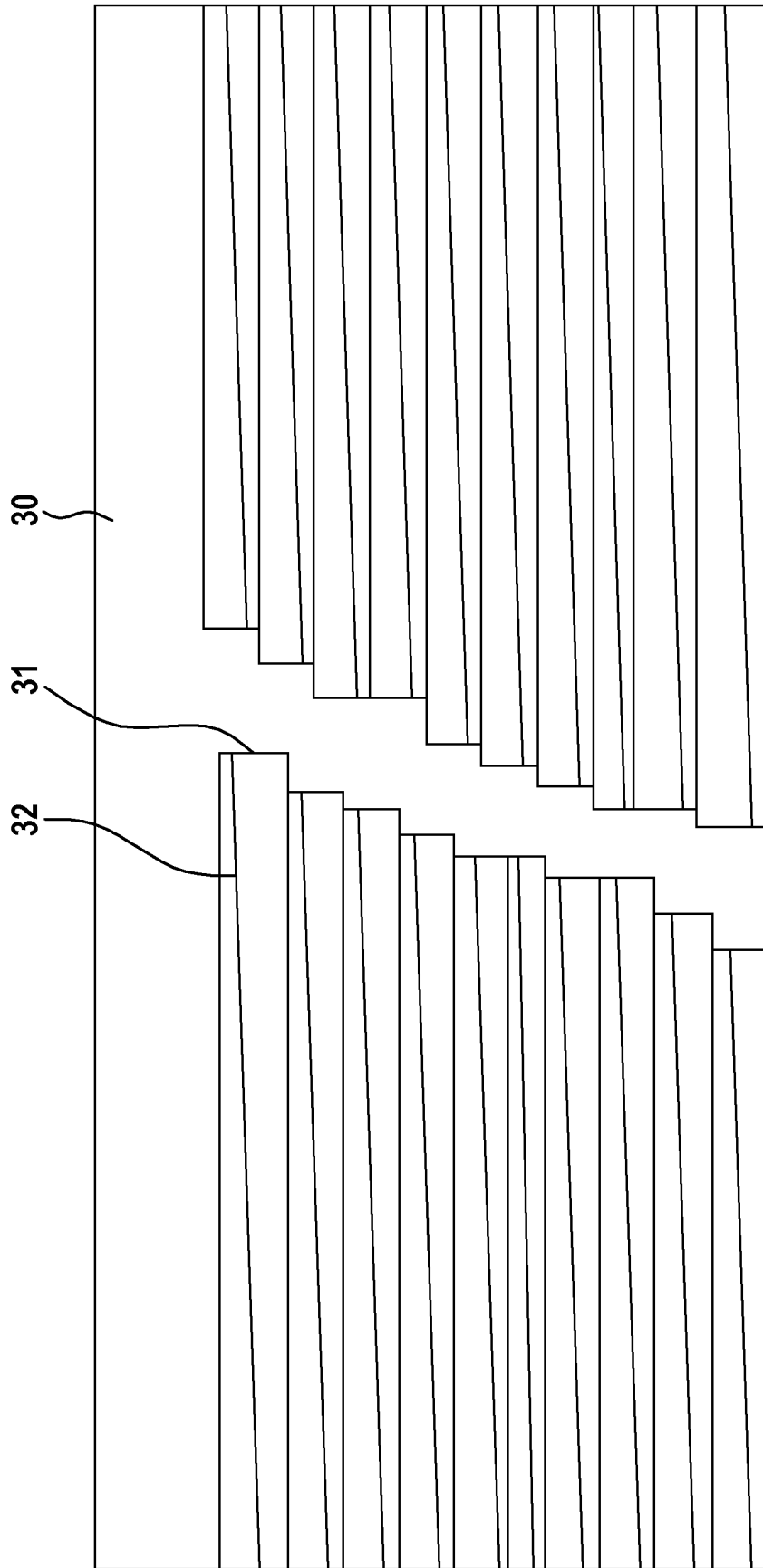


Fig. 6

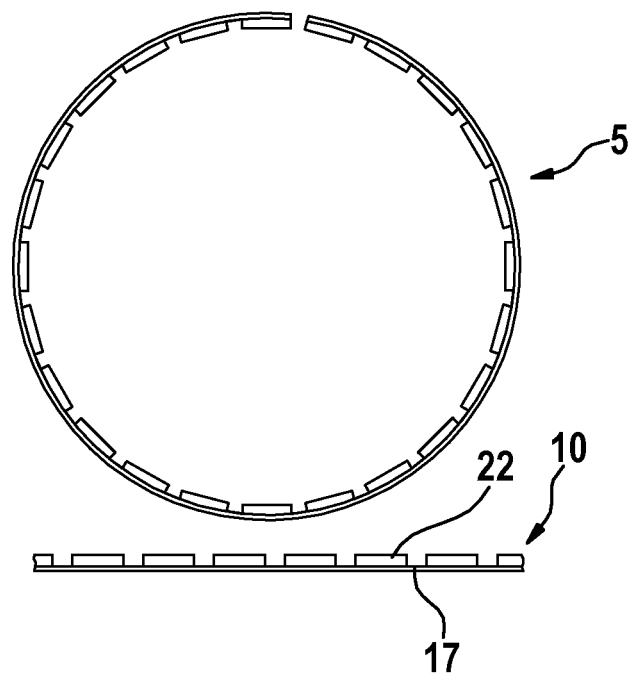


Fig. 7

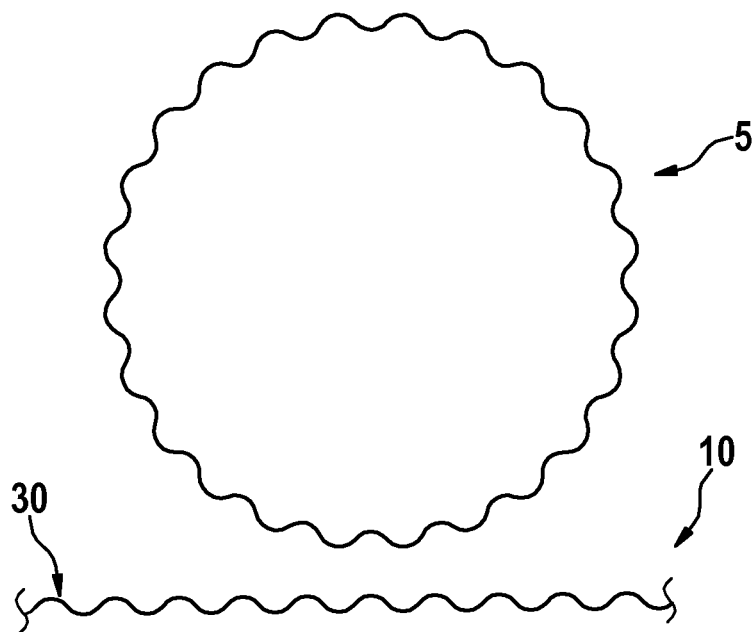


Fig. 8

REFERENCES CITED IN THE DESCRIPTION

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