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(54) Title: A WINDING OF AN ELECTRIC MACHINE

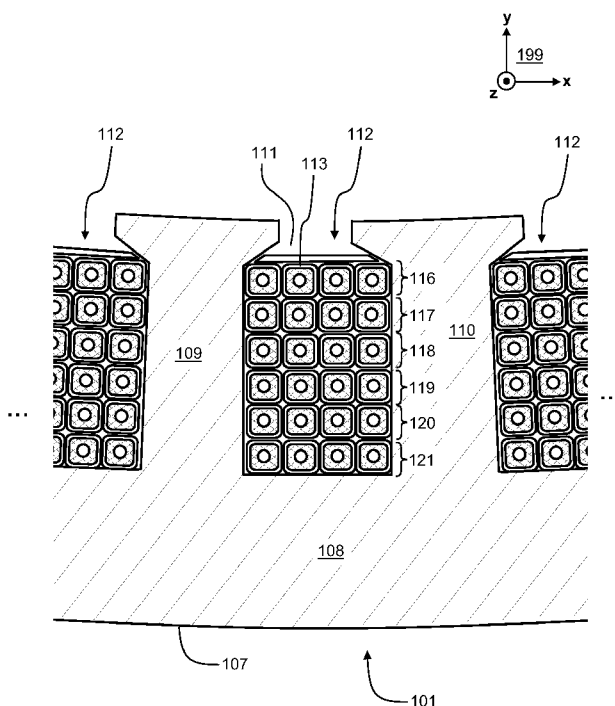


Figure 1a

(57) Abstract: A machine element (101) for an electric machine comprises a core element (101) provided with semi-closed slots. The machine element comprises at least one winding (112) constituted by shaped conductors (113) each comprising a core portion for conducting electric current and a layer of electrically insulating material surrounding the core portion. The shaped conductors have a rectangular cross-sectional profile so that the widths of the shaped conductors are smaller than the width of the slot openings. The shaped conductors are placed to form, in each of the slots, an array having rows (116-121) so that the rows are in the lateral direction of the slot, the rows are wider than the slot opening, and the rows are one upon the other in the depth direction of the slot. The array placing makes it possible to use semi-closed slots together with shaped conductors having a rectangular cross-sectional profile.



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Published:

- *with international search report (Art. 21(3))*
- *with amended claims (Art. 19(1))*

A winding of an electric machine

Field of the disclosure

The disclosure relates generally to electric machines. More particularly, the disclosure relates to a winding of an electric machine. Furthermore, the disclosure relates to an electric machine and to a method for manufacturing a winding of an electric machine.

Background

In an electric machine, such as an electric motor or a generator, a magnetic flux is developed between the electromagnetically active parts of the electric machine. Typically, at least one of the above-mentioned electromagnetically active parts comprises a ferromagnetic core element and one or more windings installed in slots of the core element. The core element can be for example the stator core of a rotating electric machine and the windings can be the stator windings of the rotating electric machine. The rotating electric machine can be for example an electrically excited synchronous machine, a permanent magnet machine, an induction machine, or a reluctance machine. The windings are constituted by conductors each comprising a core portion and a layer of electrically insulating material surrounding the core portion. The core portion comprises electrically conductive material, e.g. copper, for conducting electric current. The conductors are either round wire conductors or shaped conductors that typically have a rectangular cross-sectional profile. The core portion of a shaped conductor can be a single conductor bar, e.g. a copper bar. It is also possible that the core portion of a shaped conductor comprises many conductor bars which have rectangular cross-sectional profiles and are positioned with respect to each other so that a desired cross-sectional profile of the shaped conductor is achieved. The conductor bars can be electrically insulated from each other. It is also possible that the core portion of a shaped conductor comprises a bundle of filamentary conductors. In this case, the cross-sectional profile is determined by the layer of the electrically insulating material surrounding the core portion and/or by resin or other filler material among the

filamentary conductors. The bundle of the filamentary conductors may comprise for example one or more Litz wires where the filamentary conductors are individually insulated and twisted and/or woven together.

Shaped conductors have certain advantages with respect to round wire conductors. One of the advantages is that inductances of different phases of a multi-phase, e.g. a three phase, winding can be made more symmetrical with shaped conductors than with round wire conductors because shaped conductors are located in a more deterministic way in slots and end-winding regions than round wire conductors do. Another advantage of shaped conductors is that the conductor space factor, i.e. the filling factor, of slots can be higher than in a case where round wire conductors are used. A third advantage of shaped conductors is that, in many cases, a shaped conductor can be arranged to comprise a tubular channel for conducting water or some other suitable liquid or gaseous cooling fluid. Shaped conductors are, however, not free from challenges. One of the challenges is related to slot openings because a straightforward way to construct a winding with shaped conductors is to use open slots instead of semi-closed slots that are commonly used in conjunction with windings implemented with round wire conductors. Semi-closed slots are, however, more advantageous from the view point of air-gap harmonics of a magnetic flux distribution than open slots.

Summary

The following presents a simplified summary in order to provide basic understanding of some aspects of various invention embodiments. The summary is not an extensive overview of the invention. It is neither intended to identify key or critical elements of the invention nor to delineate the scope of the invention. The following summary merely presents some concepts of the invention in a simplified form as a prelude to a more detailed description of exemplifying embodiments of the invention.

In accordance with the invention, there is provided a new machine element for an electric machine. A machine element according to the invention comprises:

- a core element comprising a yoke section and teeth connected to the yoke section, semi-closed slots being formed between adjacent ones of the teeth and the core element being integral so that portions of the core element comprising adjacent ones of the teeth are inseparable from each other without material destructive actions, and

- at least one winding constituted by shaped conductors each comprising a core portion and a layer of electrically insulating material surrounding the core portion, the core portion comprising electrically conductive material for conducting electric current.

Each of the shaped conductors has a substantially rectangular cross-sectional profile so that the width of the shaped conductors is smaller than the width of the slot openings. The shaped conductors are placed to form, in each of the slots, an array having rows so that the rows are in the lateral direction of the slot, the rows are wider than the slot opening, and the rows are one upon the other in the depth direction of the slot. An end-portion of each of the teeth is asymmetric with respect to a geometric plane that is parallel with the shaped conductors placed in the slots and perpendicular to an air-gap surface defined by the teeth, and divides a cross-sectional area of the tooth under consideration into two substantially equal sized portions

The placing of the shaped conductors in the way described above makes it possible to use the semi-closed slots together with the shaped conductors having the rectangular cross-sectional profile. Each of the shaped conductors can be, if needed, arranged to comprise a tubular channel for conducting water or some other suitable liquid or gaseous cooling fluid. The tubular channel can be constituted by a hollow conductor bar or by a tube placed among the electrical conductors of the shaped conductor under consideration.

In accordance with the invention, there is provided also a new electric machine. An electric machine according to the invention comprises at least one machine element of the kind described above. The electric machine can be for example an inner rotor radial flux electric machine, an outer rotor radial flux electric machine, an axial flux electric machine, or a linear electric machine.

A machine element according to the invention may constitute for example a stator core and stator windings of a rotating electric machine, or two or more machine elements according to the invention may constitute the stator core and the stator windings of the electric machine so that each machine element constitutes one stator segment. It is also possible that the rotor of a rotating electric machine comprise one or more machine elements according to the invention.

In accordance with the invention, there is provided also a new method for manufacturing a machine element of the kind described above. The method comprises placing, in each of the slots, those of the shaped conductors belonging to an upmost row that is closest to the slot opening so that:

- particular ones of the shaped conductors constituting one or more portions of the upmost row that are farthest from the slot opening are placed first, and
- one or more of the shaped conductors constituting a portion of the upmost row that is closest to the slot opening are placed subsequently.

In cases where the cross-sections of the slots are symmetrical, the portions of the upmost row that are farthest from the slot opening are the ends of the upmost row and the portion of the upmost row that is closest to the slot opening is the middle portion of the upmost row. In a case where the cross-sections of the slots are asymmetrical, the situation can be, for example but not necessarily, such that one end of the upmost row represents a portion that is farthest from the slot opening whereas the other end of the upmost row represents a portion that is closest to the slot opening.

A number of exemplifying and non-limiting embodiments of the invention are described in accompanied dependent claims.

Various exemplifying and non-limiting embodiments of the invention both as to constructions and to methods of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific exemplifying and non-limiting embodiments when read in connection with the accompanying drawings.

The verbs “to comprise” and “to include” are used in this document as open limitations that neither exclude nor require the existence of unrecited features. The features recited in dependent claims are mutually freely combinable unless otherwise explicitly stated. Furthermore, it is to be understood that the use of “a” or “an”, i.e.
5 a singular form, throughout this document does not exclude a plurality.

Brief description of the figures

Exemplifying and non-limiting embodiments of the invention and their advantages are explained in greater detail below in the sense of examples and with reference to the accompanying drawings, in which:

10 figures 1a and 1b illustrate a part of a machine element according to an exemplifying and non-limiting embodiment of the invention,

figure 1c illustrates a part of a machine element according to another exemplifying and non-limiting embodiment of the invention,

figure 2 illustrates an electric machine according to an exemplifying and non-
15 limiting embodiment of the invention,

figure 3 illustrates a method according to an exemplifying and non-limiting embodiment of the invention for manufacturing a machine element, and

figure 4 illustrates a part of a machine element according to an exemplifying and non-limiting embodiment of the invention.

20 Description of the exemplifying embodiments

The specific examples provided in the description given below should not be construed as limiting the scope and/or the applicability of the appended claims. Lists and groups of examples provided in the description given below are not exhaustive unless otherwise explicitly stated.

25 Figure 1a shows a section view of a part of a machine element 101 according to an exemplifying and non-limiting embodiment of the invention. The section plane is parallel with the xy-plane of a coordinate system 199. The machine element 101

can be a part of a stator of an inner rotor radial flux machine or a part of a rotor of an outer rotor radial flux machine so that the axis of rotation is parallel with the z-axis of the coordinate system 199. The machine element 101 comprises a core element 107 and at least one winding 112. The core element 107 comprises a yoke section 108 and teeth connected to the yoke section. As shown in figure 1a, semi-closed slots are formed between adjacent ones of the teeth. In figure 1a, two of the teeth are denoted with reference numbers 109 and 110 and one of the slots is denoted with a reference number 111. The core element 107 is integral so that portions of the core element that comprise adjacent ones of the teeth are inseparable from each other without material destructive actions, e.g. cutting. The core element 107 is made of, or at least comprises, ferromagnetic material. The core element 119 may comprise a stack of ferromagnetic sheets that are electrically insulated from each other and stacked in the longitudinal direction of the slots, i.e. in the z-direction of the coordinate system 199.

The winding 112 is constituted by shaped conductors each comprising a core portion and a layer of electrically insulating material surrounding the core portion. In figure 1a, one of the shaped conductors is denoted with a reference number 113. As illustrated in figure 1a, the shaped conductors have a substantially rectangular profile so that the width of the shaped conductors is smaller than the width of the slot openings of the slots. Concerning the slot 111, the widths of the shaped conductors and the slot opening are measured in the x-direction of the coordinate system 199. The shaped conductors are placed to form, in each of the slots, an array having rows so that the rows are in the lateral direction of the slot, the rows are wider than the slot opening, and the rows are one upon the other in the depth direction of the slot. In figure 1a, the rows related to the slot 111 are denoted with reference numbers 116, 117, 118, 119, 120, and 121.

Figure 1b shows a section view of the shaped conductor 113. In figure 1b, the core portion of the shaped conductor 113 is denoted with a reference number 114 and the layer of the electrically insulating material is denoted with a reference number 115. The core portion 114 comprises electrically conductive material for conducting electric current. The electrically conductive material may comprise for example copper. In the exemplifying case illustrated in figure 1a and 1b, the core portion

114 comprises a bundle of filaments each comprising the electrically conductive material. In figure 1b, one of the filaments is denoted with a reference number 122. The bundle of the filaments may comprise for example one or more Litz wires where the filaments are individually insulated and twisted and/or woven together.

- 5 Figure 1c shows a section view of a shaped conductor 133 of a machine element according to another exemplifying and non-limiting embodiment of the invention. In this exemplifying case, the core portion 134 of the shaped conductor 133 comprises bars 136 and 137 made of electrically conductive material and positioned with respect to each other so that the bars form a substantially rectangular cross-
- 10 sectional profile. The bars 136 and 137 are surrounded by a layer 135 of electrically insulating material. It is also possible that the core portion of each shaped conductor comprises only one bar made of electrically conductive material.

- In the exemplifying machine element illustrated in figures 1a and 1b and in the other exemplifying machine element whose shaped conductor is illustrated in figure 1c, the core portion of each shaped conductor comprises a tubular channel for
- 15 conducting cooling fluid in the longitudinal direction of core portion. The tubular channel can be constituted by a hollow conductor bar or a tube placed among electrical conductors. In figure 1b, the tubular channel of the shaped conductor 113 is denoted with a reference number 123, and in figure 1b, the tubular channel
- 20 of the shaped conductor 133 is denoted with a reference number 138. The tubular channels 123 and 138 are constituted by tubes placed among electrical conductors of the shaped conductor. The tubes can be made of different material than the electrical conductors. The tubes can be made of for example stainless steel so as to provide a good resistance against corrosion and erosion.

- 25 Figure 2 shows a section view of an electric machine according to an exemplifying and non-limiting embodiment of the invention. The section plane is parallel with the xy-plane of a coordinate system 299. In this exemplifying case, the electric machine is an inner rotor radial flux machine that comprises permanent magnets in its rotor 224. In figure 2, one of the permanent magnets is denoted with a reference
- 30 number 225. The axis of rotation of the rotor 224 is parallel with the z-axis of the coordinate system 299. A stator 224 of the electric machine comprises machine elements 201, 202, 203, 204, 205, and 206 according to an embodiment of the in-

vention. Each of the machine elements 201-206 can be for example such as described above with reference to figures 1a and 1b or 1c.

Figure 3 illustrates a method according to an exemplifying and non-limiting embodiment of the invention for manufacturing a machine element of the kind described above with reference to figures 1a and 1b or 1c. The method is illustrated with reference to the slot 111 shown in figure 3. In phase 301, the upmost row 116 of the shaped conductors is missing. In phase 302, the shaped conductor constituting one end of the upmost row 116 has been placed and the shaped conductor constituting the other end of the upmost row 116 is being placed. In phase 303, the shaped conductors constituting the ends of the upmost row 116 have been placed, one of the shaped conductors constituting the middle portion of the upmost row 116 has been placed, and another of the shaped conductors constituting the middle portion of the upmost row 116 is being placed. In phase 304, the shaped conductors belonging to the slot 111 have all been placed. Further method phases may include for example installing slot wedges and/or casting or injecting resin or some other suitable impregnation material.

Figure 4 shows a section view of a part of a machine element 401 according to an exemplifying and non-limiting embodiment of the invention. The section plane is parallel with the xy-plane of a coordinate system 499. The machine element 401 comprises a core element 407 and at least one winding 412. The core element 407 comprises a yoke section 408 and teeth connected to the yoke section. As shown in figure 4, semi-closed slots are formed between adjacent ones of the teeth. In figure 4, two of the teeth are denoted with reference numbers 409 and 410 and one of the slots is denoted with a reference number 411. The core element 407 is integral so that portions of the core element that comprise adjacent ones of the teeth are inseparable from each other without material destructive actions, e.g. cutting. The winding 412 comprises shaped conductors having substantially rectangular cross-sectional profiles and placed in the slots as illustrated figure 4 where one of the shaped conductors is denoted with a reference number 413.

In the exemplifying machine element illustrated in figure 4, the end-portion of each tooth is asymmetric with respect to a geometric plane that is parallel with the shaped conductors placed in the slots and perpendicular to the air-gap surface defined by the teeth, and divides the cross-sectional area of the tooth under considerations into two substantially equal sized portions. In figure 4, the geometric plane of the kind mentioned above and related to the tooth 409 is depicted with a dashed line and denoted with a reference number 440. Due to the asymmetrical teeth, the machine element illustrated in figure 4 is more suitable for cases where circumferential force acting on the teeth is in the negative x-direction of the coordinate system 199 than for cases where the circumferential the force is in the positive x-direction. Thus, an electrical machine comprising a machine element of the kind illustrated in figure 4 is more suitable for generating torque in one direction than in the other direction. However, in some cases, a winding of a machine element of the kind illustrated in figure 4 can be easier to manufacture than a winding of a machine element having symmetrical teeth and slots.

The specific examples provided in the description given above should not be construed as limiting the applicability and/or the interpretation of the appended claims. Lists and groups of examples provided in the description given above are not exhaustive unless otherwise explicitly stated.

What is claimed is:

1. A machine element (401) for an electric machine, the machine element comprising:

- 5 - a core element (407) comprising a yoke section (408) and teeth (409, 410) connected to the yoke section, semi-closed slots (411) being formed between adjacent ones of the teeth and the core element being integral so that portions of the core element comprising adjacent ones of the teeth are inseparable from each other without material destructive actions, and
- 10 - at least one winding (412) constituted by shaped conductors (113) each comprising a core portion (114) and a layer (115) of electrically insulating material surrounding the core portion, the core portion comprising electrically conductive material for conducting electric current,

wherein each of the shaped conductors has a substantially rectangular cross-sectional profile so that a width of the shaped conductors is smaller than a width of slot openings, and the shaped conductors are placed to form, in each of the slots, an array having rows (116-121) so that the rows are in a lateral direction of the slot, the rows are wider than the slot opening, and the rows are one upon the other in a depth direction of the slot, **characterized** in that an end-portion of each of the teeth is asymmetric with respect to a geometric plane that is parallel with the shaped conductors placed in the slots and perpendicular to an air-gap surface defined by the teeth, and divides a cross-sectional area of the tooth under consideration into two substantially equal sized portions.

2. A machine element according to claim 1, wherein the core portion (114) of each of the shaped conductors comprises a bundle of filaments (122) each comprising the electrically conductive material.

3. A machine element according to claim 1, wherein the core portion of each of the shaped conductors comprises only one bar made of the electrically conductive material.

4. A machine element according to claim 1, wherein the core portion of each of the shaped conductors comprises bars (136, 137) made of the electrically conductive material and positioned with respect to each other so that the bars form the substantially rectangular cross-sectional profile.
5. A machine element according to any of claims 1-4, wherein the core portion of each of the shaped conductors comprises a tubular channel (123, 138) for conducting cooling fluid in a longitudinal direction of the shaped conductor under consideration.
6. A machine element according to claim 5, wherein core portion of each of the shaped conductors comprises a tube constituting the tubular channel.
7. A machine element according to claim 6, wherein the tube is made of material different from the electrically conductive material for conducting the electric current.
8. An electric machine comprising at least one machine element (201-206) according to any of claims 1-7.
9. An electric machine element according to claim 8, wherein a rotor of the electric machine comprises the machine element according to any of claims 1-7.
10. An electric machine element according to claim 8 or 9, wherein a stator (224) of the electric machine comprises the machine element according to any of claims 1-7.
11. A method for manufacturing a machine element according to any of claims 1-7, **characterized** in that the method comprises placing, in each of the slots, those of the shaped conductors belonging to an upmost one of the rows (116) that is closest to the slot opening so that:
- particular ones of the shaped conductors constituting one or more portions of the upmost row that are farthest from the slot opening are placed first, and

- one or more of the shaped conductors constituting a portion of the upmost row that is closest to the slot opening are placed (303) subsequently.

AMENDED CLAIMS

received by the International Bureau on 06 October 2016 (06.10.2016)

1. A machine element (401) for an electric machine, the machine element comprising:

- 5 - a core element (407) comprising a yoke section (408) and teeth (409, 410) connected to the yoke section, semi-closed slots (411) being formed between adjacent ones of the teeth and the core element being integral so that portions of the core element comprising adjacent ones of the teeth are inseparable from each other without material destructive actions, and
- 10 - at least one winding (412) constituted by shaped conductors (113) each comprising a core portion (114) and a layer (115) of electrically insulating material surrounding the core portion, the core portion comprising electrically conductive material for conducting electric current,

15 wherein each of the shaped conductors has a substantially rectangular cross-sectional profile so that a width of the shaped conductors is smaller than a width of slot openings, and the shaped conductors are placed to form, in each of the slots, an array having rows (116-121) so that the rows are in a lateral direction of the slot, the rows are wider than the slot opening, and the rows are one upon the other in a depth direction of the slot.

20 2. A machine element according to claim 1, wherein the core portion (114) of each of the shaped conductors comprises a bundle of filaments (122) each comprising the electrically conductive material.

3. A machine element according to claim 1, wherein the core portion of each of the shaped conductors comprises only one bar made of the electrically conductive material.

25 4. A machine element according to claim 1, wherein the core portion of each of the shaped conductors comprises bars (136, 137) made of the electrically conductive material and positioned with respect to each other so that the bars form the substantially rectangular cross-sectional profile.

5. A machine element according to any of claims 1-4, wherein the core portion of each of the shaped conductors comprises a tubular channel (123, 138) for conducting cooling fluid in a longitudinal direction of the shaped conductor under consideration.
- 5 6. A machine element according to claim 5, wherein core portion of each of the shaped conductors comprises a tube constituting the tubular channel.
7. A machine element according to claim 6, wherein the tube is made of material different from the electrically conductive material for conducting the electric current.
- 10 8. An electric machine comprising at least one machine element (201-206) according to any of claims 1-7.
9. An electric machine element according to claim 8, wherein a rotor of the electric machine comprises the machine element according to any of claims 1-7.
10. An electric machine element according to claim 8 or 9, wherein a stator (224)
15 of the electric machine comprises the machine element according to any of claims 1-7.
11. A method for manufacturing a machine element according to any of claims 1-7, **characterized** in that the method comprises placing, in each of the slots, those of the shaped conductors belonging to an upmost one of the rows (116) that is
20 closest to the slot opening so that:
- particular ones of the shaped conductors constituting one or more portions of the upmost row that are farthest from the slot opening are placed (302) first, and
 - one or more of the shaped conductors constituting a portion of the upmost
25 row that is closest to the slot opening are placed (303) subsequently.

- one or more of the shaped conductors constituting a portion of the upmost row that is closest to the slot opening are placed (303) subsequently.

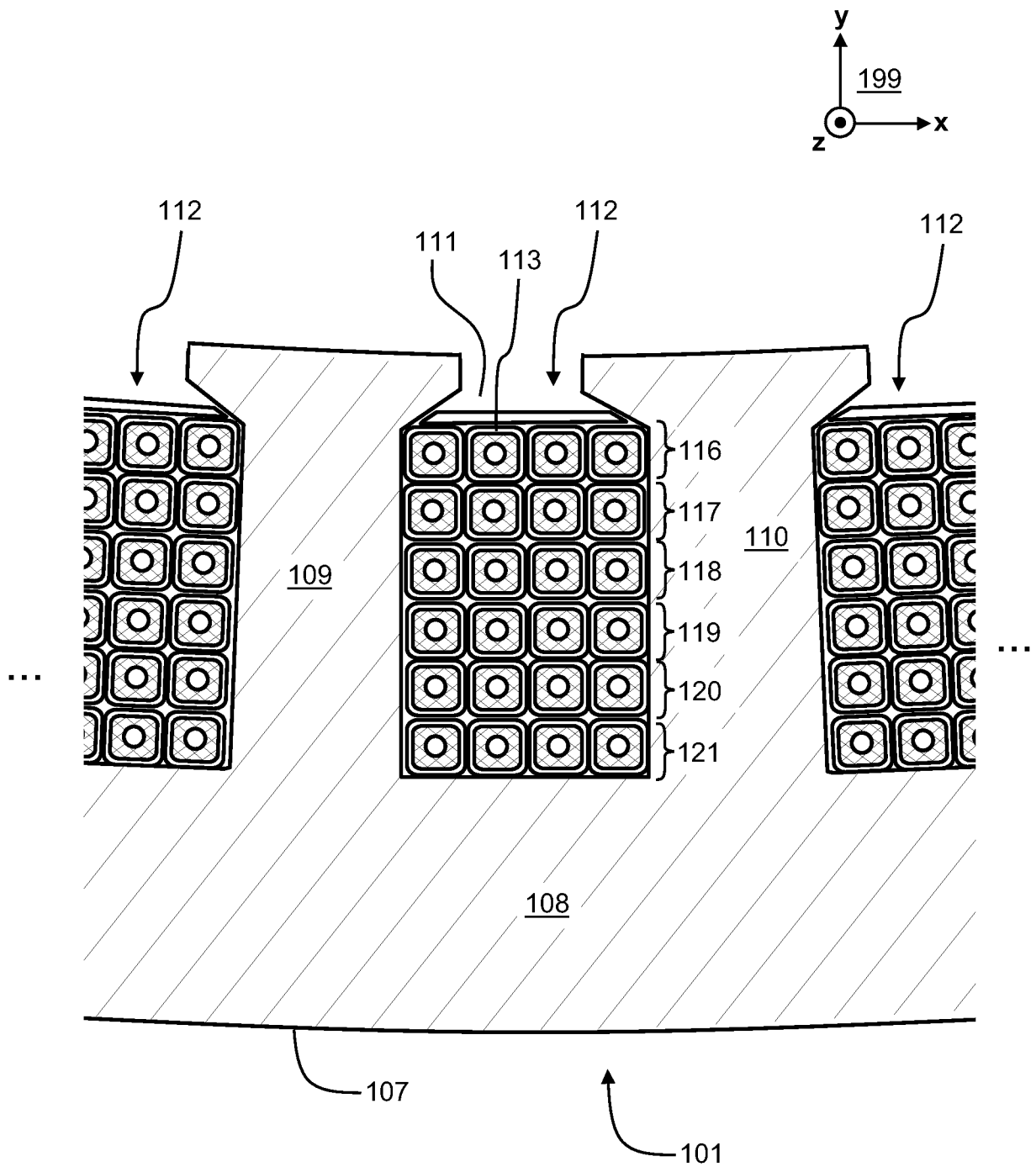


Figure 1a

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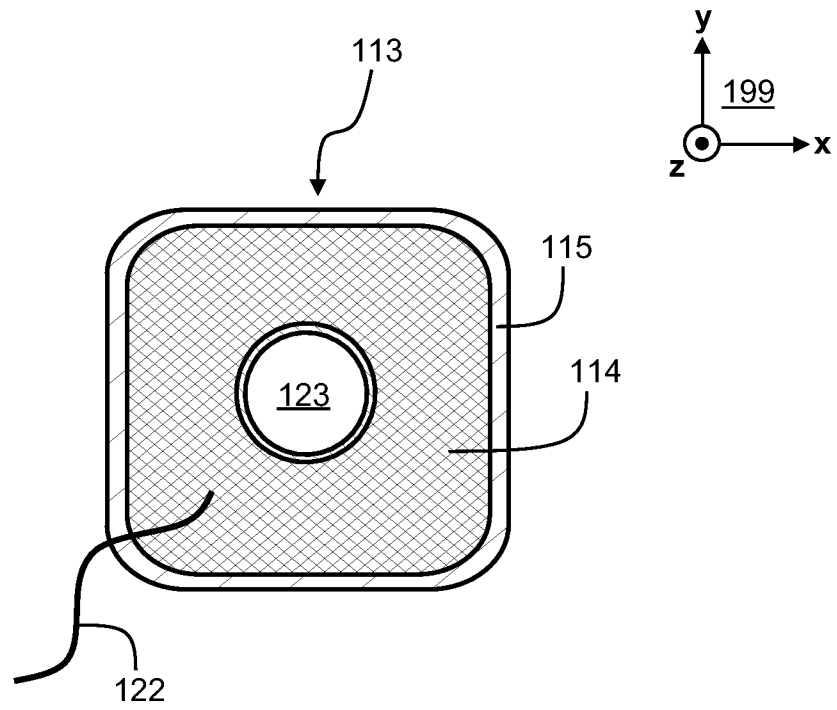


Figure 1b

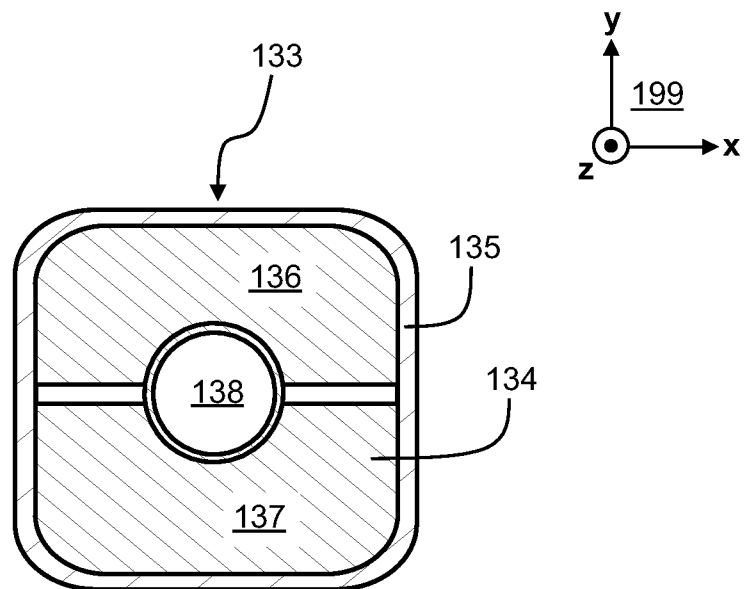


Figure 1c

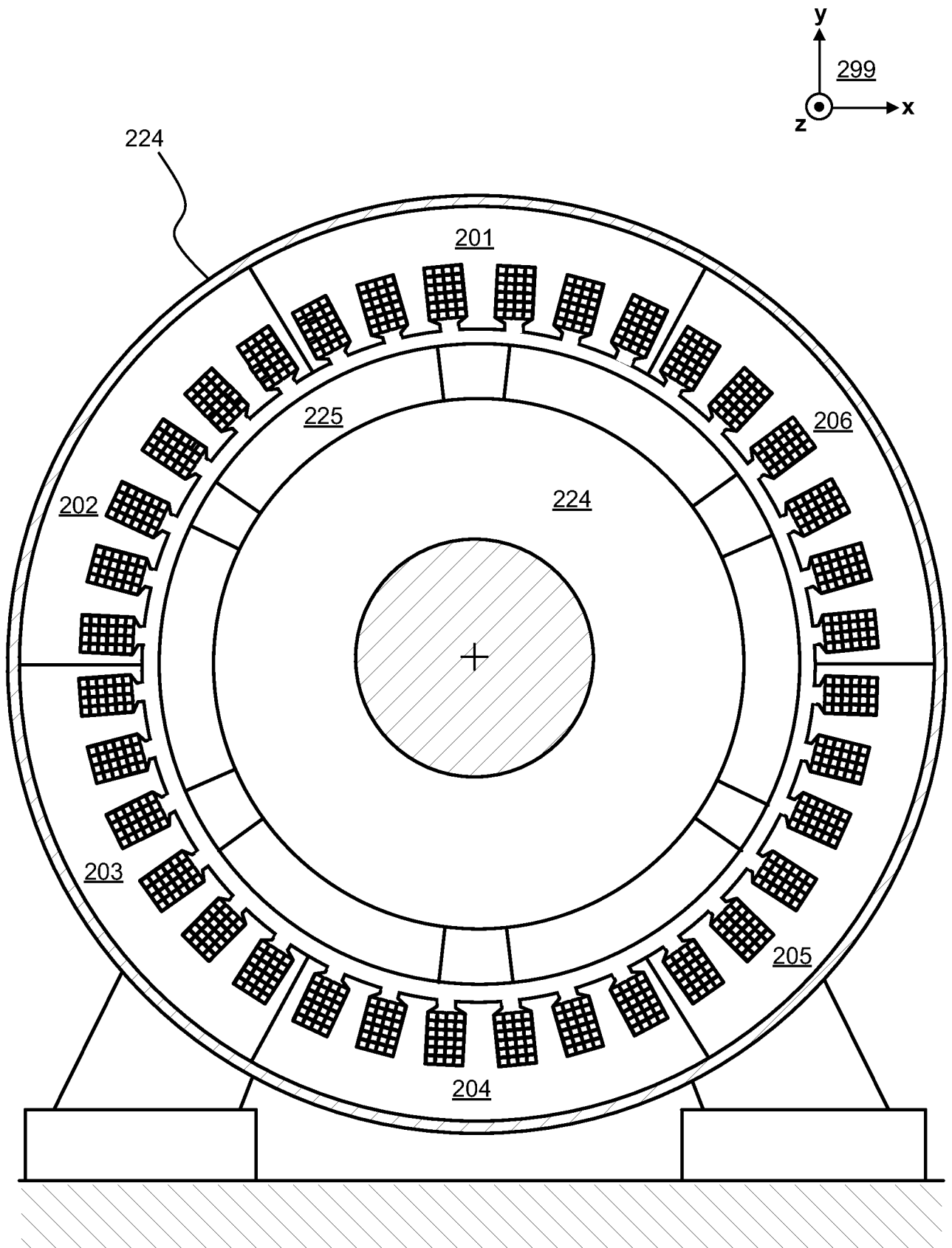


Figure 2

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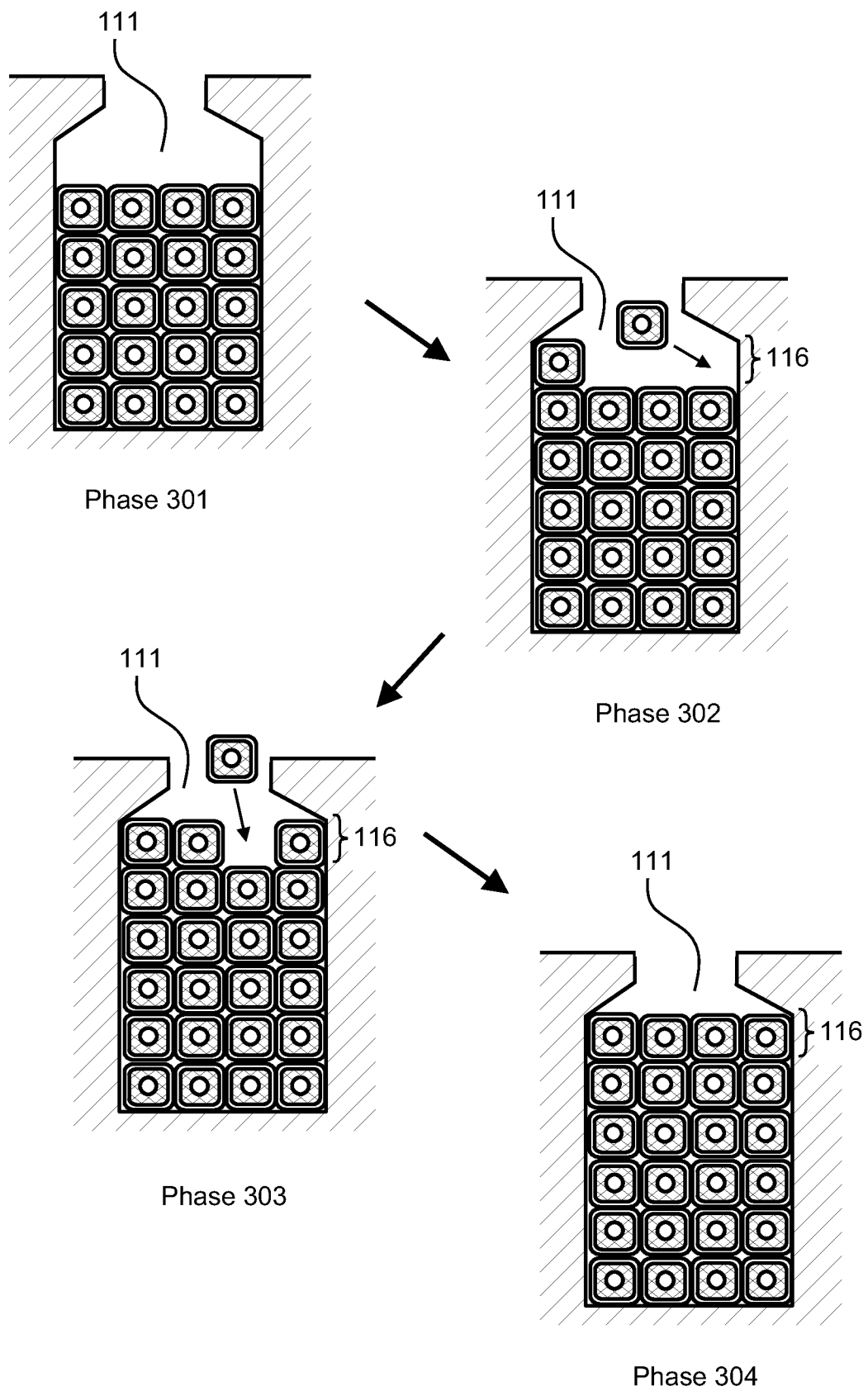


Figure 3

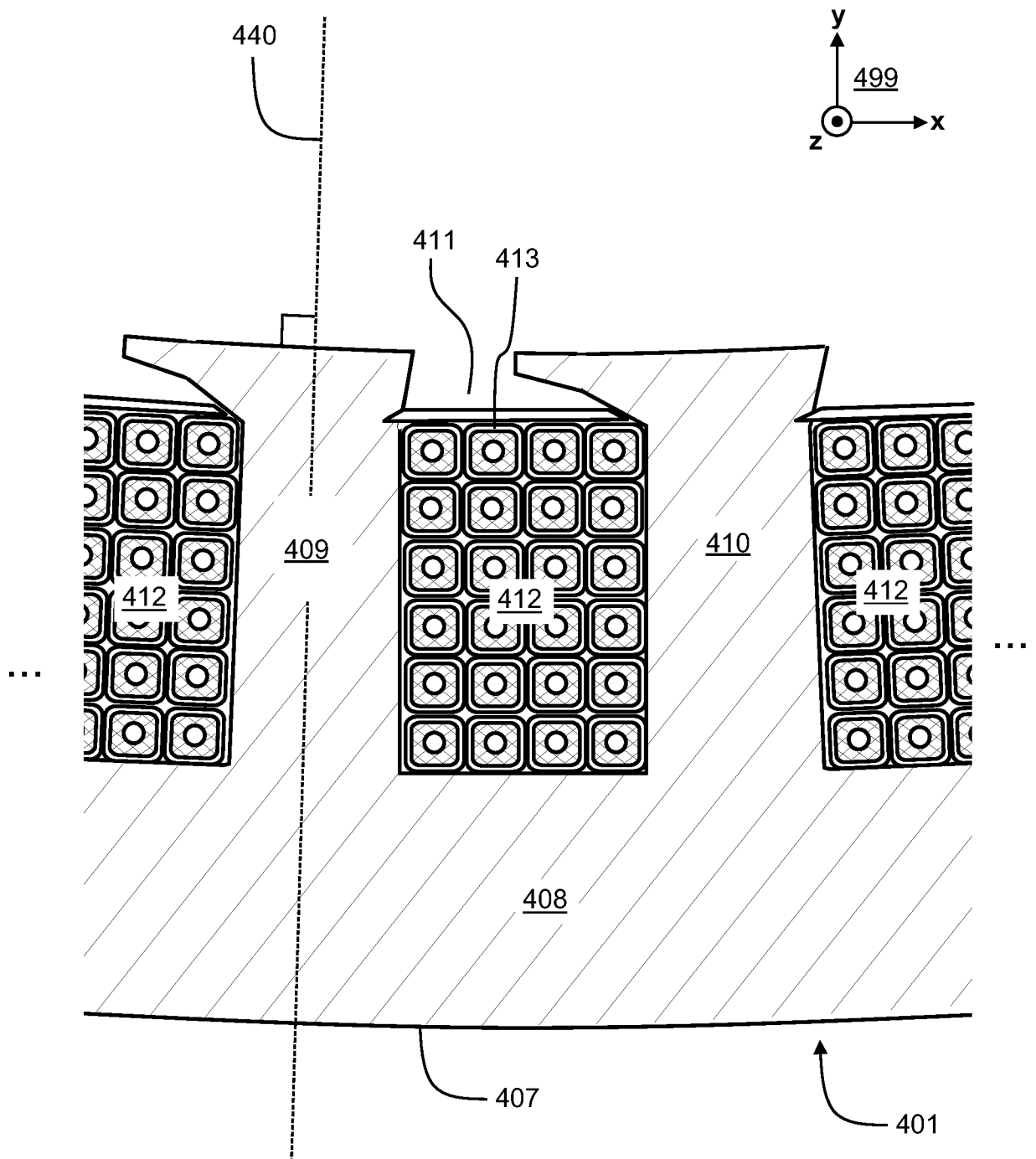


Figure 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2016/050309

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base, and, where practicable, search terms used)

EPO-Internal, WPIAP, COMPDX, EMBASE, INSPEC, TDB, NPL, XP3GPP, XPAIP, XPESP, XPETSI, XPI3E, XPIEE, XPIETF, XPIOP, XPIPCOM, XPMISC, XPOAC, XPRD, XPTK

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 5704288 B1 (MITSUBISHI ELECTRIC CORP [JP]) 22 April 2015 (22.04.2015) figures, abstract [online] EPOQUENET EPODOC & WPI, machine translation into English by EPO [online] EPOQUENET TXPJPOEB paragraphs 0012, 0014, 0022 – 0024, 0026, 0027, 0029, 0034 – 0040, 0043, 0050 – 0052, 0056, 0060, 0061, 0090, 0122, and claims	1 - 11
X	EP 1583205 A2 (TOYOTA JIDOSHOKKI KK [JP]) 05 October 2005 (05.10.2005) abstract, paragraphs 0001, 0002, 0011, 0012, 0026, 0027, claims, and figures	1 - 11
X	US 2010181948 A1 (TANIGUCHI MAKOTO [JP] et al.) 22 July 2010 (22.07.2010) abstract, paragraphs 0069 – 0072, 0085 – 0087, claims, and figures	1 - 11

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
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"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

18 August 2016 (18.08.2016)

Date of mailing of the international search report

23 August 2016 (23.08.2016)

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2016/050309

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012274172 A1 (KOGA KIYOTAKA [JP]) 01 November 2012 (01.11.2012) abstract, paragraphs 0006 – 0008, 0033, claims, and figures	1 - 11
X	EP 1914866 A2 (HITACHI LTD [JP]) 23 April 2008 (23.04.2008) abstract, paragraph 37, claims, and figures	1 - 11
A	WO 2012052618 A2 (LAPPEENRANNAN TEKNILLINEN YLIOPISTO [FI]) 26 April 2012 (26.04.2012) abstract, page 32 line 27 – page 33 line 20, claims, and figures 25 – 29	1 - 11

INTERNATIONAL SEARCH REPORT
Information on Patent Family Members

International application No.
PCT/FI2016/050309

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CLASSIFICATION OF SUBJECT MATTER

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