



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
12.06.2013 Bulletin 2013/24

(51) Int Cl.:
H01F 27/06 ^(2006.01) **H01F 27/12** ^(2006.01)

(21) Application number: **11009669.0**

(22) Date of filing: **08.12.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

- **Larsson, Jonas**
72482 Västerås (SE)
- **Forsberg, Erik**
77751 Smedjebacken (SE)
- **Schmidt, Lars**
57232 Oskarhamn (SE)
- **Hübner, Marikka**
06116 Halle (DE)

(71) Applicant: **ABB Technology AG**
8050 Zürich (CH)

(74) Representative: **Kock, Ina**
ABB AG
GF-IP
Wallstadter Straße 59
68526 Ladenburg (DE)

(72) Inventors:
• **Brendel, Hartmut**
06120 Halle (DE)
• **Anger, Jan**
77130 Ludvika (SE)

(54) **Coil-fixture and oil-transformer**

(57) The invention is related to a coil-fixture (10, 36, 38, 60, 62, 70, 90) for mounting on a front side of a hollow cylindrical high voltage transformer coil (32, 58), comprising a ring-shaped ground plate (12, 72, 164) with an inner opening (14, 80, 114) for a limb (54, 56) of a transformer core (52) and rib-like spacer-elements (16, 18, 74, 76, 92, 94, 96, 98) suitable for supporting at least the weight of a belonging transformer coil (32, 58), which are arranged flat on one side of the ground-plate (12, 72, 164). Flow-channels (24, 26, 40, 42, 108, 110, 112) are foreseen inbetween the spacer elements (16, 18, 74, 76,

92, 94, 96, 98), which are leading directly or indirectly to an area around the inner opening (14, 80, 114). The ground-plate (12, 72, 164) and the rib-like spacer elements (16, 18, 74, 76, 92, 94, 96, 98) are manufactured as one monolithic part.. The invention also relates to an oil transformer, comprising a transformer vessel and a transformer core (52) with at least one transformer coil (32, 58) mounted therein, whereas the transformer coil is clamped inbetween two coil fixtures (10, 36, 38, 60, 62, 70, 90) whereas at least one coil fixture is built according to the invention.

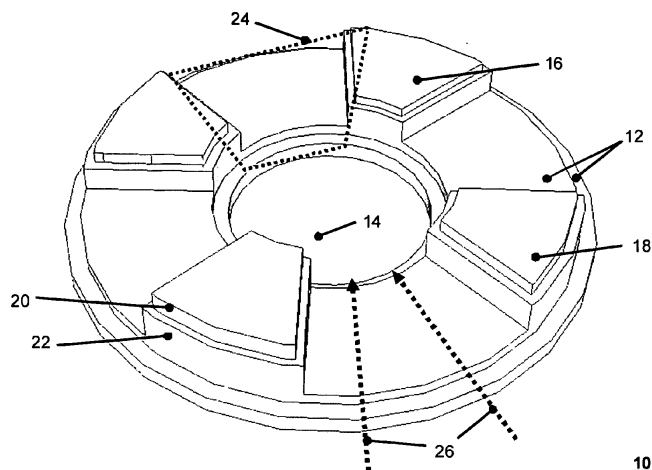


Fig. 1

Description

[0001] The invention relates to a coil-fixture for mounting on a front side of a hollow cylindrical high voltage transformer coil, comprising a ring-shaped ground plate with an inner opening for a limb of a transformer core, rib-like spacer-elements suitable for supporting at least the weight of a belonging transformer coil, which are arranged flat on one side of the ground-plate whereas flow-channels are foreseen inbetween the spacer elements which are leading directly or indirectly to an area around the inner opening.

[0002] It is known, that transformers in energy distribution networks of for example with a rated voltage of 110kV or 380kV are usually designed as oil transformers. The transformer core with its coils is arranged in an oil filled vessel, whereas the oil is on one side insulation medium and on the other side cooling medium. Typically the oil circulates inbetween cooling channels through the windings, where heat losses are generated during operation of the transformer, and a cooling device which transfers the heat from the oil to outer environment. The circulation of the oil might be generated by a pump for example but also a natural circulation is possible.

[0003] The transformer coil has to become mechanically strengthened to withstand the mechanical forces which occur inbetween neighbored conductor windings during short-circuit, which might cause a temporary current of for example 100kA or higher. Especially in axial direction of the transformer winding such a mechanical strengthening is required, whereas in radial direction the ring like arrangement of the windings around the winding axis is strong enough to withstand the belonging short-circuit forces. Compared with the forces caused by the weight of the transformer coil itself, the axial forces during short-circuit might, for example, be five times higher.

[0004] Thus an axial clamping structure is required at both axial ends of the transformer coil, which puts an axial clamping pressure on the axial ends of the coil and which prevents a mechanical deformation of the coil in axial direction during short circuit. This clamping structure has to be designed in a way that an oil flow through this structure to the inner cooling channels of the transformer coil clamped therein is enabled, respectively from the inner cooling channels through the clamping structure at the opposite side of the transformer winding.

[0005] This is normally done by using a so called press-ring and a so called spacer-ring, which are placed more or less congruently on each other and which are arranged on each axial end of a transformer coil. The press ring is designed for withstanding the expected mechanical forces and has a typical thickness of for example 10cm, dependent on the belonging frame conditions. The spacer-ring typically consists of a flat ring structure, where spacer-elements are mounted on. The spacer elements are arranged in such a way, that flow channels inbetween adjacent spacer elements are built so that oil can flow through them and then into the axial cooling

channels of the transformer coil. The height of such spacer elements might be 4cm for example whereas they also have to fulfil requirements of electrical insulation. Thus, a press ring is designed according to mechanical requirements and a spacer ring is designed according to electrical rules concerning the insulation and according to the requirements of the oil flow.

[0006] Since those spacer elements are only subject to an axial pressure force and a displacement along the surface of the flat ring structure has not to be expected therefore, no strong mechanical connection of the spacer elements is foreseen. Moreover, this are typically ashlar-like elements, for example cut from a longer bar with belonging cross section, which are stuck on the flat ring structure. A mechanical connection inbetween press-ring and spacer-ring is not foreseen. Upper and lower press-rings are connected by an axial tension device to put a pressure force thereon. To enable the arrangement of such a pressed winding around a transformer limb, the press-and spacer-rings comprise an inner hollow, of which the cross section corresponds more or less to the inner cross section of the hollow cylindrical transformer coil. Disadvantageously within the state of the art is that such an arrangement of press ring and spacer ring, respectively the coil fixture composed therefrom, requires usually a space of for example 14cm at each side along the axial length of the transformer coil, which can not be used for electrically active parts, namely the winding. So the theoretical maximum rated power of a transformer of a given size is significantly reduced by using such coil fixtures, which are on the other side required for improving the axial strengthens of the winding.

[0007] Based on this state of the art it is the objective of the invention to provide an improved coil-fixture of reduced height, which allows taking better usage of the available space within a transformer.

[0008] This problem is solved by a coil fixture of the aforementioned kind. This is characterized in that the ground-plate and the rib-like spacer elements are manufactured as one monolithic part.

[0009] The basic idea of this invention consists in using the spacer ring, which has according to the state of the art no contribution to increase the flexural strength of a coil fixture, to increase its flexural strength. The flexural strength of a part is on one side dependent on the height of the part and on the other side on the characteristics of the material. If for example two identical bars are placed on each other without any additional connection, the total flexural strength is twice as high as for one single bar. If on the other side a monolithic bar of the same material and same size is considered, the flexural strength is four times higher than for a single bar and twice as high as for the two single bars due to a quadratic dependency between thickness and flexural strength of monolithic parts.

[0010] The principal dependency for the flexural strength of a bar-like monolithic specimen, which is placed on two points with a span inbetween whereas a

force is applied at half of the span can be calculated as follows:

$$\sigma_f = \frac{3FL}{2bh^2}$$

where

σ_f is the flexural-stress parameter in question;

F is the applied force, in newtons;

L is the span, in millimetres;

b is the width, in millimetres, of the specimen;

h is the thickness, in millimetres, of the specimen.

[0011] Thus a part can be considered to be monolithic, if the rule above is in principal applicable thereon. This might for example also be valid for a part, which is glued together with a high tensile glue.

[0012] Since the spacer elements according to the invention are rib-like shaped - similar to a bar - they are also suitable for a contribution to an increased flexural strength of a coil fixture. According to the invention, the whole coil-fixture is manufactured as one monolithic part, so that the effect of the quadratic dependency is also used there. In an advantageous way, the rib-like distance elements have to be arranged in that way on the ground plate, that those areas of highest expected flexural stress are supported therewith. Thus the arrangement of transformer core, coil and coil fixture might be considered for placing the rib-like distance elements.

[0013] Thus, an arrangement of for example 9cm press ring and 5cm spacer ring can be replaced by a monolithic coil fixture of for example 11 cm with comparable and sufficient flexural strength. Considering this effect for the coil fixtures at both axial ends of the coil, a total axial length of 6cm is gained in an advantageous way.

[0014] Preferably the method of milling is used for the manufacturing of such monolithic coil fixture. This is usually supported by CAD systems, so that a nearly unlimited variation of shapes can be realized therewith.

[0015] In a further embodiment of the invention the monolithic part consists of laminated material. A laminated material consists of several flat layers which are glued together by using a high pressure. Thus a monolithic block of extreme high stiffness is produced, which is also suitable to be milled in a desired shape. According to a further aspect of the invention, the monolithic block respectively part consists at least predominantly of press-board. This is a cellulose based material of a high stiffness and excellent electrical insulation capability, which is very suitable for the use in oil transformers, for

example as supporting element.

[0016] In a further embodiment of the invention the rib-like spacer-elements are arranged on the ground plate at least predominantly radially to the inner opening. Such radial arrangement is on one side advantageous for short flow-channels as for the mechanical stiffness of the coil fixture since there is preferably an equidistant angled arrangement of the spacer elements.

[0017] According to a further embodiment of the invention the rib-like spacer-elements are arranged on the ground plate at least predominantly concentrically to the inner opening. Also this arrangement is advantageous for a high mechanical stiffness respectively flexural strength, since the support by the rib-like spacer elements is not reduced in radial outer areas if a concentric arrangement is selected for example. Preferably the position of the rib-like spacer elements corresponds to the arrangement of belonging support areas at the axial ends of the transformer coil which is intended to be placed thereon, so that the force or load transmission from spacer elements to the transformer coil is improved.

[0018] According to a further embodiment of the coil fixture with mainly radial arranged spacer elements the radial inner width of at least one rib-like spacer element is higher than its radial outer width, so that the flow channels inbetween adjacent spacer elements are shaped like a flat widened cone. The height of the spacer elements is preferably the same, for example 3 - 6cm. A widened cone has to be seen in comparison to a cone, which is built inbetween ashlar-formed rib-like spacer elements. The widened cone has a wider opening angle so that oil or any other fluid flowing through it gets an increased flowing speed in the radial inner area. Thus in the radial inner area a kind of nozzle is formed, which injects the oil in the inner opening. Due to the increased turbulences within the oil the cooling effect is increased once more.

[0019] According to a further embodiment of the invention the coil fixture is congruently mounted at a front side of a hollow cylindrical high voltage transformer coil with axial cooling channels. The sum of the respective minimal cross-sections of the flow channels leading to the area around the inner opening of the coil fixture is adapted to the sum of the cross-sections of the axial cooling channels of the transformer coil.

[0020] In a further embodiment of the invention the rib-like spacer elements are shaped at their side-walls in a way which differs from a plane perpendicular to the ground plate, so that the axial creeping distance along the side walls is prolonged. Especially the production method of milling enables a high variation of shapes of the rib-like spacer elements. Those spacer elements also have to fulfil requirements of insulation - each front side of a transformer coil is on high voltage level during the operation of the transformer, whereas the adjacent transformer core is on earth potential. Since the overall thickness of the coil fixture is reduced in an advantageous way by the invention, it is also within the scope of the

invention to gain at least the same axial insulation ability which is provided by a comparable coil fixture according to the state of the art. Especially the manufacturing method of milling enables a wide variation of shapes, which prolongs the creeping distance along the axial surface. According to a further embodiment the rib-like spacer elements and/or the side walls of the ground plate are shaped at their side-walls in a stepped manner. This can for example be graded or alternating such as a row of saw teeth.

[0021] In a further embodiment of the invention an upper ground plate adjacent to the rib-like spacer elements and face to the ground plate is foreseen, so that a double stock coil-fixture plate is formed. Such coil-fixture might be used as part of an oil chamber. Such an oil chamber is typically placed under the lower front side of an upright transformer coil within an oil transformer and is used for pressuring oil through the cooling channels of the adjacent transformer coil. Typically a pump system is foreseen for feeding cold oil into the oil chamber. At the upper side of the transformer vessel the heated transformer oil is fed to an external cooling system, cooled down and then fed back to the oil chamber. Such an oil chamber can be realized for example by additional bordering walls at the radial outer and inner edge of a coil fixture. Those walls can be either mounted thereon as separate elements or be included in the monolithic structure of the coil-fixture. It is also thinkable to place such oil chamber on the belonging upper axial end of a transformer coil, wherein the oil chamber is the operated with under-pressure.

[0022] The problem is also solved by an oil transformer, comprising a transformer vessel and a transformer core with at least one transformer coil mounted therein, whereas the transformer coil is clamped inbetween two coil fixtures, whereas the at least one coil fixture is built according to the invention. This enables either to reduce the height of the transformer respectively the transformer vessel or to increase the rated power of a transformer with given size, since in this case the active part of the coil, the windings, is enlarged.

[0023] Further advantageous embodiments of the invention are mentioned in the dependent claims.

[0024] The invention will now be further explained by means of an exemplary embodiment and with reference to the accompanying drawings, in which:

Figure 1 shows an exemplary first coil-fixture,

Figure 2 shows an exemplary transformer coil,

Figure 3 shows an exemplary transformer core with coil,

Figure 4 shows an exemplary second coil-fixture,

Figure 5 shows an exemplary third coil-fixture,

Figure 6 shows an example for flexural strength of a laminated bar,

Figure 7 shows examples for cross-sections of bars and

Figure 8 shows an oil chamber.

[0025] Fig. 1 shows an exemplary first monolithic coil-fixture 10 in a three-dimensional view. On a ring-shaped ground plate 12, which has step graded side walls for increasing the axial creeping distance, four rib-like spacer elements 16, 18 are arranged in radial orientation. For increasing the axial creeping distance, also the side walls of the rib-like spacer elements are shaped in stepped 20, 22 manner. In the center of the ring-shaped ground plate an inner opening 14 is foreseen, which also has a step graded shape for increasing the axial creeping distance. Inbetween adjacent rib-like spacer elements 16, 18 flow channels are formed, which are marked with the dotted area 24 respectively the arrows 26, which indicate a flowing direction of a fluid through the flow channels. Due to the monolithic arrangement of this coil fixture, its flexural stability is increased in an advantageous way compared to a composition of a comparable coil fixture from a press ring and a spacer ring. Thus the axial height of this coil fixture is reduced in an advantageous way while providing at least the same flexural stability than a composed press ring and spacer ring.

[0026] Fig. 2 shows an exemplary transformer coil 32 which is clamped inbetween a lower 36 and upper 38 coil fixture and arranged around a center axis 34 in a sketch 30. The coil fixtures 36, 38 comprise on that side, which is face to the belonging front side of the transformer coil 32, rib-like spacer elements, whereas flow channels 40, 42 are formed inbetween them. A pressure force 44 is applied on both coil fixtures 36, 38, for example by a tension rod respectively several tension rods.

[0027] Fig. 3 shows an exemplary transformer core 52 with coil 58. The coil 58 is arranged around of one of the three limbs 54, 56 of the transformer core 58 and clamped inbetween a lower 60 and an upper 62 monolithic coil fixture. Additional press supports 64, 66 are foreseen at the top respectively bottom of the coil for fixing the coil 58 together with the transformer core 52. Typically a coil is arranged on each of the three limbs since it is required for a three phase transformer.

[0028] Fig. 4 shows an exemplary monolithic second coil-fixture 70 from a birds view perspective. On a ring-shaped ground-plate 72 with inner opening 80 several rib-like spacer elements 74, 76 are arranged along two concentric circles in tangential direction around a center axis 78.

[0029] Fig. 5 shows an exemplary third coil-fixture 90 from a birds view perspective. On a ring shaped ground plate with inner opening 114 several rib-like spacer elements 92, 94, 96, 98 are arranged radially around the inner opening 114. The coil fixture is divided into two

exemplary areas by the dotted line 116. Above this line, ashlar-formed rib-like spacer elements 92, 94 are shown, that's radial inner width 102 and radial outer width 100 are the same. Inbetween the sides of the spacer elements radial flow channels are formed, as indicated with the arrow 108.

[0030] Under the dotted line 116 an exemplary area with trapezoidal-formed rib-like spacer elements 96, 98 is shown. The radial inner width 106 of those elements is higher than the radial outer width 104, so that the opening angle of the flow channels 110, 112 formed inbetween is higher than the opening angle of the comparable flow channel 108 inbetween the ashlar-shaped spacer elements 94, 96. Thus a kind of nozzle is formed at the belonging end of the flow channels 110, 112 in the area around the inner opening 114. Oil flowing there through will be more turbulent, so that the cooling effect is improved.

[0031] Fig. 6 shows an example for flexural strength of a laminated bar in a sketch 120. Several layers 126, 128, 130, 132 of press board are laminated to a bar. Inbetween the laminated layers glue or example epoxy resin has been added during the lamination process. At its outer sides the bar is seated on two triangular supports 122, 124. A pressure force 134 is applied in the middle of the bar. As lower the bowing of the bar per pressure force as higher is the flexural strength. Due to the high-strength adhesion inbetween the different layers, the flexural strength of the laminated bar is at least as high as the flexural strength of a massive, non-laminated bar of the same size.

[0032] Fig. 7 shows examples for different cross-sections of bars. The bar 142 on the left has the width b and the height h. The two bars 144, 146 in the middle have the same cross section each, but are stacked on each other. Thus the flexural strength of the two stacked bars 144, 146 is twice as high as the flexural strength of the single bar 142. The bar 148 on the right side has the same cross section than the two stacked bars, but is from a monolithic part, for example a laminated block of press board. Due to a quadratic dependency of the flexural strength on the height h, the right bar 148 has a four times higher flexural strength than the left bar 142. This effect is used for increasing the flexural strength of a monolithic coil fixture according to the invention.

[0033] Fig. 8 shows an exemplary oil chamber 150. A disc-like ground plate 164 is surrounded by a radial inner 162 and radial outer 164 bordering wall. Both bordering walls have to be seen optional for such a double stock coil-fixture. On the other axial side of the optional bordering walls 160, 162 flat perforated panels are foreseen, so that an inner area of the oil chamber is formed. Inbetween ground plate 164 and perforated panels rib-like spacer elements 152, 154 are foreseen. If the filled inner oil chamber is charged with an over pressure the oil is flowing out through the perforation holes into the axial cooling channels of a belonging adjacent transformer winding. Thus an oil chamber comprises also the basic

components of a coil-fixture and the structural advantages as mentioned before are also useable for an oil chamber.

5 List of reference signs

[0034]

10	exemplary first coil-fixture
12	ring-shaped ground plate of first coil-fixture
14	inner opening for a limb of a transformer
16	first rib-like spacer element of first coil fixture
18	second rib-like spacer element of first coil fixture
20	first grade of rib-like spacer element
22	second grade of rib-like spacer element
24	exemplary first flow channel of first coil-fixture
26	exemplary second flow channel of first coil-fixture
30	exemplary transformer coil
32	transformer winding
34	center axis
36	lower coil fixture
38	upper coil fixture
40	first flow channel of lower coil fixture
42	second flow channel of lower coil fixture
44	pressure force inbetween upper and lower coil fixture
50	exemplary transformer core with coil
52	transformer core
54	first transformer limb
56	second transformer limb
58	transformer coil
60	lower coil fixture
62	upper coil fixture
64	lower press support

66	upper press support		126	first layer of laminated bar
70	exemplary second coil-fixtured		128	second layer of laminated bar
72	ring-shaped ground plate of second coil-fixtured	5	130	third layer of laminated bar
74	first concentrically arranged rib-like spacer element		132	fourth layer of laminated bar
76	second concentrically arranged rib-like spacer element	10	134	force
78	center axis		140	examples for cross-sections of bars
80	inner opening for a limb of a transformer	15	142	first bar
90	exemplary third coil-fixtured		144	second bar
92	first ashlar-formed rib-like spacer element		146	third bar
94	second ashlar-formed rib-like spacer element	20	148	fourth bar
96	first trapezoidal-formed rib-like spacer element		150	exemplary oil chamber
98	first trapezoidal-formed rib-like spacer element	25	152	first rib-like spacer element of oil chamber
100	radial outer width of ashlar-formed rib-like spacer element		154	second rib-like spacer element of oil chamber
102	radial inner width of ashlar-formed rib-like spacer element	30	156	first perforation hole
104	radial outer width of trapezoidal-formed rib-like spacer element		158	second perforation hole
106	radial inner width of trapezoidal-formed rib-like spacer element	35	160	optional radial outer bordering wall
108	flow-channel inbetween ashlar-formed rib-like spacer elements	40	162	optional radial inner bordering wall
110	first flow-channel inbetween trapezoidal-formed rib-like spacer elements		164	disk-like ground plate
112	2nd flow-channel inbetween trapezoidal-formed rib-like spacer elements	45	166	flat perforated panel
114	inner opening for a limb of a transformer			
116	limit inbetween first exemplary area and second exemplary area	50		
120	example for flexural strength of a laminated bar			
122	first support	55		
124	second support			

Claims

- Coil-fixtured (10, 36, 38, 60, 62, 70, 90) for mounting on a front side of a hollow cylindrical high voltage transformer coil (32, 58), comprising
 - a ring-shaped ground plate (12, 72, 164) with an inner opening (14, 80, 114) for a limb (54, 56) of a transformer core (52),
 - rib-like spacer-elements (16, 18, 74, 76, 92, 94, 96, 98) suitable for supporting at least the weight of a belonging transformer coil (32, 58), which are arranged flat at one side of the ground-plate (12, 72),
- whereas flow-channels (24, 26, 40, 42, 108, 110, 112) are foreseen inbetween the spacer elements (16, 18, 74, 76, 92, 94, 96, 98), which are leading directly or indirectly to an area around the inner open-

- ing (14, 80, 114), **characterized in that** the ground-plate (12, 72, 164) and the rib-like spacer elements (16, 18, 74, 76, 92, 94, 96, 98) are manufactured as one monolithic part.
2. Coil-fixture according to claim 1, **characterized in that** the monolithic part consists of laminated (126 + 128 + 130 + 132) material.
 3. Coil-fixture according to claim 1 or 2, **characterized in that** the monolithic part consists at least predominantly of press-board.
 4. Coil-fixture according to any of the previous claims, **characterized in that** the rib-like spacer-elements (16, 18, 92, 94, 96, 98) are arranged on the ground plate (12, 72, 164) at least predominantly radially to the inner opening (14, 80, 114).
 5. Coil-fixture according to any of the previous claims, **characterized in that** the rib-like spacer-elements (74, 76) are arranged on the ground plate at least predominantly concentrically to the inner opening (14, 80, 114).
 6. Coil-fixture according to claim 4, **characterized in that** the radial inner width (102, 106) of at least one rib-like spacer element (16, 18, 92, 94, 96, 98) is higher than its radial outer width (100, 104), so that the flow channels (24, 26, 40, 42, 108, 110, 112) inbetween adjacent spacer elements (16, 18, 92, 94, 96, 98) are shaped like a flat widened cone.
 7. Coil-fixture according to any of the previous claims, **characterized in that** the coil fixture is congruently mounted at a front side of a hollow cylindrical high voltage transformer coil (32, 58) with axial cooling channels, **characterized in that** the sum of the respective minimal cross-sections of the flow channels (24, 26, 40, 42, 108, 110, 112) leading to the area around the inner opening (14, 80, 114) of the coil fixture is adapted to the sum of the cross-sections of the axial cooling channels of the transformer coil (32, 58).
 8. Coil-fixture according to any of the previous claims, **characterized in that** the rib-like spacer elements (16, 18, 74, 76, 92, 94, 96, 98) are shaped at their side-walls in a way which differs from a plane perpendicular to the ground plate (12, 72, 164), so that the axial creeping distance along the side walls is prolonged.
 9. Coil-fixture according to claim 8, **characterized in that** the rib-like spacer elements and/or the side walls of the ground plate (12, 72, 164) are shaped at their side-walls in a stepped manner (20, 22).
 10. Coil-fixture according to any of the previous claims, **characterized in that** it comprises an upper ground plate adjacent to the rib-like spacer elements and face to the ground plate (12, 72, 164), so that a double stock coil-fixture plate is formed.
 11. Oil transformer, comprising a transformer vessel and a transformer core (52) with at least one transformer coil (32, 58) mounted therein, whereas the transformer coil is clamped inbetween two coil fixtures (10, 36, 38, 60, 62, 70, 90), **characterized in that** the at least one coil fixture is built according to any of the claims 1 to 10.

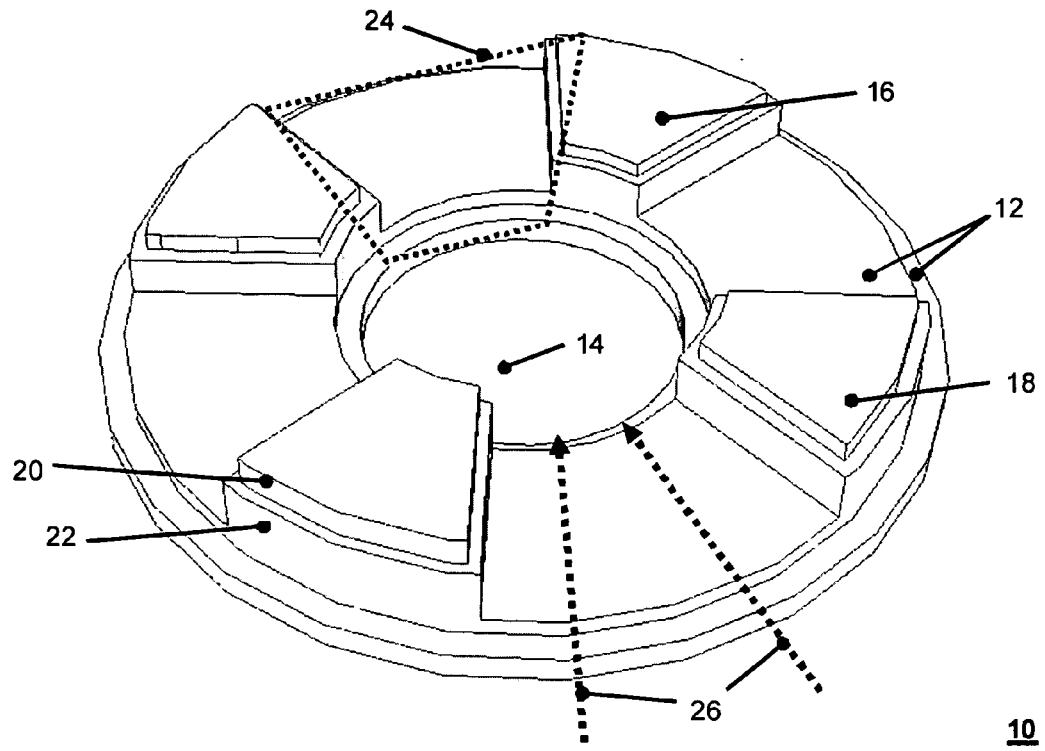


Fig. 1

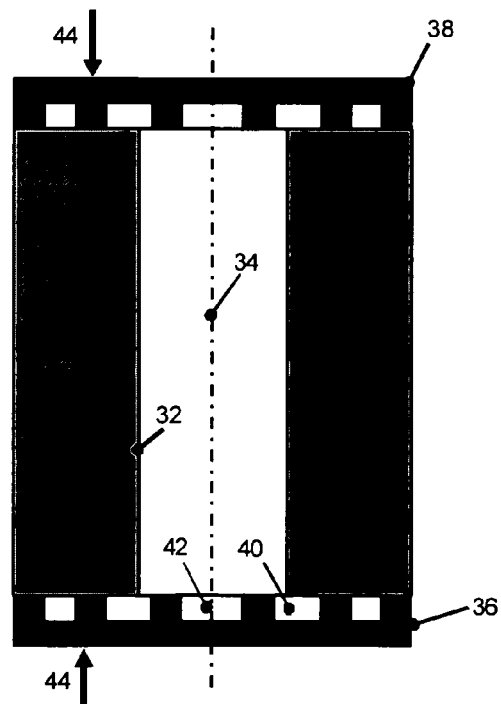


Fig. 2

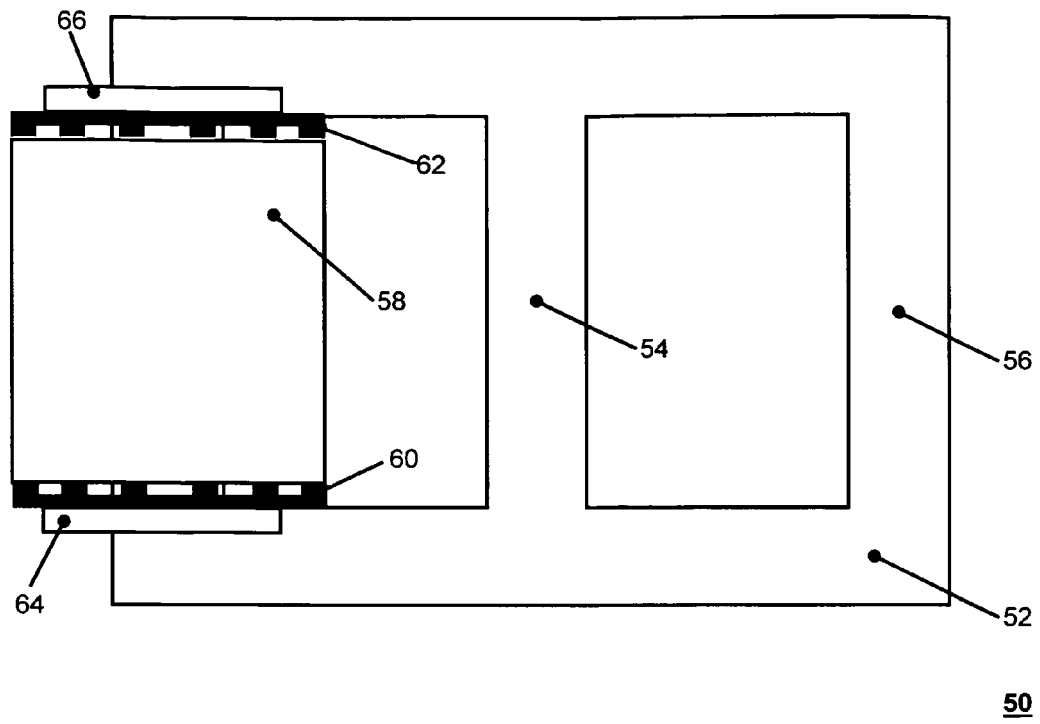


Fig. 3

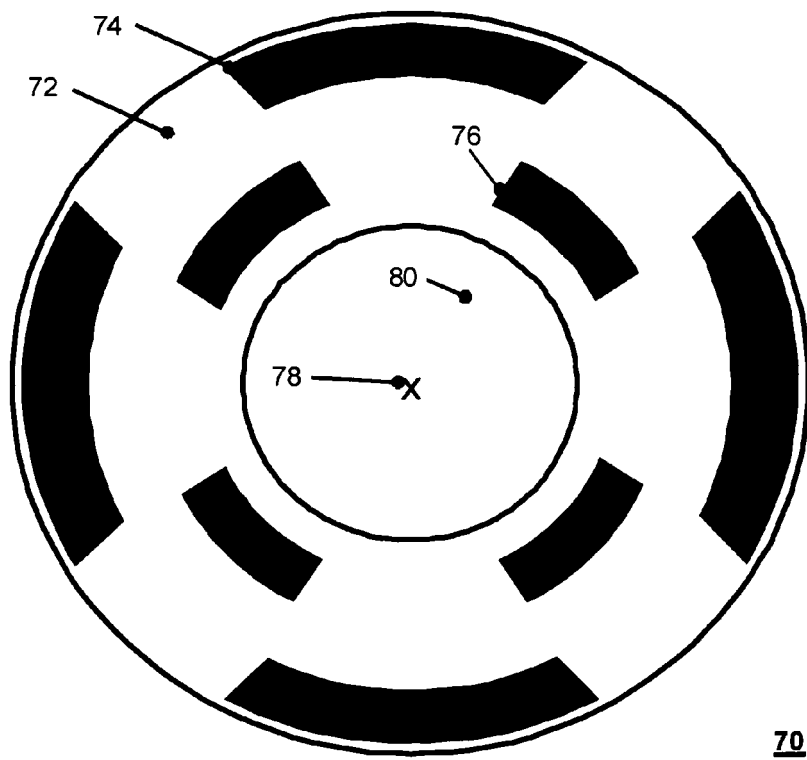
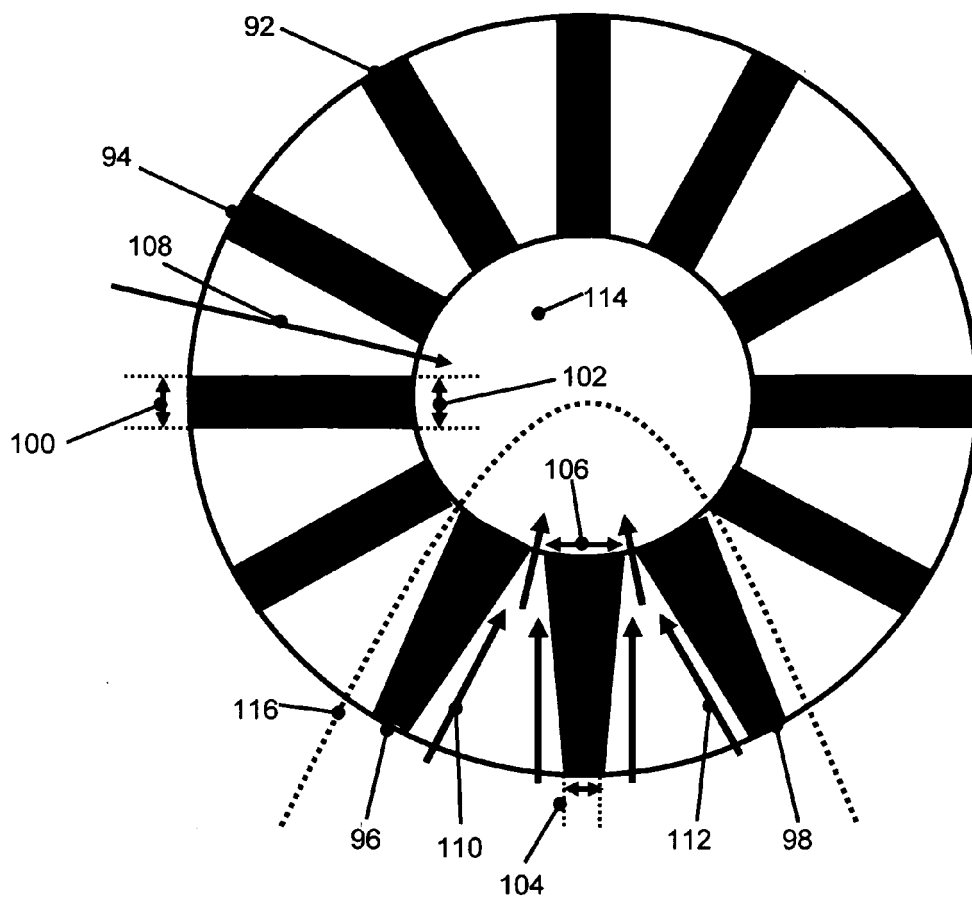
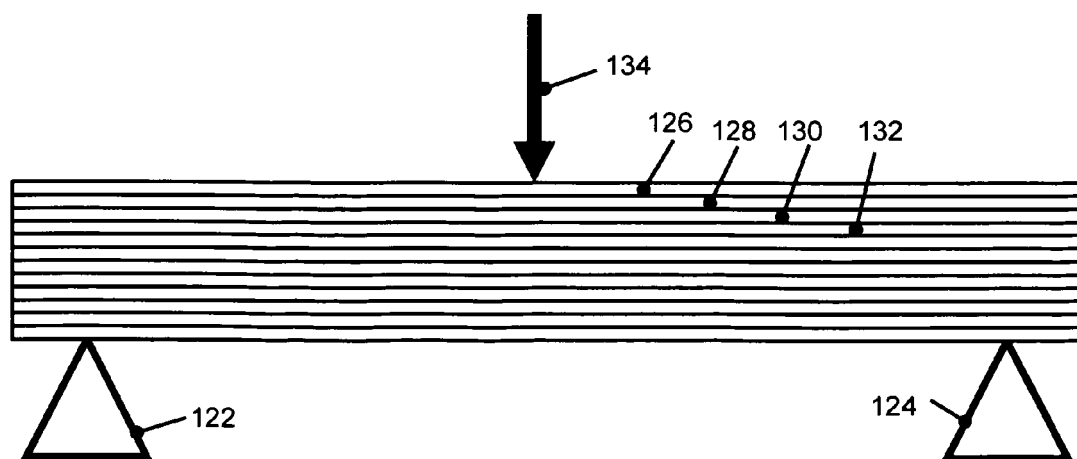


Fig. 4



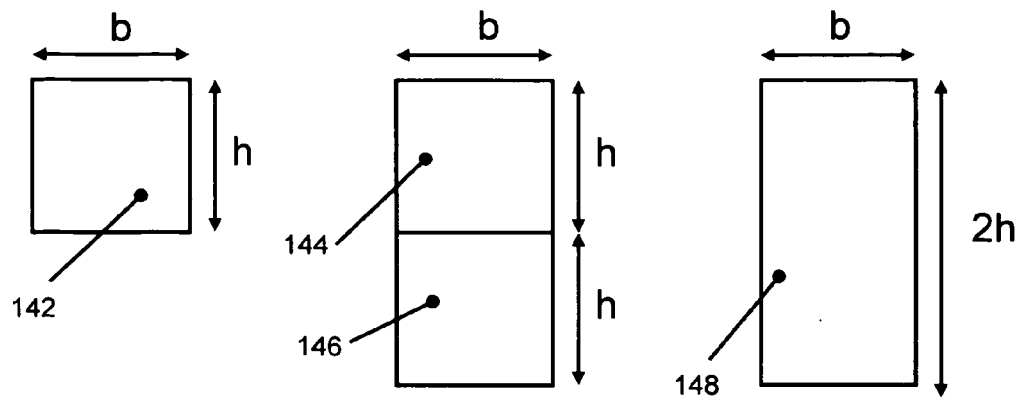
90

Fig. 5



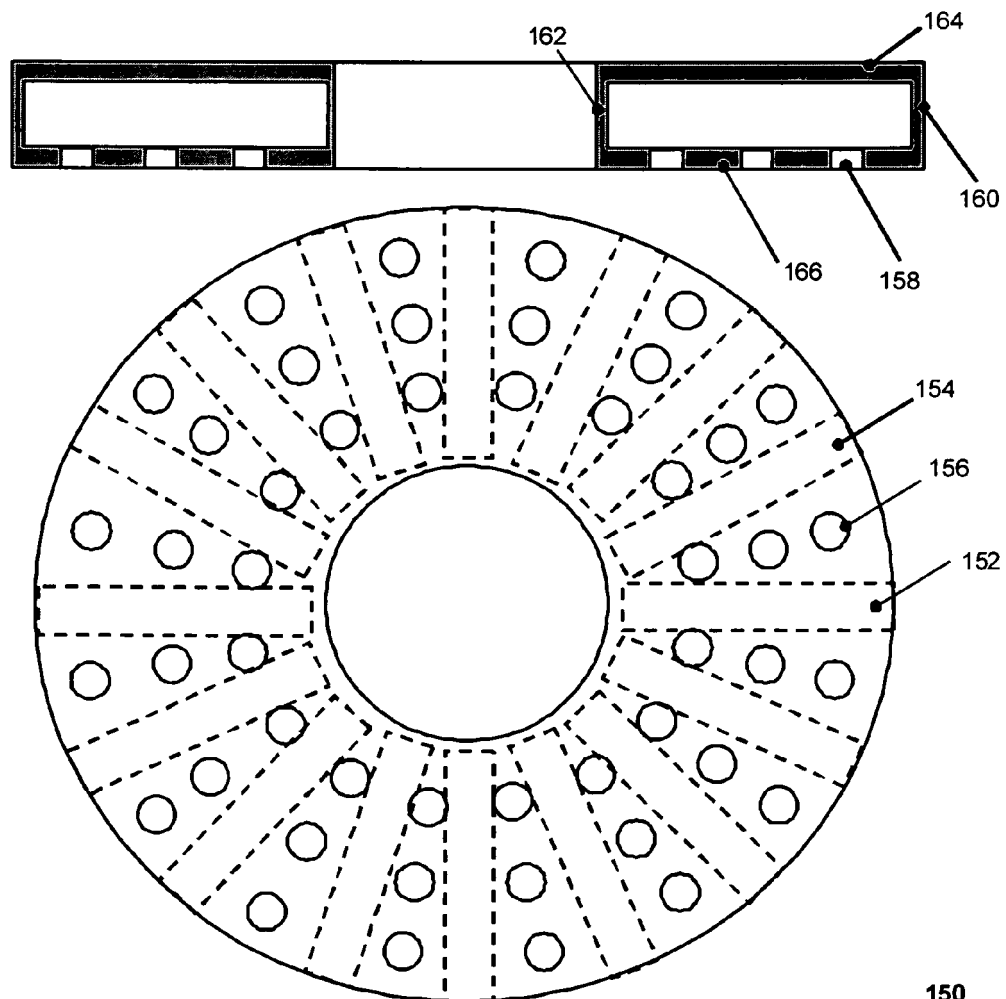
120

Fig. 6



140

Fig. 7



150

Fig. 8



EUROPEAN SEARCH REPORT

Application Number
EP 11 00 9669

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2011/267161 A1 (MACLENNAN GRANT A [US] ET AL) 3 November 2011 (2011-11-03) * page 3, paragraph 38-39 * * page 10, paragraph 106-111 * -----	1-11	INV. H01F27/06 H01F27/12
X	US 4 983 859 A (NAKAJIMA SHIN [JP] ET AL) 8 January 1991 (1991-01-08) * column 6, line 59 - column 7, line 43 * -----	1-10	
A	JP 2009 283757 A (TOSHIBA IND PRODUCTS MFG CORP) 3 December 2009 (2009-12-03) * abstract; figures 5,6 * -----	1-11	
A	JP 51 127500 A (NITTO ELECTRIC IND CO) 6 November 1976 (1976-11-06) * abstract * -----	2,3	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 4 May 2012	Examiner Gols, Jan
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

1
EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 00 9669

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

04-05-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011267161 A1	03-11-2011	NONE	

US 4983859 A	08-01-1991	DE 3943626 C2	31-03-1994
		JP 1937911 C	09-06-1995
		JP 2058811 A	28-02-1990
		JP 6070922 B	07-09-1994
		US 4983859 A	08-01-1991

JP 2009283757 A	03-12-2009	NONE	

JP 51127500 A	06-11-1976	NONE	
