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(54) **Current Transformer Unit**

(57) A transformer (3, 3') including a housing (6), a magnetic core (10, 10') and transformer coils (12, 12') wound around the housing. The housing (6) defines a magnetic core receiving cavity (20, 20') in which the magnetic core (10, 10') is mounted. The housing further comprises positioning portions (8) projecting from walls of the housing in the magnetic core receiving cavity, configured to position the magnetic core in the magnetic core receiving cavity to form a dielectric air space (15, 15') between the magnetic core and the transformer coil.

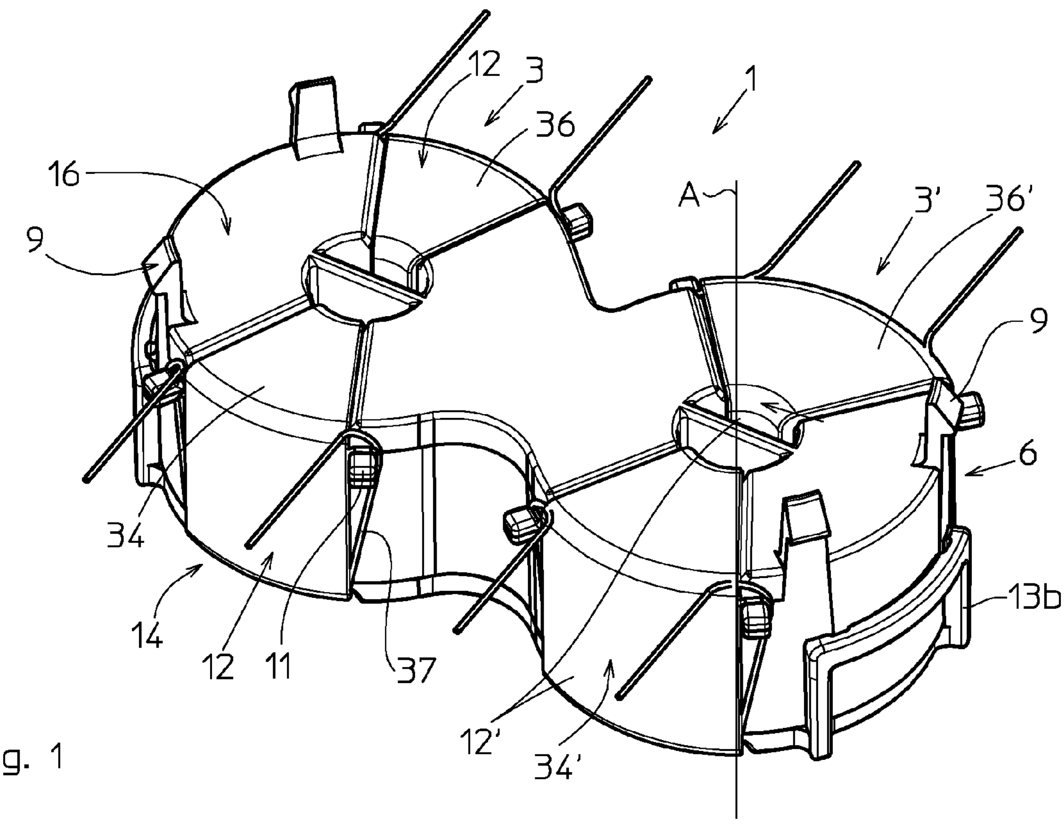

Fig. 1

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Description

[0001] The present invention relates to a high voltage electrical current transformer unit. In a specific application, the invention relates to a transformer unit for use in a sensor for measuring electrical parameters in a high voltage environment.

[0002] There are many applications requiring highly isolated yet accurate and rapid measurement of electrical parameters such as voltage, current, frequency and power in a high voltage environment for control and drive purposes or simply for monitoring purposes. An example is electrical drives for railway locomotives that are supplied with electrical current at a voltage of around 3000V. In many of these applications, the measurement signal needs to be transmitted to electronic circuitry in a low voltage environment for control and/or display purposes. It is also desired in certain applications to power the sensor from a power supply situated in the low voltage environment. The transmission of power and signals from a high voltage environment to a low voltage environment requires isolation between the high and low voltage circuit commensurate with the maximum possible voltage difference and applicable standards in order to avoid partial discharge and in some cases electrical tracking.

[0003] A sensor comprising a transformer for high voltage applications is described in European patent application 1 659 413 in which the measurement signal is transmitted from the high voltage to the low voltage side via an optical fiber transmission, whereas the power supply for the sensor is transmitted through an insulating transformer system. The insulating transformer comprises three transformer cores interconnected by conductor windings/coils formed by U-shaped terminals mounted on circuit boards having conductive circuit traces interconnecting the ends of the U-shaped terminals in order to close the winding loops, thus forming coils. Another sensor for measuring electrical parameters in a high voltage environment comprising an insulating transformer for high voltage applications is described in European patent application 2 144 070.

[0004] Transformers typically comprise a magnetic core and transformer coils. In many transformers, there is a first coil and a second coil wound around the magnetic core, the coils being separated from the core by an insulation layer. The insulation layer not only protects against damage to the insulation layer on the coil wiring due to sharp corners or rough edges of the magnetic core, but also provides a dielectric separation that should withstand breakdown of the dielectric due to the voltage difference for which the transformer is intended to be employed.

[0005] In high voltage applications, which may be considered to be applications where the voltage difference is greater than 1000 volts, even without breakdown of the dielectric separation between coils and core, there may be a phenomenon of partial discharge that could eventually lead to an electrical breakdown or have an adverse effect on the performance of the transformer, such as on the fidelity of the electrical signal transmission from one transformer coil to the other transformer coil. The problem of partial discharge increases as the voltage difference between the transformer coils or between the coils and the magnetic core increases.

[0006] In a typical configuration of a high voltage transformer, a dielectric layer (such as a plastic layer) is positioned against and surrounds the magnetic core, and the transformer coils are wound the magnetic core directly over the dielectric layer. This however leads to the presence of small air spaces or voids between sections of the coil windings and the dielectric layer, whereby small voids in a dielectric layer are sites that favor the occurrence of partial discharge. One way of overcoming this problem would be to fill the small voids with a dielectric material with similar properties to that of the dielectric layer. This could be done by applying a vacuum in the environment of the wound transformer to draw out the air and then injecting a polymer or other dielectric material around the coil, the material being drawn between the windings and substantially filling the voids. This process is however difficult and costly to perform.

[0007] Another way of overcoming the problem of partial discharge would be to increase the dielectric layer thickness, however this implies a device with a greater volume, mass and cost. Moreover, in many applications there may be limited space and a need to reduce the size of certain components in view of their assembly in a product.

[0008] An object of the invention is to provide a transformer unit for high voltage applications that is economical, compact, and presents stable and reliable performance over time and usage.

[0009] It is advantageous to provide a transformer unit for high voltage applications that is easy to produce and assemble.

[0010] It is advantageous to provide a transformer unit that is compact for use in limited space applications, yet can support high voltage differences reliably.

[0011] It is advantageous to provide a transformer unit that can transfer both power and data in a compact configuration.

[0012] Objects of the invention have been achieved by providing a current transformer according to claim 1.

[0013] Disclosed herein is a transformer including a dielectric housing, a magnetic core and transformer coils wound around the housing. The housing defines a magnetic core receiving cavity in which the magnetic core is mounted. The housing further comprises positioning portions projecting from walls of the housing in the magnetic core receiving cavity, configured to position the magnetic core in the magnetic core receiving cavity to form a dielectric air space between the magnetic core and the transformer coil. The dielectric air space is configured for eliminating or reducing partial discharge.

[0014] In an advantageous embodiment, a minimum air distance between the magnetic core and the transformer coil through said dielectric air space has a length big enough to limit the electrical field strength in this space to values below 2.5 kV/mm.

[0015] In an advantageous embodiment, the positioning portions are arranged in the magnetic core receiving cavity outside coil winding zones. The positioning portions may advantageously be elastically compressed against the magnetic core positioned in the magnetic core receiving cavity. The positioning portions may be integrally formed with the housing. The positioning portions may comprise side wall spacers arranged on inner or outer side walls, bottom wall spacers arranged on a bottom wall and top wall spacers arranged on a top wall. The coil winding zones preferably extend around the magnetic core over a sector angle less than 180°, advantageously less than 120°.

[0016] In an advantageous embodiment, positioning portions may include spacers on a top wall and/or on a bottom wall in the form of resiliently deflectable cantilever arms or other elastically deflectable elements. The resilient arms may advantageously comprise a rounded tip and/or an angle of inclination configured to deflect the arm in a pre-defined direction when brought in contact and biased against the magnetic core.

[0017] The positioning portions may further include side wall spacers in the form of an axially extending rib. The ribs may advantageously comprise a tapered or rounded insertion entry.

[0018] The housing may advantageously comprise an insulating wall portion positioned in a central passage configured to electrically insulate the first coil from the second coil.

[0019] In a specific embodiment, the invention also includes a transformer unit comprising a first transformer and a second transformer, wherein the housing is a single housing comprising a first core receiving cavity and a second core receiving cavity separated by an internal separating wall, each cavity receiving a respective magnetic core. In a specific application, the transformer unit may be configured for use in an electrical current or voltage sensor for high voltage applications, whereby the first transformer is configured to transmit data or a signal and the second transformer is configured to transmit power for the current or voltage sensor.

[0020] Further objects and advantageous features of the invention will be apparent from the claims, from the detailed description, and annexed drawings, in which:

Fig. 1 is a perspective view of an embodiment of a transformer unit according to the invention;

Fig. 2 is a perspective view of a base portion of a housing of the transformer unit according to Fig. 1;

Fig. 3 is a top view on the transformer unit according to the embodiment of Fig. 1;

Fig. 4 is an end view of the transformer unit according to the embodiment of Fig. 1;

Fig. 5 is a cross section view along line V-V of Fig. 3;

Fig. 6 is a cross section view along line VI-VI of Fig. 3;

Fig. 7 is a top view of the base portion of Fig. 2, further depicting coil winding zones;

Fig. 8 is a cross section view along line VIII-VIII of Fig. 7;

Fig. 9 is a cross section view along line IX-IX of Fig. 7;

Fig. 10 is top view of a cover portion of the housing of the embodiment according to Fig. 1, further depicting coil winding zones;

Fig. 11 is a side view of the cover portion of Fig. 10;

Fig. 12 is cross section view along line XII-XII of Fig. 10; and

Fig. 13 is a perspective view of an under side of the cover portion of Fig. 10.

[0021] Referring to the figures, a transformer unit 1 according to a specific embodiment of the invention, comprises two transformers 3, 3'. One of the transformers 3 is used to transmit data in the form of a signal from a high voltage side to a low voltage side, and the other transformer 3' is used to transmit power from a low voltage side to a high voltage side. The specific embodiment illustrated may advantageously be employed in a current sensing application for measuring currents or voltages in a high voltage system, whereby the transformer 3' for transmitting power is to supply the measurement sensor circuit on the high voltage side with power.

[0022] The present invention however is not limited to the double transformer configuration of the specific embodiment illustrated. The two transformers 3, 3' are combined in a single unit in the illustrated embodiment, however each transformer could, in a variant, form a separate unit from the other, in particular by providing separate housings or insulating supports for each transformer core. The invention also includes a single transformer configuration, either for power or for data transmission. Except for the aspects of the invention that are specific to the illustrated double transformer configuration, the following detailed description with reference to the figures shall also be understood to apply to a single transformer.

[0023] The transformer 3, 3' comprises a housing 6, a magnetic core 10, 10' and transformer coils 12, 12' as best seen in figures 5 and 6. The transformer coils 12, 12' comprise at least a first coil 34, 34' and a second coil 36, 36'. The first coil 34, 34' and the second coil 36, 36' each cover a coil winding zone or a sector (CH1, CL1, CH2, CL2) on the housing 6 as illustrated in figures 3, 7 and 10. Each coil 34, 34', 36, 36' comprises a wire 37 made of an electrically conductive material.

[0024] The housing 6 comprises a cover portion 14 and base portion 16 that are assembled together and attached in a closed configuration by fixing means which may comprise latches 13a, 13b that engage with one another in a latching manner, or may comprise other means such as adhesive bonding or welding. The housing comprises, in the inside of the housing, core positioning portions 8. The housing may further comprise unit fixing portions 9, for instance in the form of latching arms, for fixing the unit on a circuit board or other external support or device. The housing may further include coil end fixing posts 11 for fixing ends of wires forming the transformer coils 12, 12'. The housing portions 14 and 16 may be produced as separate components, or as a single component, in particular by injection molding. In the latter variant, the portions may be held together by one or more integrally formed pliable or breakable webs to allow the portions to be moved from the open position in which the magnetic core can be inserted in the housing to the closed and assembled position.

[0025] In the embodiment shown in the figures, the housing 6 is designed as a double housing 6 configured to receive two magnetic cores 10, 10', however as mentioned above, it is within the scope of this invention that the housing 6 can be configured to receive only one single magnetic core 10, 10'.

[0026] The cover portion 14 comprises a top wall 26 as illustrated in Figure 13. During a first step of assembly of the current transformer unit 1 the magnetic cores 10, 10' are positioned in the base portion 16. During a second step, the cover portion 14 is attached to the base portion 16 via the fixing means 13a, 13b, as shown in figure 6. After attaching the cover portion 14, wires forming the first and second coils 34, 34', 36, 36' are wound around the housing 6 whereby ends of the coil wires are fixed on the coil end fixing posts 11.

[0027] The housing comprises a magnetic core receiving cavity 20, 20'. The magnetic core receiving cavity 20, 20' is defined by a bottom wall 24, an inner side wall 28, 28', which also defines a central passage 22, 22', an outer side wall 30, a separating wall 32, and a top wall 26. The magnetic core receiving cavity 20, 20' has a shape configured to receive the magnetic core 10, 10' which in the illustrated embodiment is in the shape of a circular ring. The magnetic core and corresponding receiving cavity may however have other regular or irregular closed shapes such as oval, rectangular, square, polygonal and similar.

[0028] The unit fixing portions 9, the fixing means 13a, 13b and the coil end fixing posts 11 may advantageously be integrally formed with the housing, in particular with the base portion 16, for example by injection molding. The unit fixing portions 9 may for example engage in complementary fixing portions (e.g. holes) arranged on a circuit board or other external support or device (not shown).

[0029] The magnetic core 10, 10' is positioned within the housing receiving cavity 20, 20'against positioning portions 8. The positioning portions advantageously extend integrally from walls of the housing, the positioning portions 8 comprising side wall spacers 40, bottom wall spacers 42 and top wall spacers 44, as best seen in figures 2, 6, 7, 8, 9, 12 and 13.

[0030] In a variant the positioning portions 8 may be formed as a separate component or element, comprising the side wall spacers 40, the bottom wall spacers 42 and the top wall spacers 44, assembled in the housing receiving cavity or mountable on the magnetic core, prior to insertion of the magnetic core in the receiving cavity. In another variant the separate component or element may comprise two members, a first member comprising the side wall spacers 40 and the bottom wall spacers 42 and a second member comprising the top wall spacers 44. Such a separate component would interconnect the spacers 40, 42, 44 and being placed within the magnetic core receiving cavity 20, 20' before the magnetic core 10, 10' and the cover portion 14 is mounted.

[0031] In the embodiment of the present invention, the side wall spacers 40 and bottom wall spacers 42 are integrally formed with the base portion 16 and the top wall spacers 44 are integrally formed with the cover portion 14. The spacers 40, 42, 44 being made of the same material as the cover portion 14 and the base portion 16. In a variant a different material may be used, for example in a two component injection molding process, to produce the spacers 40, 42, 44 and the base portion 16/cover portion 14.

[0032] The side wall spacer 40 is in the form of an axially extending rib having a tapered or rounded insertion end 35 which is directed to the cover portion 14 or to an open end of the base portion 16 when the cover portion 14 is not mounted on the base portion 16. The rounded insertion end 35 is best seen in figures 2 and 8. The rounded end 35 guides the insertion of the magnetic core 10, 10' into the magnetic core receiving cavity 22, 22'. Axially extending A means a direction corresponding to an axis of the central passage 22, 22', or perpendicular to the top or bottom wall 26,24.

[0033] In a variant the axially extending rib may have a shape that is tapered, configured to engage the magnetic core 10, 10' in a wedging manner when said magnetic circuit core 10, 10' is mounted in the magnetic core receiving cavity 20, 20' and the cover portion is assembled to the base portion.

[0034] The outer side wall 30 comprises preferably at least three side wall spacers 40 (per magnetic core), but could comprise four or more, advantageously in the form of axially extending ribs.

[0035] When inserted into the magnetic core receiving cavity 20, 20' the magnetic core 10, 10' rests against the bottom wall spacers 42 and the top wall spacers 44. In an advantageous embodiment, at least one set of spacers on the top wall and/or on the bottom wall are in the form of an inclined or tapered cantilever arm 37 with a rounded tip 39, as illustrated for example in figures 6, 8 and 13. One set of spacers on the top wall and/or on the bottom wall preferably comprises at least three spacers per magnetic core. In the embodiment illustrated, the top wall 26 and the bottom wall 24 comprises six top wall spacers 44 arranged axially symmetrical to a central axis passing through the central passage 22, 22'. The bottom wall 24 comprises six bottom wall spacers 42 also arranged axially symmetrical to a central axis passing through the central passage 22, 22'. It is clear, that a different amount of spacers 42, 44 can be chosen in order to securely position the magnetic core 10, 10' in the magnetic core receiving cavity 20, 20'. In advantages embodiment the bottom wall 24 and the top wall 26 each comprises at least three bottom wall spacers 44 respectively three top wall spacers 44 for each receiving cavity.

[0036] The magnetic core 10, 10' is positioned in the magnetic core receiving cavity 20, 20' in a force fit or elastically clamped manner. The rounded tips 39 of the bottom wall spacers 42 and/or top wall spacers 44 advantageously facilitate elastic bending of the spacers as they engage with magnetic core 10, 10', configured to apply an elastic biasing force onto the magnetic core 10, 10' when it is assembled in the housing to eliminate play and absorb shocks and vibration.

[0037] The positioning portions 8 may have other shapes configured to engage the magnetic core 10, 10' in an elastic, force-fit or clamping manner in order to eliminate play and position the magnetic core 10, 10' in the receiving cavity. Instead of shaping the positioning portions 8 in an elastic manner, the position portions may comprise an elastically compressible material such as an elastomer.

[0038] The positioning portions 8 ensure the forming of an air space 15, 15' between the magnetic core 10, 10' and the housing walls against and around which the transformer coils 12, 12' are formed. The provision of a very large air gap (in relative measure to unwanted small voids found in conventional transformers) between the magnetic core and the transformer coils, eliminates or reduces the generation of partial discharges that would otherwise be present in small air voids in a solid dielectric material path between core and coil. Such partial discharges in conventional systems deteriorate the dielectric material over usage and/or adversely affect the transformer signal. In the present invention, the minimum air distance between the magnetic core 10, 10' and the transformer coils 12, 12' through said dielectric air space 15, 15' has a length big enough to limit the electric field strength in the air space to values lower than 2.5 kV/mm, as defined by the voltage difference between the first and second coils 34, 34', 36, 36' of the transformer, the thickness of the wall portions of the case and the relative permittivity of the case material.

[0039] In an advantageous embodiment, in an uninterrupted air space region surrounded by the coil winding zones (CH1, CL1, CH2, CL2), the dielectric air space 15, 15' arranged within the magnetic core receiving cavity 20, 20' completely and continuously surrounds the magnetic core 10, 10', as best seen in figure 5. The dielectric air space 15, 15' in this region has no interruptions whereby the positioning portions 8, namely the top wall spacers 44, the bottom wall spacers 42 and the side wall spacers 40, are arranged outside of the coil winding zones (CH1, CL1, CH2, CHL2). The coil winding zones extend around the closed loop magnetic core over a sector angle $\beta 1$, $\beta 2$, $\beta 3$, $\beta 4$, that may be less than 180°, preferably less than 120°.

[0040] In advantageous embodiment the uninterrupted air space regions extend around the magnetic core beyond the coil winding zones (CH1, CL1, CH2, CL2), which for a circular configuration means that the angles of the sectors occupied by the uninterrupted air space regions are greater than the angles of the respective overlapping coil winding zones (CH1, CL1, CH2, CHL2).

[0041] The first and second coil 34, 34', 36, 36' are separated by an insulating wall portion 18, 18'. The insulating wall portion 18, 18' may advantageously be integrally formed with the housing and extends across the central passage 22, 22'. The insulating wall portion 18, 18' provides a well defined solid dielectric separation between the closest positioned portions of the first and second transformer coils 34, 34', 36, 36' that are respectively connected to high and low voltages.

[0042] In the embodiments illustrated in figures 5 and 6, the magnetic circuit has a substantially rectangular cross-sectional shape. Within the scope of the invention, it would also be possible for the magnetic circuit to comprise other cross-sectional shapes, such as square, round, elliptical, oval, polygonal or irregular shapes. The base portion and cover portion of the housing can have different shapes, or have identical or similar shape, for instance two similar or identical housing parts that clamp together around the magnetic core. The positioning or spacer elements may also accordingly have different shapes and be positioned in different positions around the magnetic core receiving cavity to firmly hold and position the magnetic core within the housing such that the dielectric air space is created between the magnetic core and the housing walls in the region where the transformer coils are wound.

Claims

1. A transformer (3, 3') including a housing (6), a magnetic core (10, 10') and transformer coils (12, 12'), the housing (6) defining a magnetic core receiving cavity (20, 20') and a central passage (22, 22'), the magnetic core (10, 10') being arranged in said magnetic core receiving cavity, the transformer coils comprising at least a first coil (34, 34') and at least a second coil (36, 36'), said first and second coils being wound around the housing such that sections of the coil extend through the central passage, each coil covering a coil winding zone (CH1, CL1, CH2,

CL2) around the housing, wherein the housing further comprises positioning portions (8) projecting from walls of the housing in the magnetic core receiving cavity, the positioning portions configured to position the magnetic core in the magnetic core receiving cavity to form a dielectric air space (15, 15') between the magnetic core and the transformer coil configured for eliminating or reducing partial discharge.

2. Transformer according to claim 1 wherein a minimum air distance between the magnetic core and the transformer coil through said dielectric air space has a length sufficient to limit the electric field strength in the air space to values smaller than 2.5 kV/mm in the presence of a maximum voltage difference between the first and second coils of the transformer.

3. Transformer according to any of the preceding claims, wherein the positioning portions (8) are arranged in the magnetic core receiving cavity (20, 20') outside of the coil winding zones (CH1, CL1, CH2, CL2).

4. Transformer according to any of the preceding claims, wherein the positioning portions (8) are elastically compressed against the magnetic core positioned in the magnetic core receiving cavity.

5. Transformer unit according to any of the preceding claims, wherein the positioning portions (8) are integrally formed with the housing (6).

6. Transformer according to any of the preceding claims, wherein the housing (6) comprises a cover portion (14) and a base portion (16).

7. Transformer unit according to any of the preceding claims, wherein the housing comprises a bottom wall (24), an inner side wall (28), an outer side wall (30) and a top wall (26), the magnetic core receiving cavity (20, 20') being defined by said bottom wall, said inner and outer side wall and said top wall.

8. Transformer according to the preceding claim, wherein the positioning portions (8) comprise side wall spacers (40) arranged on the inner or outer side walls (28, 30), bottom wall spacers (42) arranged on the bottom wall (24) and top wall spacers (44) arranged on the top wall (26).

9. Transformer according to any of the preceding claims, wherein the positioning portions (8) comprise bottom wall spacers (42) and/or the top wall spacers (44) in the form of resiliently deflectable cantilever arms (37).

10. Transformer according to the preceding claim, wherein the cantilever arms (37) comprise a rounded tip (39) and/or an angle of inclination configured to deflect the cantilever arm in a pre-defined direction when brought in contact with the magnetic core (10, 10').

11. Transformer according to any of the preceding claims, wherein the positioning portions (8) comprise side wall spacers (40) comprising a tapered or rounded insertion entry (35) and wherein said side wall spacers are in the form of an axially extending rib.

12. Transformer according to any of the preceding claims, wherein the housing (6) comprises an insulating wall portion (18, 18') positioned in the central passage (22, 22') configured to electrically insulate the first coil (34, 34') from the second coil (36, 36').

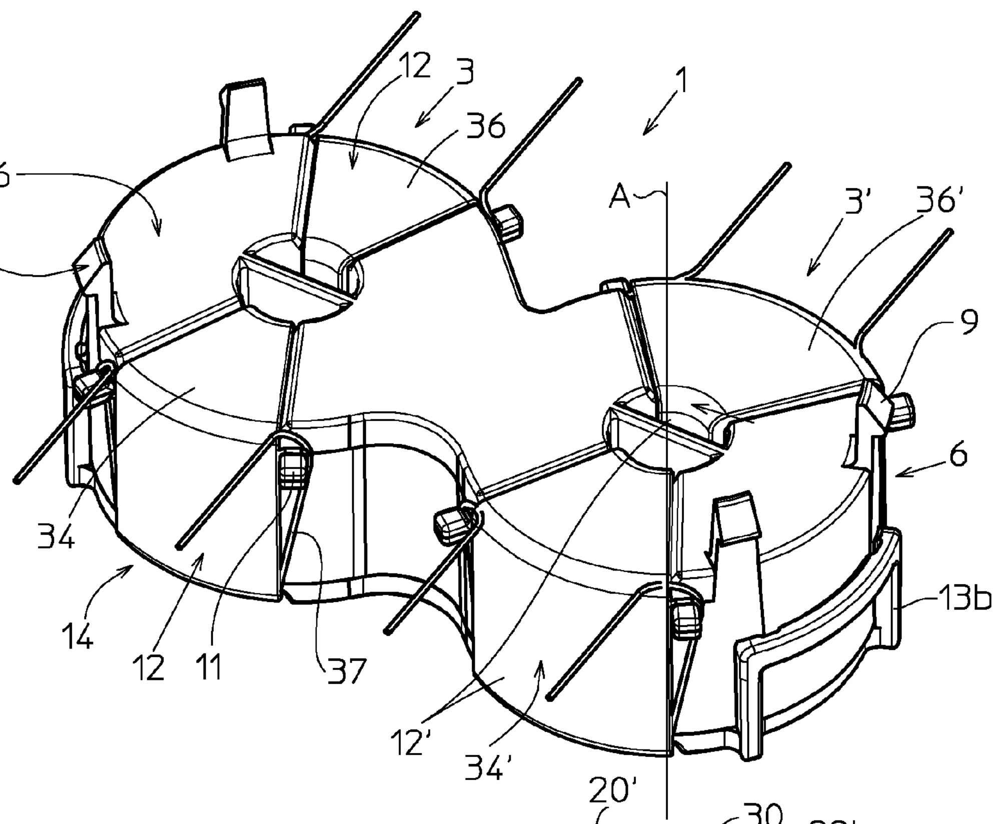
13. Transformer according to any of the preceding claims, wherein the coil winding zones extend around the magnetic core over a sector angle (β1, β2, β3, β4) that may be less than 180°, preferably less than 120°.

14. Transformer unit, comprising a first transformer (3) and a second transformer (3') according to any of the preceding claims, wherein the housing is a single housing comprising a first core receiving cavity (20) and a second core receiving cavity (20') separated by an internal separating wall (32), each cavity receiving a respective magnetic core (10, 10').

15. Transformer unit according to the preceding claim, wherein the first transformer is configured to transmit data or a signal.

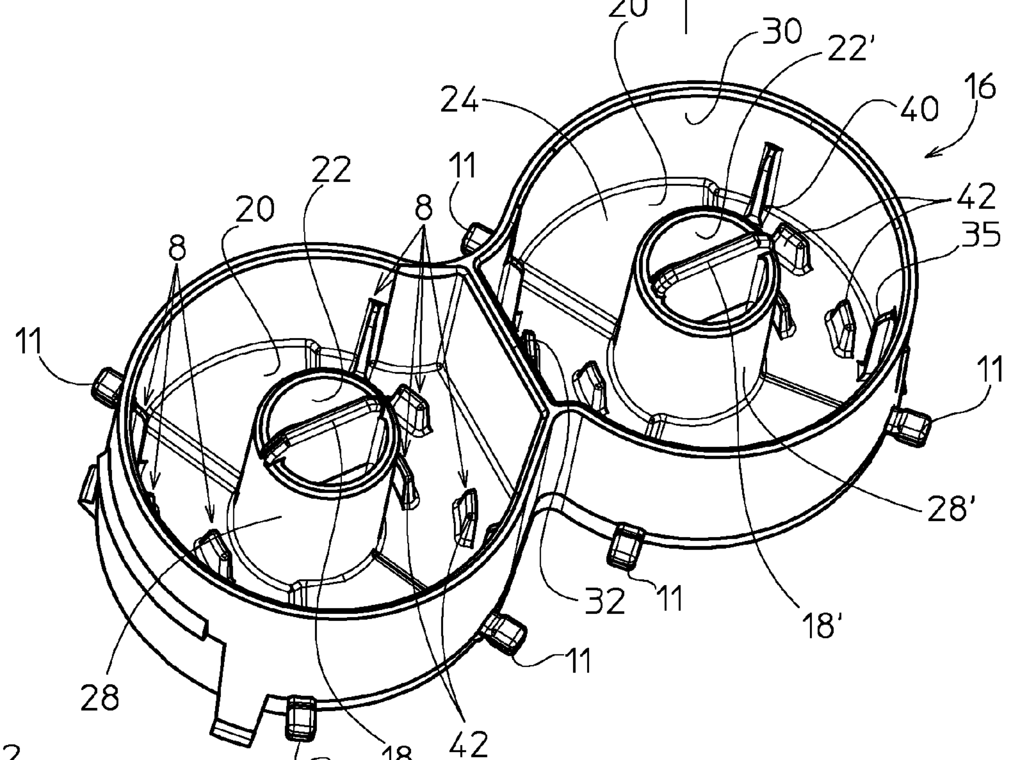
16. Transformer unit according to any of the two directly preceding claims, wherein the second transformer is configured to transmit power for a power supply.

17. Transformer unit according to any of three direct preceding claims for use in an electrical current sensor for high voltage applications.



1
3
12
36
16
9
A
3'
36'
9
6
34
14
12
11
37
12'
34'
13b

Fig. 1



20'
30
22'
16
24
40
11
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42
8
20
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11
28'
32
11
18'
11
28
18
42
11

Fig. 2

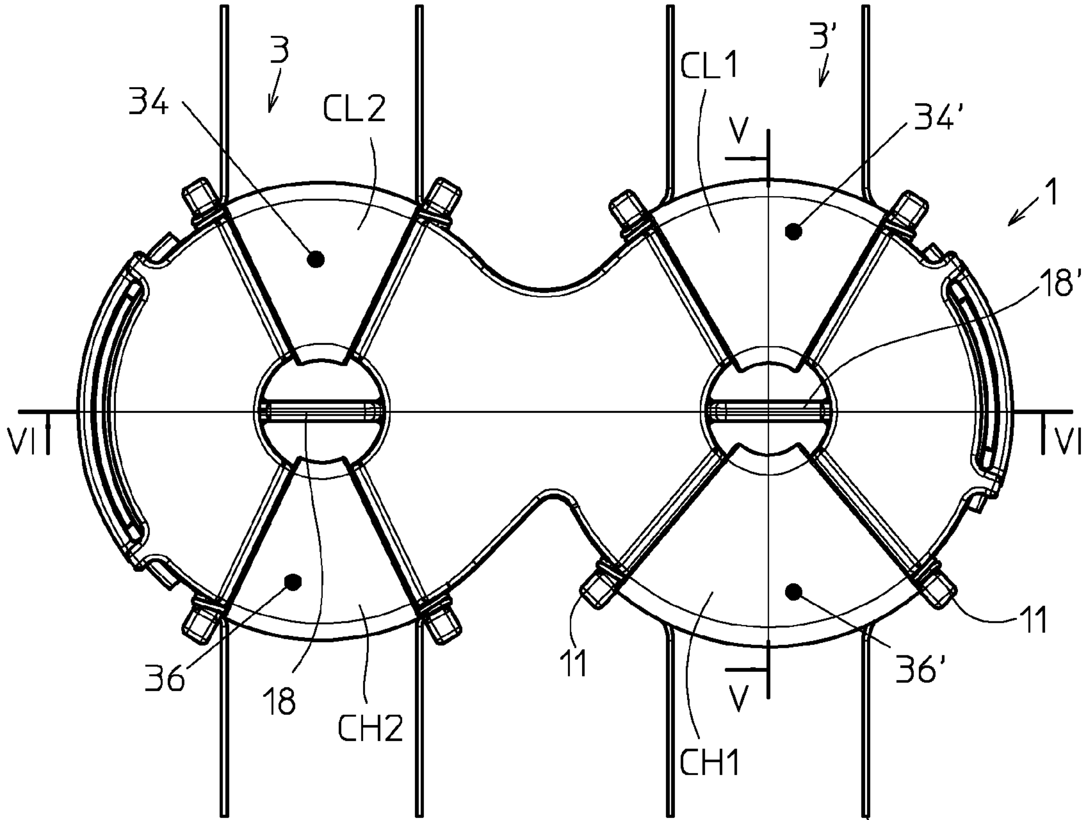
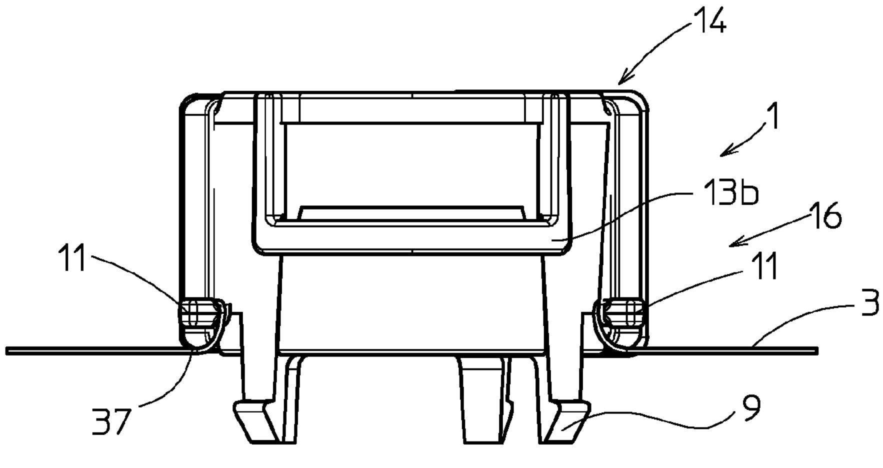

3
34
CL2
3'
CL1
V
34'
1
18'
VI
VI
11
36'
11
36
18
CH2
V
CH1
4

Fig. 3


14
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9

Fig. 4

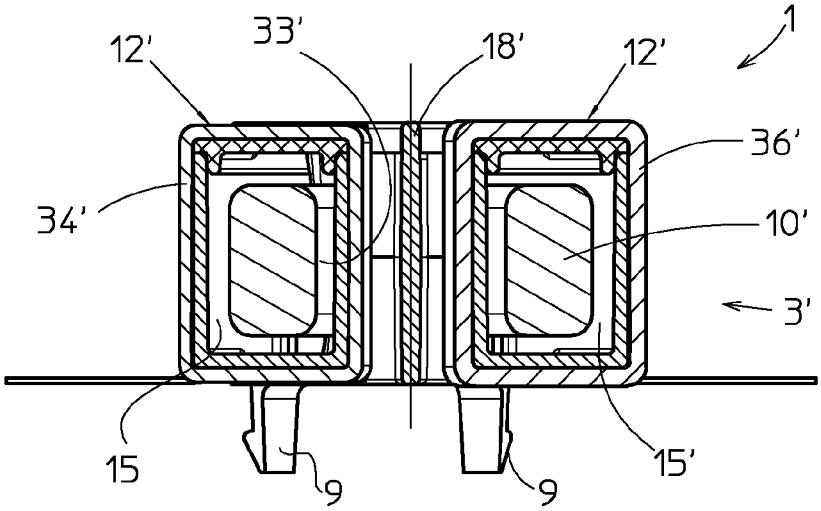
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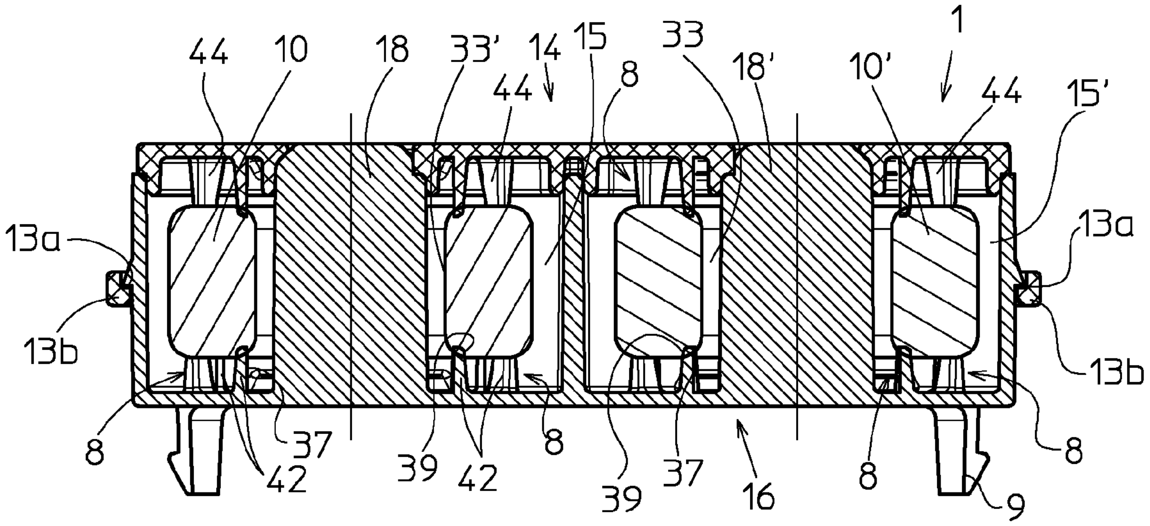
Fig. 5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33'
14
15
33
18'
10'
1
44
15'
8
44
13a
13a
13b
13b
8
37
39
42
8
39
37
16
8
8
9
42

Fig. 6

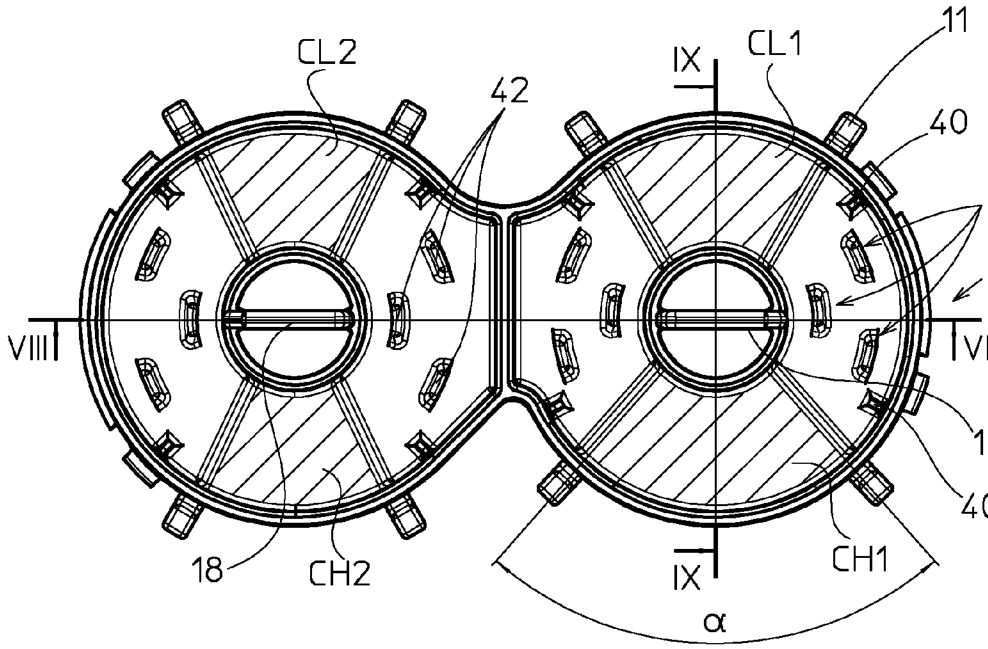
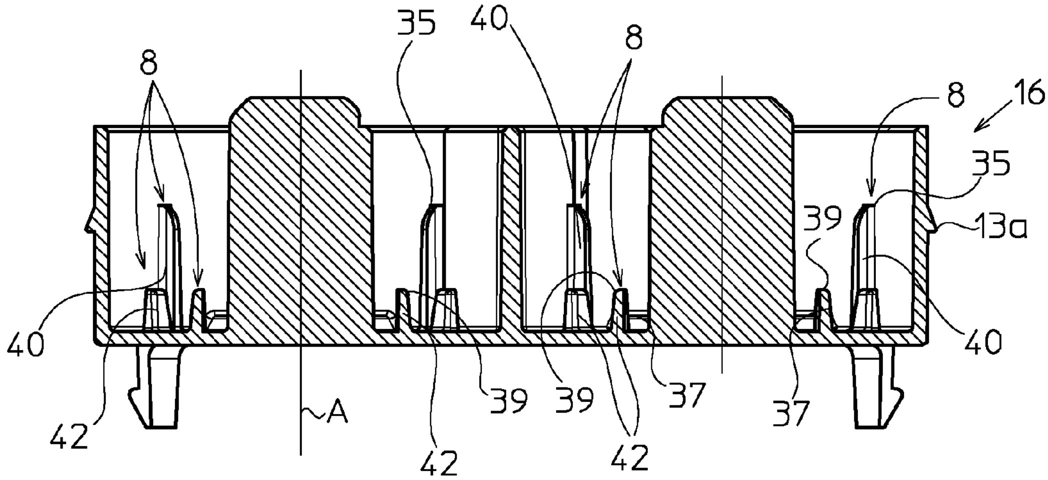

CL2
42
IX
CL1
11
40
8
16
VIII
VIII
18'
40
18
CH2
IX
CH1
α

Fig. 7


35
40
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13a
40
40
42
A
39
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42
42

Fig. 8

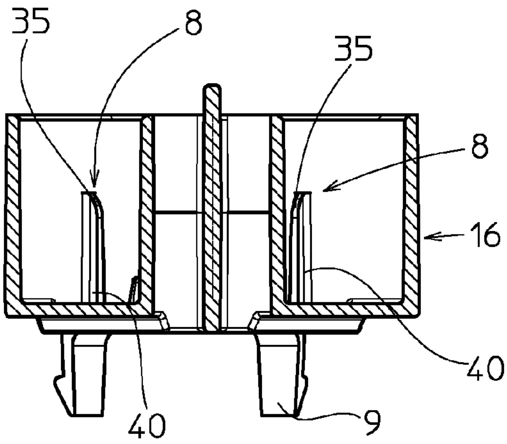

Fig. 9

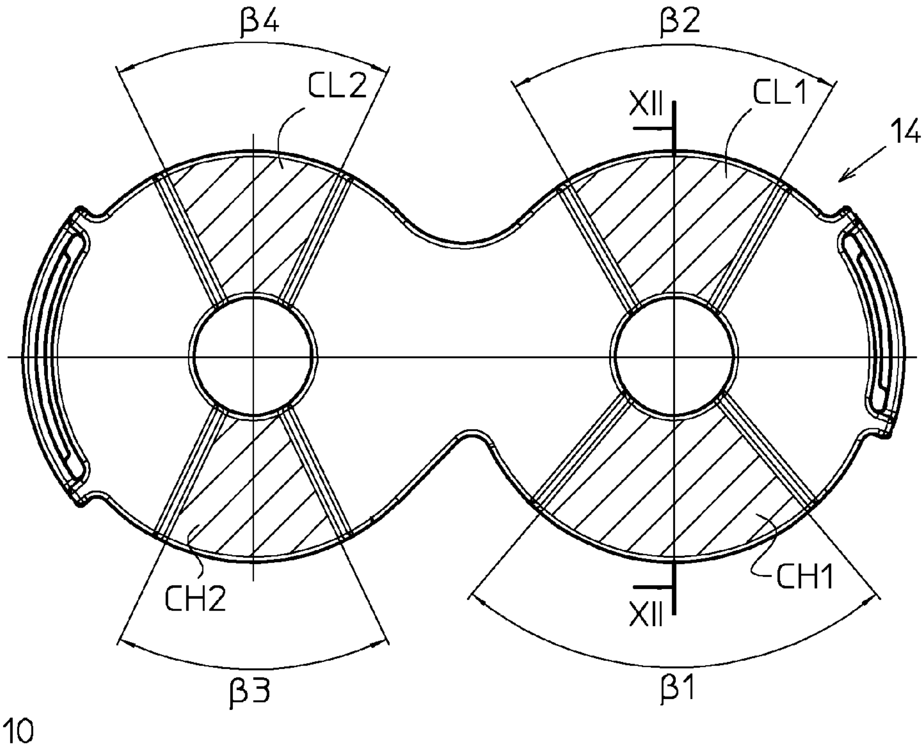

Fig. 10

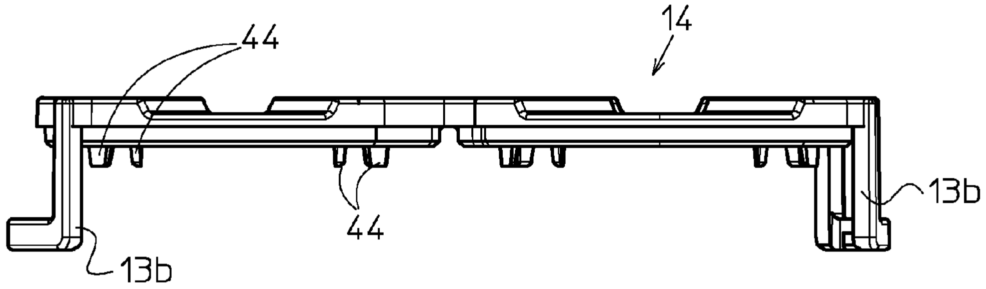

Fig. 11

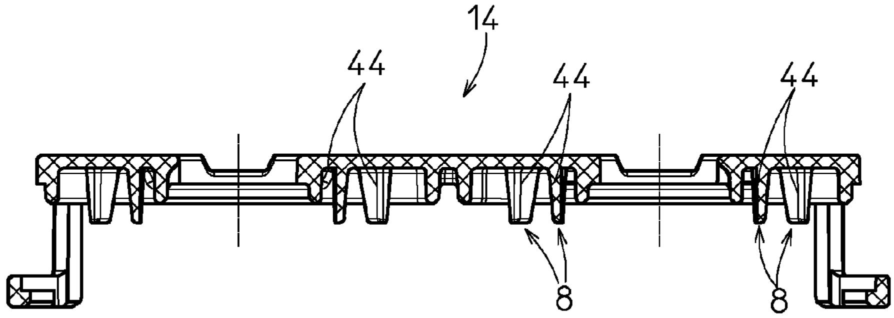

Fig. 12

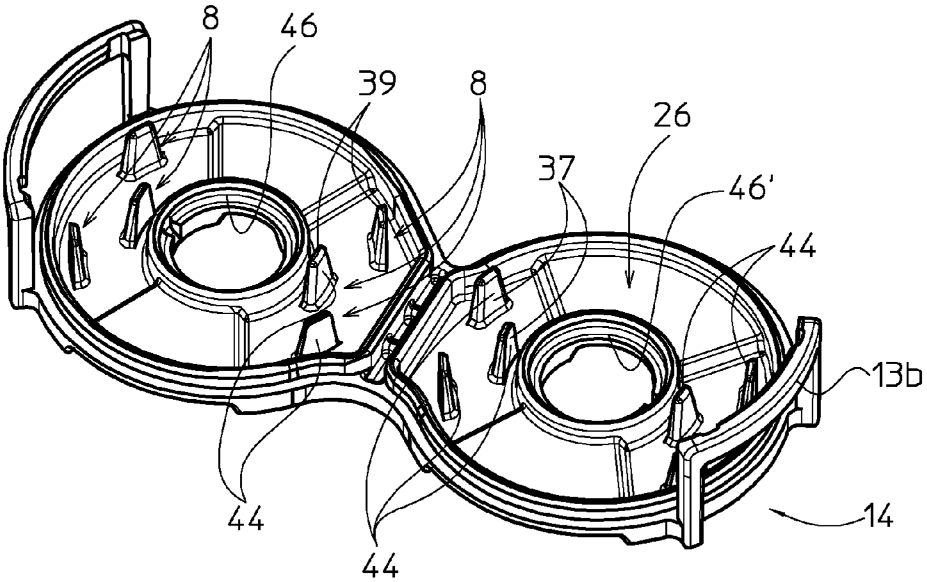

Fig. 13

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EUROPEAN SEARCH REPORT

Application Number
EP 12 16 9233

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 2 423 693 A1 (LEM LIAISONS ELECTRON MEC [CH]) 29 February 2012 (2012-02-29) * abstract * * paragraph [0028]; figures 1-4 * -----	1-17	INV. H01F27/28 H01F27/32
A,D	EP 1 659 413 A1 (LEM LIAISONS ELECTRON MEC [CH]) 24 May 2006 (2006-05-24) * abstract * * paragraphs [0037], [0038]; figures 2, 3a * -----	1-17	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	24 October 2012	Winkelman, André

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 12 16 9233

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24-10-2012

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REFERENCES CITED IN THE DESCRIPTION

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- EP 1659413 A **[0003]**
- EP 2144070 A **[0003]**