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(54) **TAP CHANGER IN POWER TRANSFORMER**

STUFENSCHALTER IN EINEM LEISTUNGSTRANSFORMATOR

CHANGEUR DE PRISES DANS UN TRANSFORMATEUR DE PUISSANCE

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to an On-Load Tap Changer (OLTC) for a fluid-filled power transformer.

BACKGROUND

[0002] Tap changer barrier systems are used for separating tap-changer insulation fluid, which are prone to be polluted by particles formed by the diverter switches, from the insulation fluid of the transformer. Typically, the backboard of the barrier system is flat and relatively thick to be able to withstand the pressure differences and the structural deformations in the interface between the transformer liquid and the OLTC. Problems with these thick barriers include that they take up much space, that they are difficult to stress release from strong electrical fields, and that they are difficult to manufacture with homogenous material and easily get shrinkage cracks and internal blisters. Thick barriers therefore also reduce the number of manufacturing methods being possible to use, especially if good structural materials such as epoxy glass systems are used which may be preferred if the material shall pass the transformer drying process.

[0003] JP H09 162041 A discloses an On-Load Tap Changer according to the preamble of claim 1.

SUMMARY

[0004] It is an objective of the present invention to provide an improved barrier for separating the insulation fluid of the tap changer from the insulation fluid of the transformer, to avoid contamination of the transformer fluid, as well as for protecting the tap changer from pressure changes in the transformer fluid during operation of the power transformer. The tap changer is typically an OLTC, as is exemplified herein.

[0005] According to an aspect of the present invention, there is provided an On-Load Tap Changer (OLTC) for a fluid-filled power transformer. The OLTC comprises a barrier which is sealingly arranged to separate an electrically insulating tap changer fluid of the OLTC from an electrically insulating transformer fluid in a transformer tank of the power transformer. The OLTC also comprises a diverter switch unit arranged in the tap changer fluid and fixed to an inside surface of a backboard of the barrier. The OLTC also comprises a tap selector unit arranged in the transformer fluid and fixed to an outside surface of the backboard. The diverter switch unit and the tap selector unit are galvanically connected with each other via phase holes in the backboard, and the backboard is arched. The backboard is arched such that the backboard is shaped like a longitudinal envelope section of a circular, elliptical or parabolic cylinder, preferably a circular cylinder.

[0006] According to the present disclosure, there is

provided an arched backboard of a barrier, or a barrier comprising said backboard, for separating an electrically insulating tap changer fluid of an OLTC from an electrically insulating transformer fluid in a transformer tank of a power transformer. The backboard comprises phase holes for allowing a diverter switch unit arranged in the tap changer fluid and fixed to an inside surface of the backboard to communicate, e.g. electrically (e.g. galvanically) and/or mechanically, with a tap selector unit arranged in the transformer fluid and fixed to an outside surface of the backboard. The backboard also comprises a keyway in the inside or outside surface, preferably the outside surface, along longitudinal end surfaces of the backboard for allowing the barrier to be sealingly arranged in the OLTC. The backboard is arched in shape. According to another aspect of the present invention, there is provided a fluid-filled power transformer comprising an embodiment of the OLTC of the present disclosure.

[0007] By designing the barrier, or more specifically the backboard thereof, in an arched shape, the barrier can better withstand pressure changes without deformation (e.g. flexing inward or outward like a flat barrier is prone to do) and may thus be made thinner. A thinner barrier has advantages including taking less space, using less material and reducing problems with electrical fields. The arched form also allows the barrier to be integrated in the tap changer in a more space efficient way, making the tap changer more compact and less bulky.

[0008] The barrier backboard may be made of a suitable material for allowing the barrier to pass a drying process of the transformer, e.g. of an epoxy glass material, e.g. filament wound, which may also be suitable for withstanding the pressure differences, and any structural deformation associated therewith, between the tap changer and the transformer liquid, e.g. transformer oil, ester liquid or other electrically insulating fluid.

[0009] It is to be noted that any feature of any of the aspects may be applied to any other aspect, wherever appropriate. Likewise, any advantage of any of the aspects may apply to any of the other aspects. Other objectives, features and advantages of the enclosed embodiments will be apparent from the following detailed disclosure, from the attached dependent claims as well as from the drawings.

[0010] Generally, all terms used in the claims are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise herein. All references to "a/an/the element, apparatus, component, means, step, etc." are to be interpreted openly as referring to at least one instance of the element, apparatus, component, means, step, etc., unless explicitly stated otherwise. The steps of any method disclosed herein do not have to be performed in the exact order disclosed, unless explicitly stated. The use of "first", "second" etc. for different features/components of the present disclosure are only intended to distinguish the features/components from other similar features/components and not to impart any order or hierarchy to the

features/components.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Embodiments will be described, by way of example, with reference to the accompanying drawings, in which:

Fig 1 is a schematic sectional side view of a liquid-filled power transformer comprising an OLTC, in accordance with an embodiment of the present invention.

Fig 2 is a schematic sectional side view of an OLTC, in accordance with an embodiment of the present invention.

Fig 3 is a schematic perspective view of an embodiment of an arched backboard for an OLTC, in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION

[0012] Embodiments will now be described more fully hereinafter with reference to the accompanying drawings, in which certain embodiments are shown. However, other embodiments in many different forms are possible within the scope of the present disclosure. Rather, the following embodiments are provided by way of example so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art. Like numbers refer to like elements throughout the description.

[0013] Figure 1 illustrates a power transformer 10 comprising a tap changer 1, typically an OLTC, here a fluid-filled transformer 10 filled with an electrically insulating fluid 13, such as a gas or liquid, typically a liquid e.g. an oil or ester liquid, arranged for insulating the transformer windings 14 of the transformer. The transformer 10 comprises a transformer tank 11, encasing the transformer windings 14 and holding the insulating fluid 13, having a wall 12 in which the tap changer may be arranged, typically a side wall, e.g. a vertical side wall 12.

[0014] The tap changer 1 is arranged to connect different alternating current (AC) phases to different taps along respective phase windings of the transformer windings 14, thereby controlling the electrical power output of the transformer 10.

[0015] Figure 2 illustrates a tap changer 1 arranged in a wall 12 of a power transformer 10, e.g. as in figure 1. The tap changer 1 may comprise a tap changer tank 15 which, together with the barrier 2, forms an enclosure holding an electrically insulating tap-changer fluid 3, such as a gas or liquid, typically a liquid e.g. an oil or ester liquid. The barrier 2 is sealingly fixed to the tap changer tank 15, e.g. by means of metallic, such as aluminium, profiles 8 of the barrier, such that the tap changer fluid 3

is kept separate from the transformer fluid 13 on the other side of the barrier 2. The barrier is thus impervious to the tap-changer fluid as well as to the transformer fluid. In some embodiments, the barrier 2 may be fixed directly to the transformer tank 11, e.g. to a side 12 thereof, whereby there may be no need for a tap changer tank 15 for separating the tap changer fluid from the transformer fluid.

[0016] The tap changer 1 comprises a diverter switch unit 4 arranged in the tap changer tank 15 and arranged at an inside of the barrier 2, and a selector switch unit 5 arranged in the transformer tank 11 at an outside of the barrier 2. The diverter switches of the diverter switch unit 4 are in galvanic electrical communication with the tap selector(s) (typically one per phase) of the tap selector unit 5 via phase holes 33 (see figure 3) in the backboard 16 of the barrier 2. To separate the transformer fluid 13 from the tap changer fluid 3, thus e.g. avoiding contamination of the transformer fluid 13 by contaminants formed by the diverter switch unit 4, the diverter switch and/or tap selector units 4 and 5 are sealingly arranged around the phase holes 33 on respective sides 9 of the backboard 16. Thus, the diverter switch unit 4 is fixed to an inside surface 9a of the backboard 16 and the tap selector unit 5 is fixed to an outside surface 9b of the backboard, e.g. via some sealing means at the phase holes.

[0017] The tap changer 1 may also conventionally comprise a motor 6 and a drive shaft 7 for driving the diverter switches of the diverter switch unit 4.

[0018] In accordance with embodiments of the present invention, the backboard 16 is arched, typically outward, in the direction of the interior and windings 14 of the transformer 10, but may in some embodiments instead be arched inward. Thus, the inside or outside surface 9a or 9b, preferably the outside surface 9b, has a convex shape and the other surface 9b or 9a, preferably the inside surface 9a, has a concave shape. The arching is only in one dimension (perpendicular to the plane of the backboard 16 and along a longitudinal axis 36 (see figure 3) of the barrier 2) such that the backboard is shaped like a longitudinal envelope section of a cylinder, e.g. a circular, elliptical or parabolic cylinder, preferably circular.

[0019] By designing the barrier 2 with an arched shape, the barrier can better withstand pressure changes without deformation and may thus be made thinner. If instead a flat barrier is used as in accordance with prior art, pressure applied to either side of the barrier will result in the barrier flexing inward or outward, respectively, which will also increase the risk of leakage of insulation fluid at the interface of the barrier with e.g. the tap changer tank or transformer tank, unless a much thicker and thus less flexible backboard is used. A thinner barrier of the present invention has advantages including taking less space, using less material and reducing problems with electrical fields (stress release of the insulation material and the insulating material surfaces of the backboard 16). The arched form may also allow the barrier to be integrated

in the tap changer 1 in a more space efficient way, making the tap changer more compact and less bulky.

[0020] Traditionally, using a flat barrier, the thickness of the backboard has been around 5% of the backboard width. However, according to some embodiments of the present invention, a backboard thickness of less than 5%, e.g. 1-4%, such as around 2%, of the backboard width may be enough when equal loads are compared. This is mainly due to the arched shape but also due to the improved material that is possible to use when using the arched shape. The backboard 16 may as an example be made by a well-controlled process such as filament winding with an epoxy glass material 39. By using such a material, the backboard may also be included in the drying process of the transformer 10 without being damaged.

[0021] Figure 3 illustrates an embodiment of an arched backboard 16, e.g. as described in relation to figure 2. The backboard may have a longitudinal axis 36, which may in some embodiments also be an axis of symmetry of the backboard. The backboard comprises phase holes 33, here three phase holes 33a, 33b and 33c, one for each phase of a three-phase AC system.

[0022] Since the backboard is arched along the longitudinal axis 36, it may comprise two substantially straight, and typically parallel, longitudinal side surfaces 34a and 34b, and two curved, and typically parallel, transverse side surfaces 35a and 35b. The arched form of the backboard implies that a force of a pressure applied to the outside surface 9b of the barrier is typically taken up by the longitudinal side surfaces 34 at their interfaces/fixations to the tap changer tank 15.

[0023] Respective longitudinal keyways 38a and 38b may be arranged along respective longitudinal side surfaces 34a and 34b in the outside surface 9b, arranged to cooperate with (or be in mesh with) corresponding keys of a fixation system, e.g. comprising the profiles 8, for sealingly fastening the barrier 2 e.g. to the tap changer tank 15 or transformer tank 11. Thus, a force of a pressure applied to the inside surface 9a of the backboard may be taken up by the keyways 38 at their interfaces with the fixation system. If the backboard 16 is instead arched inward, the keyways 38 may instead be arranged in the inside surface 9a.

[0024] The backboard 16 may be made of a suitable material 39 which is impervious to the tap changer and transformer fluids 3 and 13 and which is suitable for withstanding any pressure differences, and any structural deformation associated therewith, between the tap changer and the transformer fluids during operation of the transformer. The material 39 may also be suitable for allowing the backboard 16 to pass a drying process of the transformer 10. The material 39 may e.g. comprise or consist of an epoxy glass material, e.g. filament wound.

[0025] To aid in preventing the barrier 2 from slipping in the longitudinal direction and to minimize thermal and structural movement of the barrier, the longitudinal side surfaces 34 of the backboard 16 may be provided with

projections 37 extending outward from said longitudinal side surfaces. The projections 37 may e.g. be in mesh with corresponding recesses or holes in the fixation system, e.g. the profiles 8, and may thus, with or without cooperation with the keys and keyways (if any), fix the barrier in the longitudinal direction. In the example of figure 3, one respective projection 37a or 37b is provided in each of the longitudinal side surfaces 34a and 34b, e.g. in the middle thereof.

[0026] In some embodiments of the present invention, the backboard is arched such that the outside surface has a convex shape and the inside surface has a concave shape. However, in other embodiments, the inside surface has a convex shape and the outside surface has a concave shape. As discussed above, the backboard may be arched in one or two dimensions, but often only in one dimension.

[0027] In some embodiments of the present invention, the barrier 2 is sealingly arranged by being sealingly fixed to a tap changer tank 15 of the OLTC 1. However, in other embodiments, the barrier 2 may additionally or alternatively be sealingly fixed directly to the transformer tank 11, possibly obviating the need for a tap changer tank 15.

[0028] In some embodiments of the present invention, the barrier 2 is sealingly arranged by means of a keyway 38 in the inside or outside surface 9a or 9b, preferably in the outside surface 9b, of the backboard 16 along longitudinal end surfaces 34 of the backboard. In some embodiments, the barrier 2 is sealingly arranged by means of metallic profiles 8 of the barrier arranged along the longitudinal end surfaces 34 of the backboard 16 and in mesh with the keyway 38, typically by means of protruding keys in the profiles 8 which are configured to fit in recesses of the keyway(s) 38.

[0029] In some embodiments of the present invention, the OLTC is sealingly arranged in an opening of a side wall 12 of the transformer tank 11. This may facilitate easy installing of and access to the OLTC 1 from the outside of the transformer tank 11.

[0030] In some embodiments of the present invention, the backboard 16 is of an epoxy glass material 39. In some embodiments, the backboard 16 is made from filament winding of the epoxy glass material 39. The resulting material 39 may thus be electrically insulating and strong, and be able to withstand the drying process of the transformer whereby the backboard can be installed in the transformer 10 prior to drying.

[0031] The present disclosure has mainly been described above with reference to a few embodiments. However, as is readily appreciated by a person skilled in the art, other embodiments than the ones disclosed above are equally possible within the scope of the present disclosure, as defined by the appended claims.

Claims

1. An On-Load Tap Changer (1) for a fluid-filled power transformer (10), the On-Load Tap Changer comprising:

a barrier (2), sealingly arranged to separate an electrically insulating tap changer fluid (3) of the On-Load Tap Changer from an electrically insulating transformer fluid (13) in a transformer tank (11) of the power transformer;

a diverter switch unit (4) arranged in the tap changer fluid (3) and fixed to an inside surface (9a) of a backboard (16) of the barrier; and a tap selector unit (5) arranged in the transformer fluid (13) and fixed to an outside surface (9b) of the backboard;

wherein the diverter switch unit and the tap selector unit are galvanically connected with each other via phase holes (33) in the backboard;

characterized in that the backboard (16) is arched such that the backboard is shaped like a longitudinal envelope section of a circular, elliptical or parabolic cylinder, preferably a circular cylinder.

2. The On-Load Tap Changer of claim 1, wherein the backboard (16) is arched such that the outside surface (9b) has a convex shape and the inside surface (9a) has a concave shape.
3. The On-Load Tap Changer of any preceding claim, wherein the barrier (2) is sealingly arranged by being sealingly fixed to a tap changer tank (15) of the On-Load Tap Changer (1).
4. The On-Load Tap Changer of any preceding claim, wherein the barrier (2) is sealingly arranged by means of a keyway (38) in the inside or outside surface (9a; 9b), preferably in the outside surface (9b), of the backboard (16) along longitudinal end surfaces (34) of the backboard.
5. The On-Load Tap Changer of claim 4, wherein the barrier (2) is sealingly arranged by means of metallic profiles (8) arranged along the longitudinal end surfaces (34) of the backboard and in mesh with the keyway (38).
6. The On-Load Tap Changer of any preceding claim, wherein the On-Load Tap Changer (1) is sealingly arranged in an opening of a side wall (12) of the transformer tank (11).
7. The On-Load Tap Changer of any preceding claim, wherein the backboard (16) is of an epoxy glass material (39).

8. The On-Load Tap Changer of claim 7, wherein the backboard (16) is made from filament winding of the epoxy glass material (39).

9. A fluid-filled power transformer (10) comprising the On-Load Tap Changer (1) of any claim 1-8.

Patentansprüche

1. Laststufenschalter (1) für einen fluidgefüllten Leistungstransformator (10), der Laststufenschalter Folgendes umfassend:

eine Sperre (2), die abdichtend angeordnet ist, um ein elektrisch isolierendes Stufenschalterfluid (3) des Laststufenschalters von einem elektrisch isolierenden Transformatorfluid (13) in einem Transformator tank (11) des Leistungstransformators zu trennen;

eine Lastumschalteinheit (4), die in dem Stufenschalterfluid (3) angeordnet ist und an einer Innenfläche (9a) einer Rückwand (16) der Sperre befestigt ist; und

eine Stufenauswahleinheit (5), die in dem Transformatorfluid (13) angeordnet ist und an einer äußeren Oberfläche (9b) der Rückwand befestigt ist;

wobei die Lastumschalteinheit und die Stufenauswahleinheit über Phasenlöcher (33) in der Rückwand galvanisch miteinander verbunden sind;

dadurch gekennzeichnet, dass die Rückwand (16) so gebogen ist, dass die Rückwand wie ein longitudinaler einhüllender Abschnitt eines kreisförmigen, elliptischen oder parabolischen Zylinders, vorzugsweise eines kreisförmigen Zylinders, geformt ist.

2. Laststufenschalter nach Anspruch 1, wobei die Rückwand (16) so gebogen ist, dass die äußere Oberfläche (9b) eine konvexe Gestalt aufweist und die Innenfläche (9a) eine konkave Gestalt aufweist.
3. Laststufenschalter nach einem vorhergehenden Anspruch, wobei die Sperre (2) abdichtend angeordnet ist, indem sie abdichtend an einem Stufenschalter tank (15) des Laststufenschalters (1) befestigt ist.
4. Laststufenschalter nach einem vorhergehenden Anspruch, wobei die Sperre (2) mittels einer Längsnut (38) in der inneren oder äußeren Oberfläche (9a; 9b), vorzugsweise in der äußeren Oberfläche (9b), der Rückwand (16) entlang longitudinaler Endflächen (34) der Rückwand abdichtend angeordnet ist.
5. Laststufenschalter nach Anspruch 4, wobei die Sperre (2) mittels metallischer Profile (8) abdichtend

angeordnet ist, die entlang der longitudinalen Endflächen (34) der Rückwand und in Eingriff mit der Längsnut (38) angeordnet sind.

6. Laststufenschalter nach einem vorhergehenden Anspruch, wobei der Laststufenschalter (1) in einer Öffnung einer Seitenwand (12) des Transformatortanks (11) abdichtend angeordnet ist.
7. Laststufenschalter nach einem vorhergehenden Anspruch, wobei die Rückwand (16) aus einem Epoxidglasmaterial (39) ist.
8. Laststufenschalter nach Anspruch 7, wobei die Rückwand (16) aus einer Filamentwicklung des Epoxidglasmaterials (39) angefertigt ist.
9. Fluidgefüllter Leistungstransformator (10), den Laststufenschalter (1) nach einem der Ansprüche 1 bis 8 umfassend.

Revendications

1. Changeur de prise en charge (1) pour un transformateur de puissance rempli de fluide (10), le changeur de prise en charge comprenant :

une barrière (2), disposée de façon étanche pour séparer un fluide électriquement isolant de changeur de prise (3) du changeur de prise en charge d'un fluide électriquement isolant de transformateur (13) dans une cuve de transformateur (11) du transformateur de puissance ; une unité de commutation (4) disposée dans le fluide de changeur de prise (3) et fixée à une surface intérieure (9a) d'un panneau (16) de la barrière ; et

une unité de sélection de prise (5) disposée dans le fluide de transformateur (13) et fixée à une surface extérieure (9b) du panneau ; dans lequel l'unité de commutation et l'unité de sélection de prise sont reliées galvaniquement l'une à l'autre par le biais de trous de phase (33) dans le panneau ;

caractérisé en ce que le panneau (16) est arqué de telle sorte que le panneau est façonné comme une section d'enveloppe longitudinale d'un cylindre circulaire, elliptique ou parabolique, de préférence un cylindre circulaire.

2. Changeur de prise en charge de la revendication 1, dans lequel le panneau (16) est arqué de telle sorte que la surface extérieure (9b) a une forme convexe et la surface intérieure (9a) a une forme concave.
3. Changeur de prise en charge d'une quelconque revendication précédente, dans lequel la barrière (2)

est disposée de façon étanche en étant fixée de façon étanche à une cuve de changeur de prise (15) du changeur de prise en charge (1).

4. Changeur de prise en charge d'une quelconque revendication précédente, dans lequel la barrière (2) est disposée de façon étanche au moyen d'une rainure de clavette (38) dans la surface intérieure ou extérieure (9a ; 9b), de préférence dans la surface extérieure (9b) du panneau (16) le long de surfaces d'extrémité longitudinales (34) du panneau.
5. Changeur de prise en charge de la revendication 4, dans lequel la barrière (2) est disposée de façon étanche au moyen de profilés métalliques (8) disposés le long des surfaces d'extrémité longitudinales (34) du panneau et en prise avec la rainure de clavette (38).
6. Changeur de prise en charge d'une quelconque revendication précédente, le changeur de prise en charge (1) étant disposé de façon étanche dans une ouverture d'une paroi latérale (12) de la cuve de transformateur (11) .
7. Changeur de prise en charge d'une quelconque revendication précédente, dans lequel le panneau (16) est fait d'un matériau en verre époxy (39).
8. Changeur de prise en charge de la revendication 7, dans lequel le panneau (16) est fabriqué par enroulement de filaments du matériau en verre époxy (39).
9. Transformateur de puissance rempli de fluide (10) comprenant le changeur de prise en charge (1) de l'une quelconque des revendications 1 à 8.

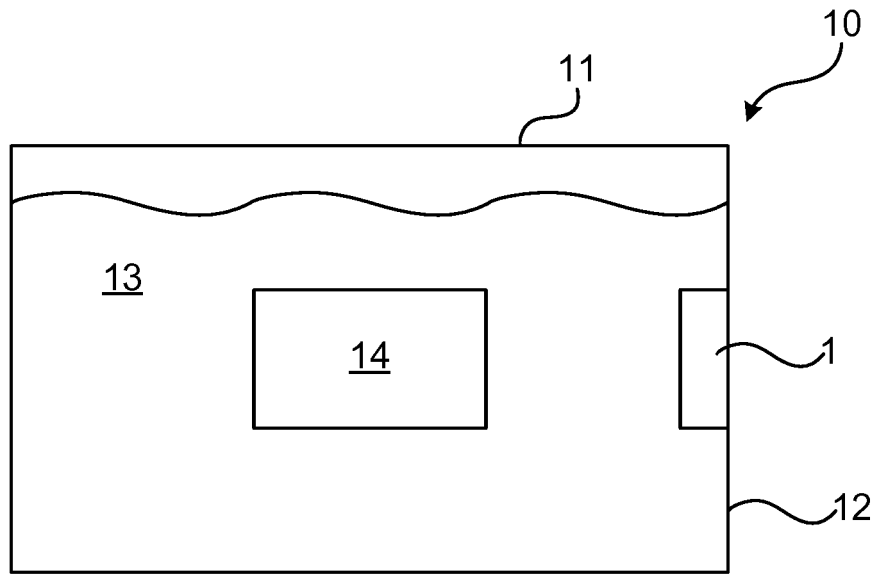


Fig. 1

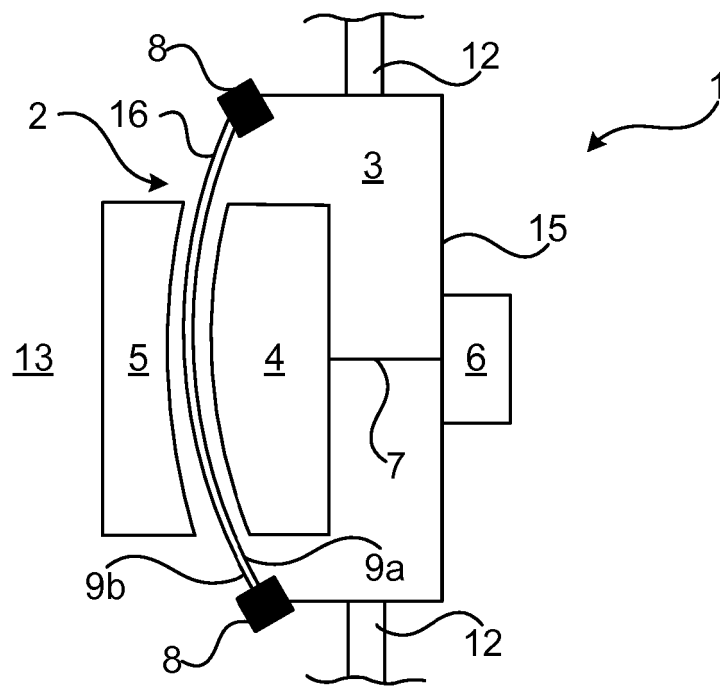


Fig. 2

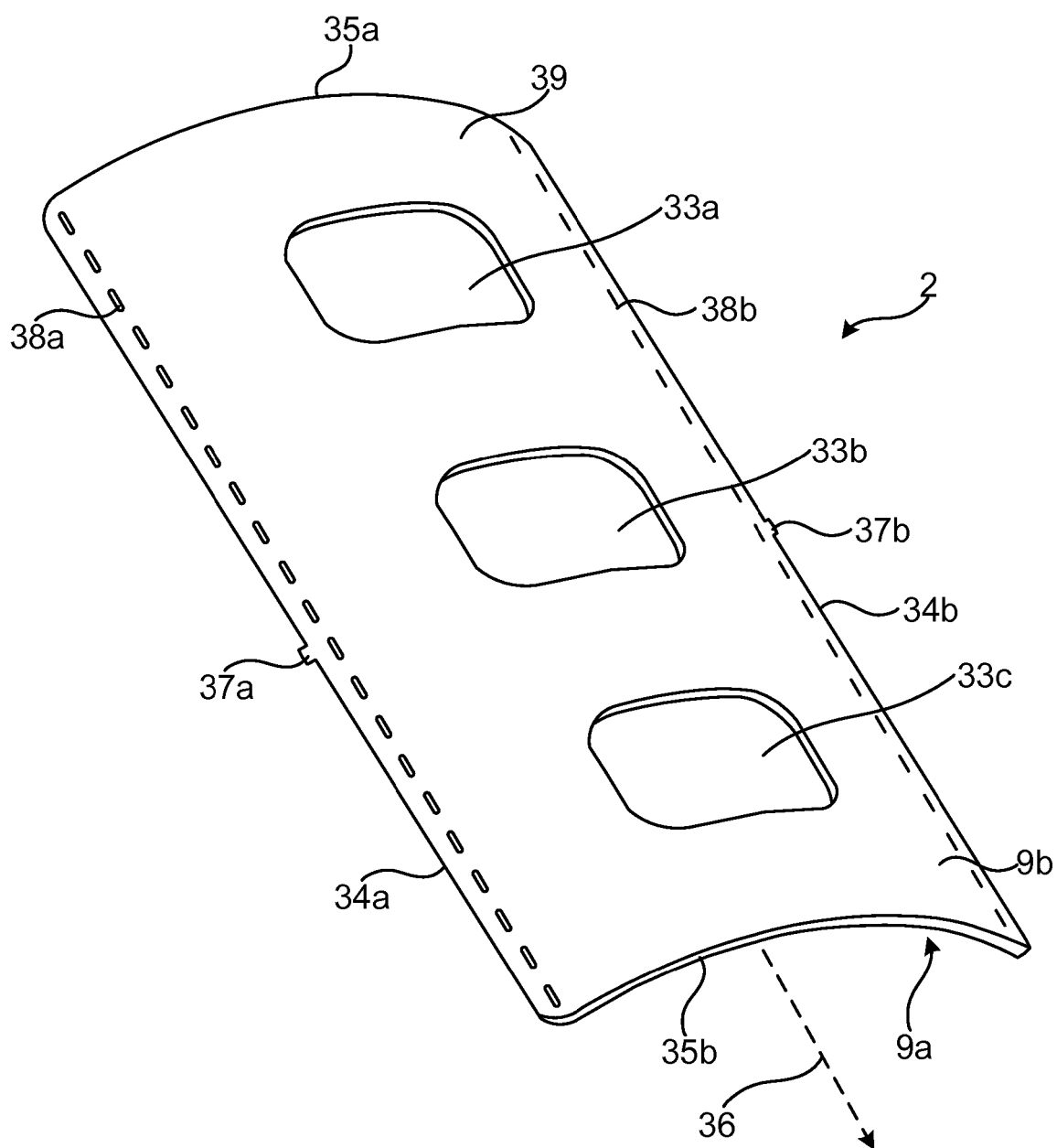


Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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