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(54) **ELECTRICAL INSULATION SYSTEM AND ELECTROMAGNETIC INDUCTION DEVICE
COMPRISING THE SAME**

ELEKTRISCHES ISOLIERUNGSSYSTEM UND ELEKTROMAGNETISCHE
INDUKTIONSVORRICHTUNG DAMIT

SYSTÈME D'ISOLATION ÉLECTRIQUE ET DISPOSITIF À INDUCTION ÉLECTROMAGNÉTIQUE
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Description

TECHNICAL FIELD

[0001] The present disclosure generally relates to electromagnetic induction devices. In particular it relates to an electrical insulation system for a high voltage electromagnetic induction device and to a high voltage electromagnetic induction device comprising an electrical insulation system.

BACKGROUND

[0002] In liquid insulated electromagnetic induction devices, such as power transformers, mineral oil, natural ester oil or synthetic ester oil is typically used as an insulating fluid between inner parts subject to different electric potentials. The inner parts of an electromagnetic induction device normally comprise a magnetic core, windings, and an electrical insulation system which provides insulation between parts having different electric potential. In particular, in the main duct of an electromagnetic induction device a certain distance in oil should be kept to avoid dielectric breakdown during tests and service.

[0003] The electrical insulation between windings in the main duct typically comprises cylindrical barriers made of e.g. pressboard to divide oil spaces in the radial direction. This subdivision greatly improves the dielectric strength for the whole width of the main duct and it allows in practice to reduce its width significantly. The pressboard barriers are normally arranged concentrically between the inner and outer winding in the main duct during the manufacturing of the electromagnetic induction device. In order to provide radial support of the windings a set of longitudinal bars, commonly referred to as sticks or strips, made of e.g. pressboard are placed evenly around the barriers. The strips provide a supporting surface for the windings.

[0004] It has been identified that the oil regions delimited by the winding conductor, the sticks supporting them, and spacers axially supporting discs of winding conductor are heavily stressed under voltage conditions during tests and operation of an electromagnetic induction device. In particular, during lightning impulse stress, in these regions so-called oil wedges can provide a point of initiation of an electrical flashover. In order for the flashover to be developed, a path for propagation must be formed and it must be connected to a surface of different potential. A streamer can propagate from the oil wedge, across the oil space close to the wedge in the duct closest to the winding. A streamer can also propagate along the surface of the stick until it reaches the cylindrical barrier and continue from that point along the barrier itself. It is desirable to prevent streamers from propagating between surfaces with differing electric potential in order to prevent electrical flashover.

[0005] An example of a streamer trap is disclosed in EP2806436 in which the longitudinal bar or stick has a

groove arranged to receive a groove-fitting end portion of a spacer, wherein streamers initiated in an oil wedge in a region between the contact surface of the longitudinal bar and the winding may be trapped in the groove. Streamers initiated in this region may however also propagate outwards instead of inwards into the groove.

[0006] JP S61 224302 A discloses a stationary induction electric apparatus. A vertical groove, having the base larger than the aperture part, is formed by a vertical duct piece. A protrusion is provided on an interlayer spacer in such a manner that the spacer is fitted in the vertical groove and that the spacer is moved vertical duct piece is constituted in such a manner that it is made wider than the width of the intercoil spacer. Partial electric discharge is generated from the wedge-shaped microscopic oil gap located between the spacer and the innermost coil of a disc coil, and the electric discharge progresses on the creeping surface of the spacer toward the inner side. However, as the width of the duct piece is wider than the width of the spacer, the progress of the electric discharge is stopped on the surface of the vertical duct.

SUMMARY

[0007] In view of the above, an object of the present disclosure is to provide an electrical insulation system which increases the probability of trapping streamers.

[0008] Hence, according to a first aspect of the present disclosure as set forth in claim 1 there is provided an electrical insulation system for a high voltage electromagnetic induction device, wherein the electrical insulation system comprises: a stick having an elevated central portion and two lateral portions, which elevated central portion is elevated relative to the two lateral portions and arranged between the two lateral portions, wherein the elevated central portion defines a winding facing surface arranged to face a winding, wherein the stick has a barrier contact surface opposite to the winding facing surface wherein a first distance between the winding facing surface and the barrier contact surface defines the thickness T of the stick, wherein the stick has a first groove, arranged between a first lateral portion of the two lateral portions and the elevated central portion, and a second groove arranged between a second lateral portion of the two lateral portions and the elevated central portion, which first groove and second groove extend axially along the stick, wherein each of the first lateral portion and the second lateral portion has a respective groove adjacent surface opposite to the barrier contact surface, wherein a second distance t_1 from each groove adjacent surface to a plane defined by the winding facing surface fulfils the relation $t_1 < 0.6T$.

[0009] By means of a stick that has two grooves, arranged on either side of the elevated central portion, which is arranged to support the winding, a streamer initiated in an oil wedge between the winding facing surface and the winding will be trapped in one of the two grooves. The relation $t_1 < 0.6T$, i.e. that the elevation of the elevated

central portion relative to the groove adjacent surfaces is at most 60% of the total thickness T , is a relation that ensures efficient streamer trapping in the two grooves, i.e. that essentially all streamers are trapped in one of the grooves instead of propagating along a different route. Thus, if this relation is fulfilled, the grooves are located at a distance from the winding, which ensures efficient streamer trapping. According to one embodiment $0.01T < t_1$. This relation ensures that the electromagnetic field strength will be limited on the groove adjacent surfaces, and that no streamers can be initiated between the winding and the groove adjacent surfaces, which could result in the initiation of streamers also in this region. Such streamers could possibly escape trapping.

[0010] According to one embodiment the depth t_4 of each of the first groove and the second groove fulfils the relation $1/3t_1 < t_4 < 0.9T$.

[0011] According to one embodiment a smallest width w_4 of the first lateral portion from the first groove to a lateral end face of the first lateral portion fulfils the relation $1/3 < w_4/t_3 < 3$, where t_3 is the distance from the bottom of the first groove to the barrier contact surface.

[0012] According to one embodiment a smallest width w_4 of the second lateral portion from the second groove arranged to a lateral end face of the second lateral portion fulfils the relation $1/3 < w_4/t_3 < 3$, where t_3 is the distance from the bottom of the second groove to the barrier contact surface.

[0013] According to one embodiment second distance t_1 is in the range 0.1 to 3 mm.

[0014] According to one embodiment the width w_2 of the winding facing surface of the elevated central portion is smaller than the w_1 width of the barrier contact surface.

[0015] According to one embodiment a distance w_5 from a lateral edge of the winding facing surface to a plane perpendicular to the plane defined by the winding facing surface and aligned with the lateral edge of the lateral portion of the two lateral portions closest to the lateral edge of the winding facing surface fulfils the relation $1/8w_5 < w_2 < 4w_5$, where w_2 is the width of the winding facing surface. By means of this relation, the streamer trap functionality may further be ensured. Furthermore, this relation is according to one variation valid for both lateral edges of the winding facing surface, i.e. to the lateral edge of a respective closest lateral portion.

[0016] According to one embodiment the stick is made of a cellulose-based material.

[0017] One embodiment comprises a spacer having a cut-out arranged to receive the elevated central portion.

[0018] According to one embodiment each of the first groove and the second groove has a mouth that opens in parallel with the plane.

[0019] According to one embodiment each of the first groove and the second groove has a depth t_4 , measured from a plane parallel with the plane and which contains the point of the respective groove adjacent surface and, which is closest to the plane.

[0020] The electrical insulation system is beneficially utilised in a high voltage electromagnetic induction device. Hence, according to a second aspect of the present disclosure as set forth in claim 12 there is provided a high voltage electromagnetic induction device comprising the electrical insulation system according to the first aspect.

[0021] According to one embodiment the high voltage electromagnetic induction device is a power transformer or a reactor.

[0022] According to one embodiment the high voltage electromagnetic induction device is liquid-insulated.

[0023] 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, etc. are to be interpreted openly as referring to at least one instance of the element, apparatus, component, means, etc., unless explicitly stated otherwise.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The specific embodiments of the inventive concept will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a cross-section of an example of a stick of an electrical insulation system for an electromagnetic induction device;

Fig. 2 is a cross-section of an example of a portion of an electrical insulation system for an electromagnetic induction device;

Fig. 3 schematically shows a cross-section of a winding portion of an electromagnetic induction device comprising the insulation system in Fig. 1; and

Fig. 4 illustrates the functionality of the electrical insulation system in Fig. 1.

DETAILED DESCRIPTION

[0025] The inventive concept will now be described more fully hereinafter with reference to the accompanying drawings, in which exemplifying embodiments are shown. The inventive concept may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided by way of example so that this disclosure will be thorough and complete, and will fully convey the scope of the inventive concept to those skilled in the art. Like numbers refer to like elements throughout the description.

[0026] Fig. 1 shows an example of an electrical insulation system 1 for a high voltage electromagnetic induction device. The electrical insulation system 1 comprises a stick 3 arranged to support a winding of a high voltage electromagnetic induction device. The stick 3 is hence

arranged to provide radial support of windings in an electromagnetic induction device. In use, one surface of the stick 3 is typically mounted towards a barrier, normally a cylindrical barrier, while an opposite surface faces and supports a portion of the winding. It is in this contact area between the stick and the winding where streamers may typically be initiated.

[0027] The stick 3 has an elevated lateral portion 5 having a winding facing surface 5a arranged to face a winding. The winding facing surface 5a typically supports the winding when arranged in an electromagnetic induction device, but may under some circumstances be arranged at a distance from the winding, with a liquid gap therebetween. The winding facing surface 5a may thus in general also be referred to as a winding support surface arranged to support a winding.

[0028] The stick 3 also has two lateral portions, viz. a first lateral portion 7 and a second lateral portion 9. The elevated central portion 5 is arranged between the two lateral portions 7 and 9, and the winding facing surface 5a is elevated relative to the first lateral portion 7 and the second lateral portion 9. Thus, only the winding facing surface 5a of the stick 3 is arranged to be in contact and support a winding.

[0029] The stick 3 has a first groove 11a arranged between the first lateral portion 7 and the elevated central portion 5 and a second groove 11b arranged between the second lateral portion 9 and the elevated central portion 5. The first groove 11a and the second groove 11b extend along the axial direction of the stick 3.

[0030] The stick 3 has a barrier contact surface 13 which is arranged opposite to the winding facing surface 5a, seen in a cross-section. The stick 3 is oblong and has a length which is defined in the longitudinal direction, i.e. the direction perpendicular to the cross-sectional plane. The stick 3 further has a width defined between the two lateral portions 7 and 9. The stick 3 has a thickness T defined by a first distance which is the distance between the winding facing surface 5a and the barrier contact surface 13.

[0031] The winding facing surface 5a has a width w_2 . The barrier contact surface 13 has a width w_1 . The width w_1 may according to one variation coincide with the width of the strip 3. Preferably, the width w_2 of the winding facing surface 5a of the elevated central portion 5 is smaller than the w_1 width of the barrier contact surface 13, i.e. $w_2 < w_1$.

[0032] The winding facing surface 5a defines a plane P_1 . Each of the first lateral portion 7 and the second lateral portion 9 has a respective groove adjacent surface 7a and 9b. The groove adjacent surface 7a of the first groove 7 delimits the first groove 11a and extends to the lateral edge 7b of the first lateral portion 7. The distance, referred to as a second distance t_1 , between the groove adjacent surface 7a to the plane P_1 fulfils the relation $t_1 < 0.6T$. The second distance is hence strictly less than 60% of the thickness T of the strip 3. The groove adjacent surface 9a of the second groove 9 delimits the second

groove 11b and extends to the lateral edge 9b of the second lateral portion 9. The distance, referred to as a second distance t_1 , between the groove adjacent surface 9a to the plane P_1 fulfils the relation $t_1 < 0.6T$. The second distance is hence strictly less than 60% of the thickness T of the strip 3. Both of the groove adjacent surfaces 7a and 9a are hence arranged at a second distance t_1 from the plane P_1 that fulfil the relation $t_1 < 0.6T$.

[0033] According to one variation the second distance t_1 is strictly greater than 0.01 times the thickness T , i.e. $0.01T < t_1$. Examples of a suitable second distance t_1 may be in the range 0.1 to 3 mm. A larger distance would also be possible, but that would not reduce the risk for initiation any further.

[0034] The winding facing surface 5a has two lateral edges 5b and 5c. A distance w_5 from the lateral edge 5b of the winding facing surface 5a to a plane P_2 perpendicular to the plane P_1 and aligned with the lateral edge 7b of the first lateral portion 7 fulfils the relation $1/8w_5 < w_2 < 4w_5$. Similarly, a corresponding distance w_5 from the lateral edge 5c of the winding facing surface 5a to a plane P_3 perpendicular to the plane P_1 and aligned with the lateral edge 9b of the second lateral portion 9 also fulfils the relation $1/8w_5 < w_2 < 4w_5$. According to one variation both of these distances w_5 fulfil a relation $1/4w_5 < w_2 < 4w_5$.

[0035] The stick 3 forms a double streamer trap by means of the first groove 11a and the second groove 11b arranged on either side of the elevated central portion 5. The stick 3 is designed such that the electrical field for all oil volume nearby the stick 3 is well below the critical electrical field for initiation of streamers, except for the volume close to the winding facing surface 5a. By means of proper dimensioning of for example the elevation of the winding facing surface 5a relative to the groove adjacent surfaces 7a, and 9a, the electrical field above each groove adjacent surface 7a and 9a is well below the initiation field, i.e. the threshold electromagnetic field strength for streamer initiation.

[0036] Each of the first groove 11a and the second groove 11b has a depth t_4 , measured from a plane parallel with the plane P_1 and which contains the point of the respective groove adjacent surface 7a and 9a, which is closest to the plane P_1 , i.e. the point which is arranged at a distance t_1 from the plane P_1 . The depth t_4 of each groove 11a, 11b fulfils the relation $1/3t_1 < t_4 < 0.9T$. Thereby, it may be ensured that none of the grooves 7 and 9 are filled up with charges that would allow a streamer to spill over an edge of the groove and propagate outside the stick 3.

[0037] Each of the first groove 11a and the second groove 11b has a respective mouth that opens parallel with the plane P_1 . The mouths of the first groove 11a and the second groove 11b hence face the winding after installation.

[0038] The stick 3 has lateral walls defined by the first lateral portion 7 and the second lateral portion 9, respectively. Each lateral wall hence extends from a respective

groove 11a, 11b. The smallest width w_4 of each lateral wall, i.e. the smallest width of the first lateral portion 7 from the first groove 11a to the associated lateral end face and the smallest width of the second lateral portion 9 from the second groove 11b to the associated lateral end face, fulfils the relation $1/3 < w_4/t_3 < 3$, where t_3 is the distance from the bottom of the groove 7, 9 to the barrier contact surface 13.

[0039] The smallest width w_4 of the lateral walls and the distance t_3 from the bottom of each of the first groove 7 and the second groove 9 to the barrier contact surface 13, i.e. the thickness of the bottom of each groove 7 and 9, is by means of the above-defined relations thick enough that the solid material of which the stick 3 is made is not electrically punctured in the event of a streamer. The necessary thickness may be calculated by the formula

$$\text{Thickness} = U_{\text{design}} / E_{\text{crit-puncture}},$$

[0040] where $E_{\text{crit-puncture}}$ is the critical field for electrical puncturing and U_{design} is the voltage drop, from the winding to the first cylindrical barrier, which the electrical insulation system is designed to withstand. The value of $E_{\text{crit-puncture}}$ may or may not be different in the thickness direction and the width direction, depending on the design of the strip 3.

[0041] The mouth of each groove 11a, 11b, in the width direction, should be dimensioned such that a streamer propagating along the winding facing surface 5a towards a groove propagates into that groove 7 or 9, and that it does not "jump" over the groove such that it can propagate further on a lateral side of the stick. According to one variation, the mouth of each groove 7 and 9 may have a width w_3 that is strictly greater than the second distance t_1 , i.e. $w_3 > t_1$. Furthermore, the width of the each mouth of a groove 7 and 9 may according to one variation additionally fulfil the relation $1/4 w_2 < w_3 < 4 w_2$.

[0042] Fig. 2 depicts a cross-section of an electrical insulation system 1 comprising the stick 3 in Fig. 1 and a spacer 15. It should however be noted that the stick 3 may also be used without a spacer. It may also be noted that in case the electrical insulation system comprises a spacer, it may have a large number of different designs; only one example is shown in Fig. 2.

[0043] The spacer 15 is arranged to provide axial spacing between layers of winding discs. The spacer 15 has a cut-out 17 arranged to receive the elevated central portion 5 of the stick 3, as shown in Fig. 2.

[0044] Turning now to Fig. 3, a cross-section of a portion of a high voltage electromagnetic induction device 18 is shown. It should be noted that the high voltage electromagnetic induction device 18 is not to scale, e.g. the tank walls of the electromagnetic induction device and their distance from the portion of the windings shown in this figure are not to scale, and neither is the curvature

of the windings relative to the size of the sticks.

[0045] The electromagnetic induction device 18 has a tank that is oil-filled, and comprises windings 19 and an electric insulation system 1. The electrical insulation system 1 shown in Fig. 3 comprises a plurality of sticks 3, and a cylindrical barrier 21 against which the barrier contact surfaces of the sticks 3 are arranged. Furthermore, the winding facing surface of each stick 3 is arranged to provide radial support of a portion of the windings 19.

[0046] Fig. 4 shows the electrical insulation system 1 in operation. In particular the streamer trapping functionality of the stick 3 will now be described. The winding facing surface 5a of the stick 3 supports the winding 19. Streamers may be initiated in a region R, in which the winding 19 is in contact with the winding facing surface 5a, where oil wedges are present and where the electrical field is sufficiently high. According to the example shown in Fig. 4, a first streamer S_1 is initiated to the left of the centre line C of the stick 3. The first streamer S_1 propagates to the left and is trapped in the first groove 11a. A second streamer S_2 initiated to the right of the centre line C propagates to the right, and is trapped in the second groove 11b.

[0047] The strip 3 presented herein may for example be manufactured of a cellulose-based or cellulose material, such as pressboard, or a thermoplastic such as Polyetherimide, Polyphenylene Sulphide, Polyetheretherketone, Polyethersulphone, Polysulphone, Polyphtalamide, Polyethylene terephthalate, or polyaramides. The strip 3 presented herein may for example be manufactured of a thermoset material such as epoxy or polyester. Any polymeric material (thermoplastic or thermoset) can be reinforced by fibres or inorganic fillers. Typical examples of fibres are glass fibres or cellulose fibres. Typical examples of inorganic fillers are SiO_2 or Al_2O_3 .

[0048] In general, the stick may have a large number of different cross-sectional shapes. The shape of the cross-section of the stick may thus vary in a number of ways as long as one or more of the relations described above are fulfilled. The stick may for example not have to be symmetric relative to the centre line C, and the shape of the elevated central portion, the lateral portions and the first groove and the second groove may be designed in a number of ways. Furthermore, the grooves can be arranged along the majority of the length of the stick in a continuous manner, or alternatively they can be provided only in regions where the stick is arranged to support a winding.

[0049] It is envisaged that the electrical insulation system presented herein finds applications within AC and HVDC power transmission both onshore and offshore. In particular, the electrical insulation system may be utilised in HVDC or AC electromagnetic induction devices such as power transformers and reactors.

[0050] The inventive concept has mainly been described above with reference to a few examples. 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 inventive concept, as defined by the appended claims.

Claims

1. An electrical insulation system (1) for a high voltage electromagnetic induction device (18), wherein the electrical insulation system (1) comprises:

a stick (3) having an elevated central portion (5) and two lateral portions (7, 9), which elevated central portion (5) is elevated relative to the two lateral portions (7, 9) and arranged between the two lateral portions (7, 9), wherein the elevated central portion (5) defines a winding facing surface (5a) arranged to face a winding (19), wherein the stick (3) has a barrier contact surface (13) opposite to the winding facing surface (5a), wherein a first distance between the winding facing surface (5a) and the barrier contact surface (13) defines the thickness T of the stick (3), wherein the stick (3) has a first groove (11a), arranged between a first lateral portion (7) of the two lateral portions (7, 9) and the elevated central portion (5), and a second groove (11b) arranged between a second lateral portion (9) of the two lateral portions (7, 9) and the elevated central portion (5), which first groove (11a) and second groove (11b) extend axially along the stick (3), wherein each of the first lateral portion (7) and the second lateral portion (9) has a respective groove adjacent surface (7a, 9a) opposite to the barrier contact surface (13), wherein a second distance t1 from each groove adjacent surface (7a, 9a) to a plane (P1) defined by the winding facing surface (5a) fulfils the relation $t1 < 0.6T$, wherein each of the first groove (11a) and the second groove (11b) has a mouth that opens in parallel with the plane (P1).

2. The electrical insulation system (1) as claimed in claim 1, wherein $0.01T < t1$.
3. The electrical insulation system (1) as claimed in claim 1 or 2, wherein the depth t4 of each of the first groove (11a) and the second groove (11b) fulfils the relation $1/3t1 < t4 < 0.9T$.
4. The electrical insulation system (1) as claimed in any of the preceding claim, wherein a smallest width w4 of the first lateral portion (7) from the first groove (11a) to a lateral end face of the first lateral portion (7) fulfils the relation $1/3 < w4/t3 < 3$, where t3 is the distance from the bottom of the first groove (11a) to

the barrier contact surface (13).

5. The electrical insulation system (1) as claimed in any of the preceding claim, wherein a smallest width w4 of the second lateral portion (9) from the second groove (11b) to a lateral end face of the second lateral portion (9) fulfils the relation $1/3 < w4/t3 < 3$, where t3 is the distance from the bottom of the second groove (11b) to the barrier contact surface (13).
6. The electrical insulation system (1) as claimed in any of the preceding claims, wherein the second distance t1 is in the range 0.1 to 3 mm.
7. The electrical insulation system (1) as claimed in any of the preceding claims, wherein the width w2 of the winding facing surface (5a) of the elevated central portion (5) is smaller than the w1 width of the barrier contact surface (13).
8. The electrical insulation system (1) as claimed in any of the preceding claims, wherein a distance w5 from a lateral edge (5b, 5c) of the winding facing surface (5a) to a plane perpendicular (P2, P3) to the plane (P1) defined by the winding facing surface (5a) and aligned with the lateral edge (7b, 9b) of the lateral portion (7, 9) of the two lateral portions (7, 9) closest to the lateral edge (5b, 5c) of the winding facing surface (5a) fulfils the relation $1/8w5 < w2 < 4w5$, where w2 is the width of the winding facing surface (13).
9. The electrical insulation system (1) as claimed in any of the preceding claims, wherein the stick (3) is made of a cellulose-based material.
10. The electrical insulation system (1) as claimed in any of the preceding claims, comprising a spacer (15) having a cut-out (17) arranged to receive the elevated central portion (5).
11. The electrical insulation system (1) as claimed in any of the preceding claims, wherein each of the first groove (11a) and the second groove (11b) has a depth t4, measured from a plane parallel with the plane (P1) and which contains the point of the respective groove adjacent surface (7a) and (9a), which is closest to the plane (P1).
12. A high voltage electromagnetic induction (18) device comprising the electrical insulation system (1) as claimed in any of claims 1-11.
13. The high voltage electromagnetic induction (18) device as claimed in claim 13, wherein the high voltage electromagnetic induction device (18) is a power transformer or a reactor.
14. The high voltage electromagnetic induction device

(18) as claimed in claim 12 or 13, wherein the high voltage electromagnetic induction (18) device is liquid-insulated.

Patentansprüche

1. System (1) zur elektrischen Isolierung für eine elektromagnetische Hochspannungs-Induktionsvorrichtung (18), wobei das System (1) zur elektrischen Isolierung Folgendes umfasst:

einen Stift (3), der einen erhöhten Mittenabschnitt (5) und zwei Seitenabschnitte (7, 9) aufweist, wobei der erhöhte Abschnitt (5) in Bezug auf die zwei Seitenabschnitte (7, 9) erhöht ist und zwischen den zwei Seitenabschnitten (7, 9) angeordnet ist, wobei der erhöhte Mittenabschnitt (5) eine einer Wicklung zugewandte Fläche (5a) definiert, die so angeordnet ist, dass sie einer Wicklung (19) zugewandt ist, wobei der Stift (3) eine Sperrkontaktfläche (13) aufweist, die der einer Wicklung zugewandten Fläche (5a) gegenüberliegt, wobei ein erster Abstand zwischen der einer Wicklung zugewandten Fläche (5a) und der Sperrkontaktfläche (13) die Dicke T des Stiftes (3) definiert, wobei der Stift (3) eine erste Fuge (11a), die zwischen einem ersten Seitenabschnitt (7) der zwei Seitenabschnitte (7, 9) und dem erhöhten Mittenabschnitt (5) angeordnet ist, und eine zweite Fuge (11b), die zwischen einem zweiten Seitenabschnitt (9) der zwei Seitenabschnitte (7, 9) und dem erhöhten Mittenabschnitt (5) angeordnet ist, aufweist, wobei sich die erste Fuge (11a) und die zweite Fuge (11b) entlang des Stiftes (3) axial erstrecken, wobei der erste Seitenabschnitt (7) und der zweite Seitenabschnitt (9) jeweils eine entsprechende, an eine Fuge angrenzende Fläche (7a, 9a) aufweisen, die der Sperrkontaktfläche (13) gegenüberliegt, wobei ein zweiter Abstand t1 von jeder an eine Fuge angrenzenden Fläche (7a, 9a) zu einer Ebene (P1), die durch die einer Wicklung zugewandte Fläche (5a) definiert ist, die Relation $t1 < 0,6 T$ erfüllt, wobei die erste Fuge (11a) und die zweite Fuge (11b) jeweils eine Mündung aufweisen, die sich parallel zu der Ebene (P1) öffnet.

2. System (1) zur elektrischen Isolierung nach Anspruch 1, wobei $0,01 T < t1$.
3. System (1) zur elektrischen Isolierung nach Anspruch 1 oder 2, wobei die Tiefe t4 jeweils der ersten Fuge (11a) und der zweiten Fuge (11b) die Relation $1/3 t1 < t4 < 0,9 T$ erfüllt.

4. System (1) zur elektrischen Isolierung nach einem der vorhergehenden Ansprüche, wobei eine kleinste Breite w4 des ersten Seitenabschnitts (7) von der ersten Fuge (11a) zu einer seitlichen Endfläche des ersten Seitenabschnitts (7) die Relation $1/3 < w4/t3 < 3$ erfüllt, wobei t3 der Abstand vom Boden der ersten Fuge (11a) zur Sperrkontaktfläche (13) ist.
5. System (1) zur elektrischen Isolierung nach einem der vorhergehenden Ansprüche, wobei eine kleinste Breite w4 des zweiten Seitenabschnitts (9) von der zweiten Fuge (11b) zu einer seitlichen Endfläche des zweiten Seitenabschnitts (9) die Relation $1/3 < w4/t3 < 3$ erfüllt, wobei t3 der Abstand vom Boden der zweiten Fuge (11b) zur Sperrkontaktfläche (13) ist.
6. System (1) zur elektrischen Isolierung nach einem der vorhergehenden Ansprüche, wobei der zweite Abstand t1 im Bereich von 0,1 bis 3 mm liegt.
7. System (1) zur elektrischen Isolierung nach einem der vorhergehenden Ansprüche, wobei die Breite w2 der einer Wicklung zugewandten Fläche (5a) des erhöhten Mittenabschnitts (5) kleiner als die Breite w1 der Sperrkontaktfläche (13) ist.
8. System (1) zur elektrischen Isolierung nach einem der vorhergehenden Ansprüche, wobei ein Abstand w5 von einer Seitenkante (5b, 5c) der einer Wicklung zugewandten Fläche (5a) zu einer Ebene (P2, P3), die zu der Ebene (P1), die durch die einer Wicklung zugewandte Fläche (5a) definiert ist, senkrecht ist und auf die Seitenkante (7b, 9b) des Seitenabschnitts (7, 9) der zwei Seitenabschnitte (7, 9), der am nächsten an der Seitenkante (5b, 5c) der einer Wicklung zugewandten Fläche (5a) liegt, ausgerichtet ist, die Relation $1/8 w5 < w2 < 4 w5$ erfüllt, wobei w2 die Breite der einer Wicklung zugewandten Fläche (13) ist.
9. System (1) zur elektrischen Isolierung nach einem der vorhergehenden Ansprüche, wobei der Stift (3) aus einem Material auf Zellulosebasis hergestellt ist.
10. System (1) zur elektrischen Isolierung nach einem der vorhergehenden Ansprüche, das ein Distanzstück (15) mit einem Ausschnitt (17), der ausgelegt ist, den erhöhten Mittenabschnitt (5) aufzunehmen, umfasst.
11. System (1) zur elektrischen Isolierung nach einem der vorhergehenden Ansprüche, wobei die erste Fuge (11a) und die zweite Fuge (11b) jeweils eine Tiefe t4 aufweisen, die von einer Ebene, die zu der Ebene (P1) parallel ist und die den Punkt der jeweiligen, an eine Fuge angrenzenden Fläche (7a) und (9a) enthält, der am nächsten an der Ebene (P1) liegt, gemessen wird.

12. Elektromagnetische Hochspannungs-Induktionsvorrichtung (18), die das System (1) zur elektrischen Isolierung nach einem der Ansprüche 1-11 umfasst.
13. Elektromagnetische Hochspannungs-Induktionsvorrichtung (18) nach Anspruch 13, wobei die elektromagnetische Hochspannungs-Induktionsvorrichtung (18) ein Leistungstransformator oder ein Reaktor ist.
14. Elektromagnetische Hochspannungs-Induktionsvorrichtung (18) nach Anspruch 12 oder 13, wobei die elektromagnetische Hochspannungs-Induktionsvorrichtung (18) flüssigkeitsisoliert ist.

Revendications

1. Système d'isolation électrique (1) pour un dispositif à induction électromagnétique haute tension (18), le système d'isolation électrique (1) comprenant :

une baguette (3) pourvue d'une portion centrale surélevée (5) et des deux portions latérales (7, 9), laquelle portion centrale surélevée (5) étant surélevée par rapport aux deux portions latérales (7, 9) et agencée entre les deux portions latérales (7, 9),

la portion centrale surélevée (5) définissant une surface (5a) en regard d'un enroulement agencée de manière à être en regard d'un enroulement (19),

la baguette (3) étant pourvue d'une surface (13) de contact avec une barrière opposée à la surface (5a) en regard d'un enroulement, une première distance entre la surface (5a) en regard d'un enroulement et la surface (13) de contact avec une barrière définissant l'épaisseur T de la baguette (3),

la baguette (3) étant pourvue d'une première rainure (11a), agencée entre une première portion latérale (7) parmi les deux portions latérales (7, 9) et la portion centrale surélevée (5), et d'une deuxième rainure (11b) agencée entre une deuxième portion latérale (9) parmi les deux portions latérales (7, 9) et la portion centrale surélevée (5), lesquelles première rainure (11a) et deuxième rainure (11b) s'étendent axialement le long de la baguette (3),

chacune de la première portion latérale (7) et de la deuxième portion latérale (9) étant pourvue d'une surface respective (7a, 9a) adjacente à une rainure opposée à la surface (13) de contact avec une barrière, une deuxième distance t1 entre chaque surface (7a, 9a) adjacente à une rainure et un plan (P1) défini par la surface (5a) en regard d'un enroulement vérifiant la relation $t1 < 0,6T$,

chacune de la première rainure (11a) et de la deuxième rainure (11b) étant pourvue d'une embouchure qui débouche parallèlement avec le plan (P1).

2. Système d'isolation électrique (1) selon la revendication 1, dans lequel $0,01T < t1$.

3. Système d'isolation électrique (1) selon la revendication 1 ou 2, dans lequel la profondeur t4 de chacune de la première rainure (11a) et de la deuxième rainure (11b) vérifie la relation $1/3t1 < t4 < 0,9T$.

4. Système d'isolation électrique (1) selon l'une quelconque des revendications précédentes, dans lequel une plus petite largeur w4 de la première portion latérale (7) entre la première rainure (11a) et une face d'extrémité latérale de la première portion latérale (7) vérifie la relation $1/3 < w4/t3 < 3$, t3 représentant la distance entre le fond de la première rainure (11a) et la surface (13) de contact avec une barrière.

5. Système d'isolation électrique (1) selon l'une quelconque des revendications précédentes, dans lequel une plus petite largeur w4 de la deuxième portion latérale (9) entre la deuxième rainure (11b) et une face d'extrémité latérale de la deuxième portion latérale (9) vérifie la relation $1/3 < w4/t3 < 3$, t3 représentant la distance entre le fond de la deuxième rainure (11b) et la surface (13) de contact avec une barrière.

6. Système d'isolation électrique (1) selon l'une quelconque des revendications précédentes, dans lequel la deuxième distance t1 s'inscrit dans l'intervalle de 0,1 à 3 mm.

7. Système d'isolation électrique (1) selon l'une quelconque des revendications précédentes, dans lequel la largeur w2 de la surface (5a) en regard d'un enroulement de la portion centrale surélevée (5) est plus petite que la largeur w1 de la surface (13) au contact d'une barrière.

8. Système d'isolation électrique (1) selon l'une quelconque des revendications précédentes, dans lequel une distance w5 entre un bord latéral (5b, 5c) de la surface (5a) en regard d'un enroulement et un plan (P2, P3) perpendiculaire au plan (P1) défini par la surface (5a) en regard d'un enroulement et aligné avec le bord latéral (7b, 9b) de la portion latérale (7, 9) parmi les deux portions latérales (7, 9) le plus proche du bord latéral (5b, 5c) de la surface (5a) en regard d'un enroulement vérifie la relation $1/8w5 < w2 < 4w5$, w2 représentant la largeur de la surface (13) en regard d'un enroulement.

9. Système d'isolation électrique (1) selon l'une quel-

conque des revendications précédentes, dans lequel la baguette (3) est constituée d'un matériau à base de cellulose.

10. Système d'isolation électrique (1) selon l'une quelconque des revendications précédentes, comprenant une entretoise (15) pourvue d'une découpe (17) agencée de manière à recevoir la portion centrale surélevée (5). 5
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11. Système d'isolation électrique (1) selon l'une quelconque des revendications précédentes, dans lequel chacune de la première rainure (11a) et de la deuxième rainure (11b) possède une profondeur t4, mesurée à partir d'un plan parallèle au plan (P1) et contenant le point de la surface respective (7a) et (9a) adjacente à une rainure le plus proche du plan (P1). 15
12. Dispositif à induction électromagnétique haute tension (18) comprenant le système d'isolation électrique (1) selon l'une quelconque des revendications 1 à 11. 20
13. Dispositif à induction électromagnétique haute tension (18) selon la revendication 13, lequel dispositif à induction électromagnétique haute tension (18) consiste en un transformateur de puissance ou une bobine d'inductance. 25
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14. Dispositif à induction électromagnétique haute tension (18) selon la revendication 12 ou 13, lequel dispositif à induction électromagnétique haute tension (18) est à isolation liquide. 35

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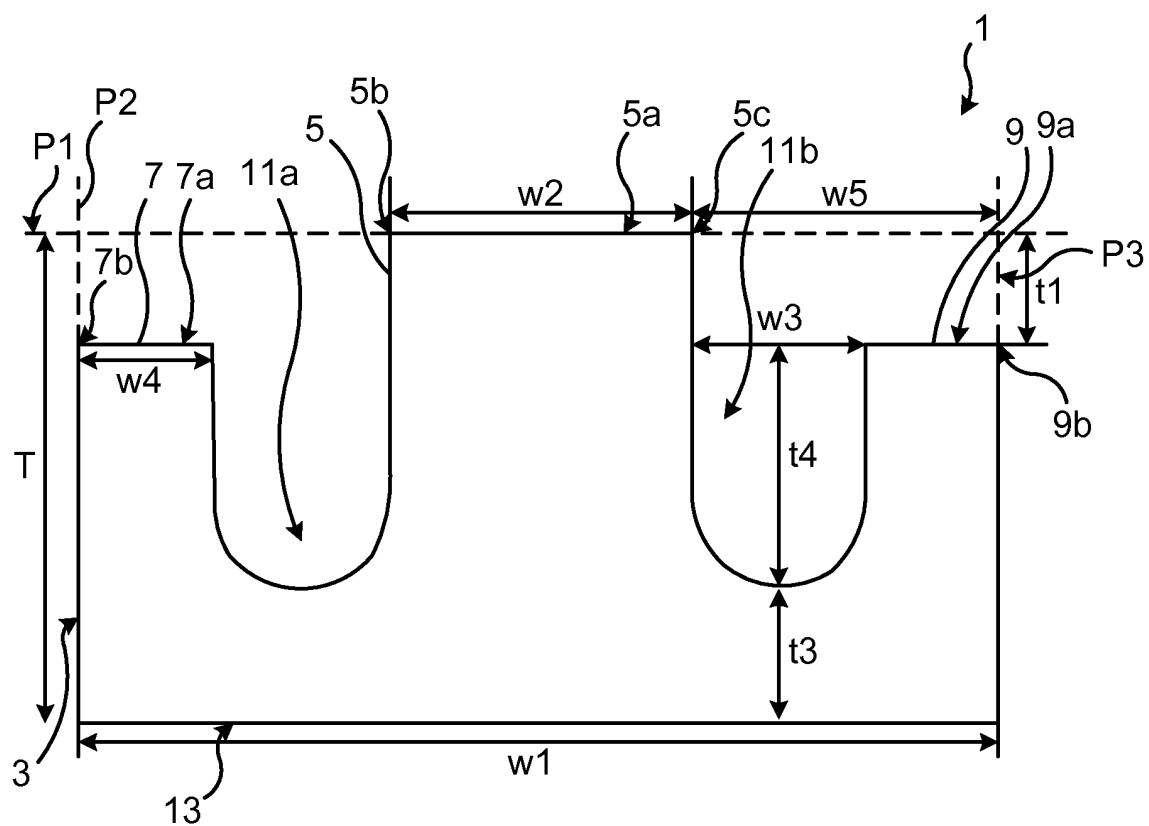


Fig. 1

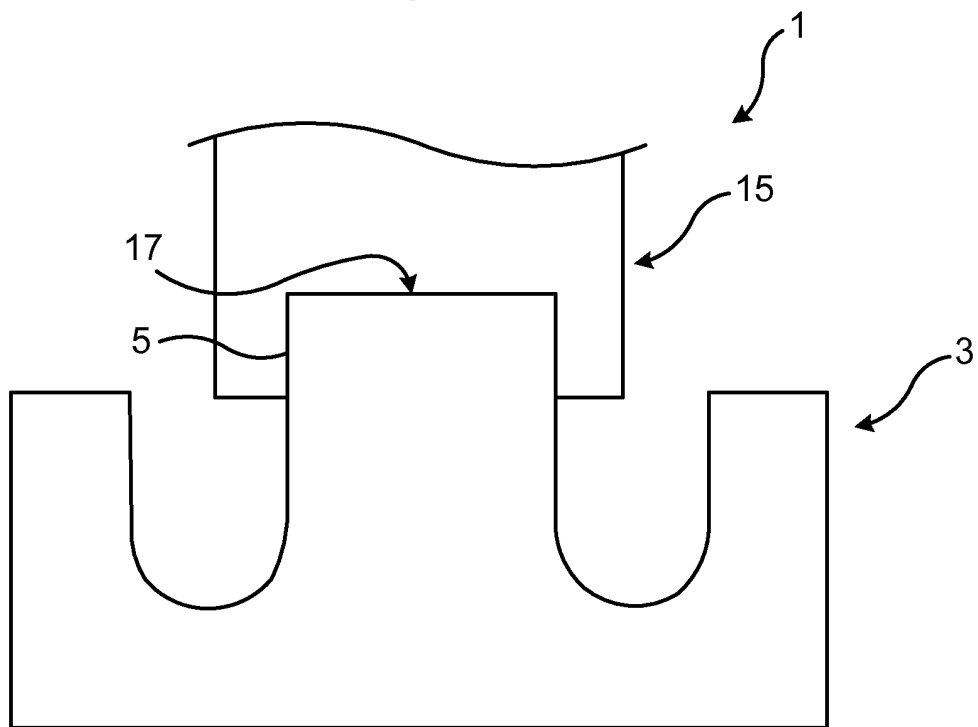


Fig. 2

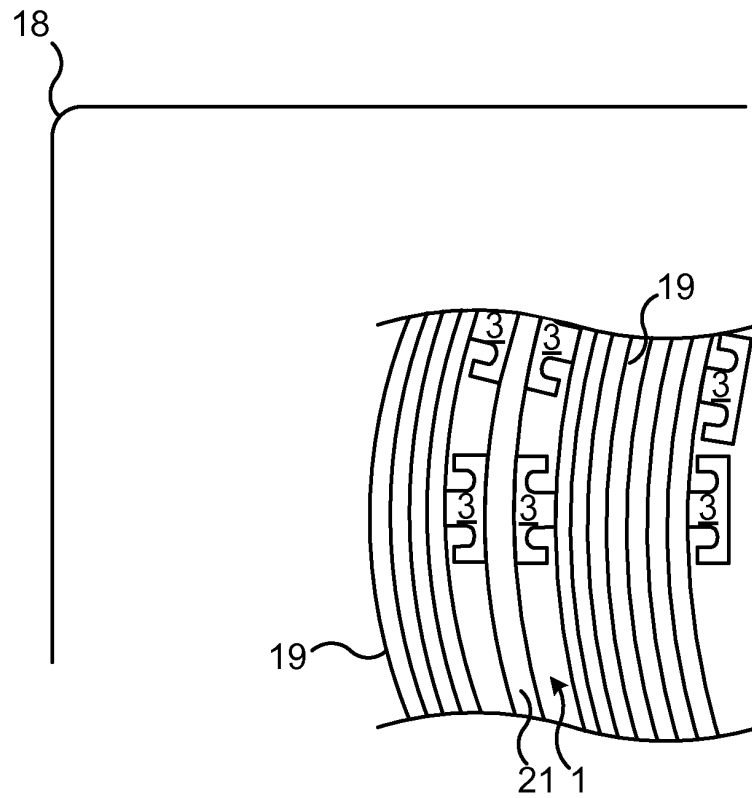


Fig. 3

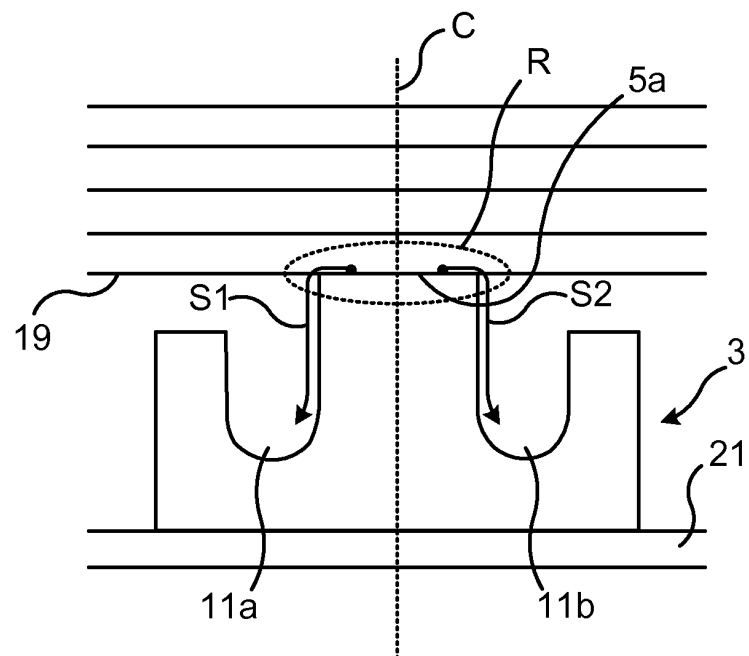


Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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