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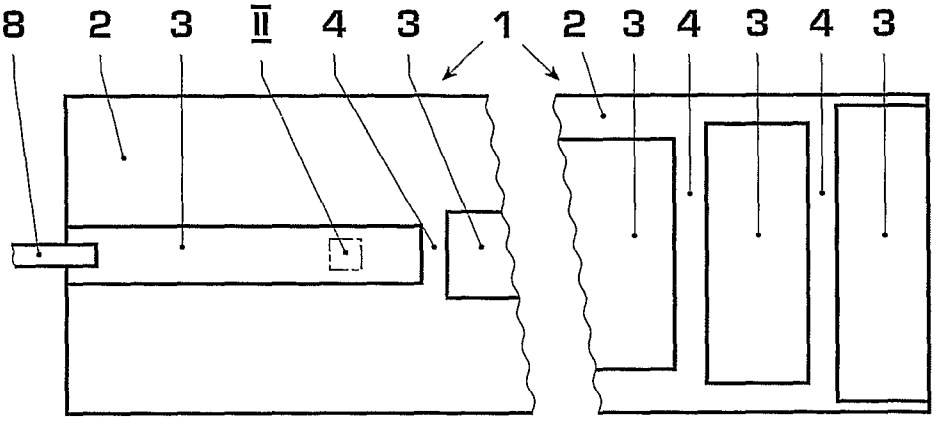
(54) **Title:** AN ELECTRODES ARRANGEMENT BUSHING AND A METHOD OF USING A BUSHING



(57) **Abstract:** A bushing comprises an electrode configuration with a film (1), which film (1) comprises a base (2) consisting of an electrically insulating polymer which carries on one- or both surfaces a sequence of electrically conductively coated areas (3) which are separated by non-coated interstices (4). The film or a superposition of films arranged one above the other is wound to form an electrode configuration with a plurality of essentially parallel electrodes which are insulated from each other and consist each of one or more electrode layers formed by the coated areas (3) and separated by insulating layers formed by sections of the base (2). An electrode layer may comprise two adjacent coated areas pertaining to subsequent turns. The electrode configuration can be used to subdivide a potential difference, e.g., in a bushing, into a series of smaller potential differences between subsequent electrodes, with the smaller potential differences preferably smaller than the minimum of the Paschen curve.

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DESCRIPTION

AN ELECTRODES ARRANGEMENT BUSHING AND A METHOD OF USING A BUSHING

Field of the invention

The invention concerns a bushing according to the generic part of claim 1. Bushings of this type are typically employed in MV and HV electrical installations. The invention also concerns a method of using a bushing according to the invention.

Prior art

Films of the generic type with a polymer base and at least one longitudinally contiguous strip of electrically conductive coating, in particular, metal, are well known, see, e.g., EP 1 329 915 A1. According to this document, two such films are wound into a coil together to form a capacitor.

Similar capacitive devices where two or three such films are arranged one immediately above the other and wound together are known from EP 1 341 195 A1. Part of the electrically conductive coatings serve as electrically unconnected floating electrodes which subdivide the potential drop between two electrodes connected to opposite leads. Subsequent electrodes are always separated by an electrically insulating base. At least part of the coatings form tracks arranged side by side on the base of the respective film. However, the tracks are always contiguous tracks, i.e. uninterrupted in the longitudinal winding direction. Also, two of the tracks in question each extend

to one of the lateral edges of the film so they can be contacted there.

Films of the types described above are not suitable as components of electrode configurations for the control of electric fields.

It is also well known in the art to use electrode configurations, in particular in bushings, comprising a series of essentially parallel electrodes which are electrically insulated from each other, for the control, in particular, the equalization, of electric fields. Large local field strength maxima which might give rise to disruptive discharges are thereby prevented. Known electrode configurations comprise a winding of paper impregnated with resin, oil or other dielectric substances and layers of metal foil or, alternatively, layers of electrically conductive ink or graphite paste applied to the paper which are each of them placed between subsequent turns of the winding.

Electrode configurations of this type are relatively difficult and costly to produce in the required high quality.

Summary of the invention

It is an object of the invention to provide a bushing with an electrode configuration of the generic type by which an electric field between electrically conductive components - conductors, grounded housing parts and the like - which during operation assume different potentials can be controlled with great precision and, in particular, the often large potential differences between the components

subdivided in a controlled manner into a relatively large number of small potential differences between mutually electrically insulated electrodes.

It is a further object of the invention to provide a bushing with an electrode configuration which comprises a film according to the invention or of several such films. Electrode configurations of high quality and reliability can be produced from such films in relatively simple and cost-saving ways. In particular, time-consuming drying and impregnation and in some cases curing steps as required for the production of known generic electrode configurations can usually be avoided.

A further advantage of bushing according to the invention is the fact that the electrically conductive coating tends to evaporate around the location of a partial breakdown, that is, the electrode configuration of the bushing is self-healing.

In a bushing with an electrode configuration as proposed the configuration essentially fills a gap between a conductor rod or tube and a surrounding wall part, e.g., a grounded metal frame surrounding an opening through which the conductor is led into a housing, e.g., of a transformer or switch gear, or into a building.

It is particularly advantageous that, due to the fact that the base of a film according to the invention can be made very thin and therefore a large number of electrodes can be provided in a gap of a given width, bushings of the inventive type can in most cases be used in such a way that the potential differences between subsequent electrodes are fairly small, in particular, smaller than the minimum

voltage of the Paschen curve. In this case, no partial discharges will occur even where the electrode configuration contains voids or gas inclusions.

Brief description of the drawings

In the following, the invention will be explained in more detail with reference to the following figures which show only embodiments.

Fig. 1 schematically shows a partial top view of a polymer film according to the invention,

Fig. 2 shows enlarged a cutout from Fig. 1 as indicated by II,

Fig. 3 shows an axial section through a bushing according to the invention,

Fig. 4 shows an axial view of the bushing of Fig. 3,

Fig. 5a schematically shows a partial longitudinal section of a film according to a first embodiment of the invention,

Fig. 5b schematically shows a cutout from a section of an electrode configuration wound from the film according to Fig. 5a,

Fig. 5c schematically shows a cutout from a section of a another capacitor wound from the film according to Fig. 5a,

Fig. 6a schematically shows a partial longitudinal section of a film according to a second embodiment of the invention,

Fig. 6b schematically shows a cutout from a section of an electrode configuration wound from the film according to Fig. 6a,

Fig. 7a schematically shows a partial longitudinal section of a superposition of two films, each according to the second embodiment of the invention, and

Fig. 7b schematically shows a cutout from a section of an electrode configuration wound from the superposition of films according to Fig. 7a.

Description of the preferred embodiments

A film 1 which may be used for producing a bushing as shown in Figs. 3, 4 comprises (Fig. 1) a base 2 comprising an electrically insulating polymer material, with a surface which is partially covered by a coating of electrically conductive material. The film 1 is wound in longitudinal direction of the film 1. The longitudinal direction of the film 1 is that direction, in which the curvatures induced by winding occur consecutively. The film 1 forms a long strip of usually but not necessarily constant width. Its thickness is preferably between 2 µm and 20 µm. The material of the base 2 is, e.g., polyethylene, polystyrole, polypropylene, polycarbonate, polyimide, polyethyleneterephtalate (PET), polyethylenenaphtalate (PEN), polyester, epoxy resin, polysulfone or a mixture of such polymers possibly also containing additives and suitable for forming a thin film with high dielectric strength. The coating is in the form of

a single sequence of at least four, but usually a much higher number of rectangular coated areas 3 which follow one upon the other in a longitudinal direction. The lateral boundaries of the said coated areas 3 are spaced from the lateral edges of the film 1, i.e. the margins of the base 2 so the latter exhibits non-coated strips adjacent to its margins which extend with varying width but uninterruptedly over the whole length of the film 1. Subsequent coated areas 3 are in each case separated by a transverse interstice 4 or gap in the coating. As a consequence, the said areas 3 are electrically insulated from each other.

The coating comprises preferably metal, and is in particular a metallization applied by vapour deposition, but use of composition of materials or other electrically conductive materials beside metals, e.g., carbon or a semiconducting material, is also possible. The electrically conductive coating can be patterned as known per se (s. EP 0 225 822 A1), that is, it comprises e.g., quadratic, patches 5, 5′ (s. Fig. 2 which shows an enlarged cutout II from Fig. 1) with adjacent patches 5, 5′ separated by uncoated strips 6 and only connected by thin bridges 7 of coating at the corners. If a partial breakdown occurs at one of the patches, e.g., patch 5′, the surrounding bridges 7 evaporate, thereby interrupting the electrically conductive connections of the patch 5′ in question with its neighbours. Alternatively, a graded or uniform conductive coating can be used. The electrical conductivity of the coating may be relatively low as larger currents will normally be perpendicular, that is, its surface resistivity will usually be at least $1\Omega_{\square}$ (Ohm-square).

As shown in Fig. 5c, in another preferred embodiment the film (1; 1a; 1b) is wound such that subsequent film layers

of the at least one film (1; 1a; 1b) are arranged one on top of the other, and in that at least one sector exists, which extends through all film layers and over the whole width of the film (1; 1a; 1b) and which sector contains only non-coated interstices (4; 4a, 4a'; 4b, 4b'). With such an arrangement a compact bushing with small diameter of the wound film layers can be manufactured. The longitudinal extension of the conductively coated areas (3, 3'; 3a, 3a'; 3b, 3b') and/or the longitudinal extension of the non-coated interstices (4; 4a, 4a'; 4b, 4b') may vary.

The variation can be done in such a way that the longitudinal extension of consecutive non-coated interstices (4; 4a, 4a'; 4b, 4b') increases in the longitudinal winding direction such that the sector has a cone-like shape. In an alternative, the variation is done in such a way that the longitudinal extension of the non-coated interstices (4; 4a, 4a'; 4b, 4b') is constant and in that the longitudinal extension of conductively coated areas (3, 3'; 3a, 3a'; 3b, 3b') increases such that the sector has a rectangular shape (Fig. 5c).

The film can be wound in such a way that at least two film layers of the wound film have a contiguous conductively coated area extending in longitudinal direction of the at least two film layers without any separation of the coated area by non coated-interstices (4, 4a, 4a', 4b, 4b') within these at least two layers.

The leftmost of the areas 3 in Fig. 1 which is electrically conductively connected to a lead 8 is relatively narrow and long. The lateral extension of the coated areas 3 increases from left to right whereas their longitudinal extension decreases. While the increase in width is by a fixed amount

from one coated area 3 to the next, the length decreases as outlined above.

The film 1 is wound - with its partially conductively coated surface facing inside - into a coil-shaped electrode configuration 9 which is used in a bushing as shown in Figs. 3, 4. The electrode configuration 9 surrounds a conductor rod 10 with a rightmost coated area 3 of the film 1 in direct contact with the same, preferably wrapped around it, whereas the lead 8 surrounds the electrode configuration 9 and is in direct mechanical and electrically conductive contact with a grounded metal plate 11 which may be part of a housing and which forms a frame surrounding an opening through which the conductor rod 10 is led through the plate 11. The electrode configuration 9 substantially fills the gap between the conductor rod 10 and the frame. Alternatively, it is possible to have the partially conductively coated surface facing outside, if an appropriate electrical connection to the innermost of the conductively coated areas 3 via lead 9 is established. In that case, the outermost of the conductively coated areas 3, which is electrically contacted via the lead 8 is preferably surrounded by at least one film layer, which is electrically insulating, i.e. which is non-coated. The electrode configuration 9 may comprise a sector containing only non-coated interstices as described above. In another embodiment of the inventive bushing the electrodes are formed by at least two subsequent film layers arranged one on top of the other.

Alternatively, lead 8 is omitted with the outermost electrode of the electrode configuration being merely capacitively coupled to the housing via the frame which may be in the shape of a ring surrounding the electrode

configuration and acting as a grounded electrode. The electrode configuration can be encapsulated in a casing of electrically insulating material for mechanical stabilization and protection.

In another preferred embodiment, with the lengths of the areas 3 following the rule indicated above, every one of them extends over a certain constant angle, in particular, over slightly more than two turns of the electrode configuration 9, forming an electrode comprising two essentially parallel electrode layers. Subsequent interstices 4 are slightly staggered (see Figs. 5a, 5b). As a consequence, radial components of the electric field are small in the neighbourhood of the interstices 4. Also, throughout every second winding of the film 1 both surfaces of the base 2 are adjacent to electrode layers pertaining to the same electrode as formed by one of the coated areas 3. Therefore the base 2 is not subjected to a strong and permanent electric field which is a further obstacle to an extension of any partial breakdown.

The width of the interstices 4 will have to be chosen large enough to prevent surface flashovers at the expected voltages. The interstices may, however, be much wider than this requirement necessitates and can extend over a complete turn of the winding or more. The risk of flashovers at the margins is generally quite small, the coated areas 3 being spaced from the lateral edges of the film 1. It is, however, possible to seal the winding there by welding or by covering it with resin or some other suitable material in order to protect the winding against humidity.

The width of the electrodes formed by the coated areas 3 decreases linearly as a function of their distance from the

conductor rod 10 as indicated by dashed lines in Fig. 3. As the electrodes are electrically insulated from each other they are on usually different floating potentials. It is advantageous that the distances between subsequent electrodes are such that, with the expected maximum overall potential difference between the conductor and ground, the potential difference between the said electrodes is always below the minimum of the Paschen curve as partial breakdowns of an insulating layer between two subsequent electrodes cannot occur in this case.

According to another embodiment (Fig. 6a, 6b) of a bushing with a film according to the invention both surfaces of the film 1 are each partially covered with an electrically conductive coating in the manner explained above. The film 1 is used to form an electrode configuration 9 like the one used in the bushing of Figs. 3, 4. The coated areas 3, 3′ extend over slightly more than one turn of the winding which forms the electrode configuration 9. So, apart from a small overlap, every electrode consists of only one electrode layer. The interstices 4, 4′ are staggered by the same amount and the coated area 3 and interstice 4 of the upper surface of a turn is congruent with the coated area 3′ and the interstice 4′ of the lower surface of a subsequent turn. Here, each electrode layer comprises two coated areas 3, 3′ which are arranged one on top of the other. They are substantially congruent and virtually everywhere in mechanical and electrically conductive contact. As a consequence, eventual air inclusions between subsequent turns of the film 1 do not entail any risk of partial discharges as such inclusions are not exposed to a substantial electric field.

According to Figs. 7a, 7b two films 1a, 1b, each conforming to the embodiment described above for Fig. 6a, 6b, are arranged one on top of the other with bases 2a, 2b carrying congruent coated areas 3a', 3b and interstices 4a', 4b to form a superposition which again is wound into an electrode configuration 9 like the one apparent in Figs. 3, 4. In a manner similar to the second embodiment, the coated areas 3a and interstices 4a on a first partially conductively coated surface on the upper side of the superposition, i.e., on the first such surface of the upper film 1a, of a turn are congruent with the coated areas 3b' and the interstices 4b', respectively, on a second partially conductively coated surface on the lower side of the superposition, i.e., on the second such surface of the lower film 1b, of the subsequent turn in each case.

There are, of course, many possibilities of forming electrode configurations in the form of a winding within the scope of the invention. E.g., several films, comprising at least one film according to the invention and not excluding films without electrically conductive coating, may be arranged one on top of the other to form a superposition and the superposition wound into an electrode configuration according to the invention. Apart from windings, it is possible to superpose subsequent sections of a film according to the invention or of a superposition of films comprising at least one film according to the invention into an inventive electrode configuration in some other way, e.g., by zigzag-folding of the film or superposition.

In some cases it may be advisable to use patches of metal foil for those electrodes which are electrically conductively connected to conductive components as they may

have to carry considerable currents unless the electrode is directly applied to the conductive component.

The electrode configurations are preferably dry, that is, they do not contain impregnation fluids applied to the film during the manufacturing of the electrode configuration and having penetrated its base. Of course, the dimensions, shapes and arrangement of the coated areas and their electrical properties as well as the dimensions and properties of the base may vary widely depending on the specific purposes of the electrode configuration for the production of which the film is to be used.

List of reference symbols

1, 1a, 1b	film
2, 2a, 1b	base
3, 3′, 3a, 3a′, 3b, 3b′	coated area
4, 4′, 4a, 4a′, 4b, 4b′	interstice
5, 5′	patch
6	uncoated strip
7	bridge
8	lead
9	electrode configuration
10	conductor rod
11	metal plate .

PATENT CLAIMS

1. A bushing with a conductor and a frame surrounding the conductor, the bushing comprising an electrode configuration (9) for controlling electric field distributions,
which electrode configuration (9) comprises at least one film (1; 1a; 1b) with a base (2; 2a; 2b),
which base (2; 2a; 2b) comprises an electrically insulating polymer, and a partial coating of electrically conductive material, the partial coating being arranged on a first surface of the base (2; 2a; 2b), and the film being wound in longitudinal direction, characterized in that
the coating forms on the first surface at least one sequence of conductively coated areas (3, 3'; 3a, 3a'; 3b, 3b'), each of them spaced from lateral edges of the base (2; 2a; 2b), the conductively coated areas (3, 3'; 3a, 3a'; 3b, 3b') following upon each other in longitudinal direction of the film (1; 1a; 1b) separated by non-coated interstices (4; 4a, 4a'; 4b), 4b') and subsequent film layers of at least one wound film (1; 1a; 1b) are arranged one on top of the other by subsequent turns of the film (1; 1a; 1b), with the conductively coated areas (3, 3'; 3a, 3a'; 3b, 3b') forming parallel electrode layers separated by the non-coated interstices (4; 4a, 4a'; 4b), and with the electrode layers forming a plurality of electrodes which are electrically insulated from each other, and in that the electrode configuration (9) fills a gap between the conductor and the frame.

2. A bushing according to claim 1, characterized in that an innermost electrode of the electrode configuration (9) is electrically conductively connected to the conductor and an outermost electrode of the electrode configuration (9) is electrically conductively connected to the frame.

3. A bushing according to claim 1 or 2, characterized in that the base (2; 2a; 2b) comprises at least one of the following materials: polyethylene, polystyrole, polypropylene, polycarbonate, polyimide, polyethyleneterephtalate, polyethylenenaphtalate, polyester, epoxy resin, polysulfone.

4. A bushing according to any of the claims 1 to 3, characterized in that the partial coating is a metallization, carbon or a semiconducting material.

5. A bushing according to any of the claims 1 to 4, characterized in that the partial coating has non-uniform conductivity, in particular, is patterned or graded.

6. A bushing according to any of the claims 1 to 5, characterized in that the film (1; 1a; 1b) has a thickness between 2 µm and 20 µm.

7. A bushing according to any of the claims 1 to 6, characterized in that the extension of the conductively coated areas (3, 3'; 3a, 3a'; 3b, 3b') perpendicular to the longitudinal direction of the film (1; 1a; 1b) is constant.

8. A bushing according to any of the claims 1 to 7, characterized in that at least one sector exists, which extends through all film layers and over the whole width of the film (1; 1a; 1b) and which sector contains only non-coated interstices (4; 4a, 4a'; 4b, 4b').

9. A bushing according to claim 8, characterized in that the longitudinal extension of the conductively coated areas (3, 3'; 3a, 3a'; 3b, 3b') and/or the longitudinal extension of the non-coated interstices (4; 4a, 4a'; 4b, 4b') varies.

10. A bushing according to claim 8 or 9, characterized in that the longitudinal extension of the non-coated interstices (4; 4a, 4a'; 4b, 4b') is constant.

11. A bushing according to claim 9, characterized in that the longitudinal extension of consecutive non-coated interstices (4; 4a, 4a'; 4b, 4b') increases such that the sector has a cone-like shape.

12. A bushing according to claim 9 or 10, characterized in that the longitudinal extension of conductively coated areas (3, 3'; 3a, 3a'; 3b, 3b') increases, in particular such that the sector has a rectangular shape.

13. A bushing according to any of the claims 1 to 12, characterized in that the base (2; 2a; 2b) has a second surface opposite the first surface,
in that a partial coating of electrically conductive material is arranged on the second surface of the base (2; 2a; 2b),
in that the coating forms on the second surface at

least one sequence of conductively coated areas (3, 3'; 3a, 3a'; 3b, 3b'), each of them spaced from lateral edges of the base (2; 2a; 2b), the conductively coated areas (3, 3'; 3a, 3a'; 3b, 3b') following upon each other in longitudinal direction of the base (2; 2a; 2b) separated by non-coated interstices (4; 4a, 4a'; 4b, 4b').

14. A bushing according to any of the claims 1 to 13, characterized in that at least one electrode layer is made up of two conductively coated areas (3', 3; 3a', 3b; 3b', 3a) arranged one immediately on top of the other such that the two conductively coated areas (3', 3; 3a', 3b; 3b', 3a) are in electrically conductive contact.

15. A bushing according to claim 14, characterized in that two conductively coated areas (3', 3; 3a', 3b; 3b', 3a) making up an electrode layer are in each case congruent.

16. A bushing according to any of the claims 1 to 15, characterized in that the electrodes are formed by at least two subsequent film layers arranged one on top of the other.

17. A bushing according to any of the claims 14 to 16, characterized in that the bushing comprises two films (1a, 1b), each with at least one partial coating of electrically conductive material, the two said films (1a, 1b) being arranged one on top of the other, with partial coatings facing each other.

18. A bushing according to any of the claims 14 to 17, characterized in that the at least one film (1; 1a, 1b) has a second surface opposite the first surface, in that a partial coating of electrically conductive material is arranged on the second surface of the base (2; 2a; 2b), in that the coating forms on the second surface at least one sequence of conductively coated areas (3, 3'; 3a, 3a'; 3b, 3b'), each of them spaced from lateral edges of the base (2; 2a; 2b), the conductively coated areas (3, 3'; 3a, 3a'; 3b, 3b') following upon each other in longitudinal direction of the base (2; 2a; 2b) separated by non-coated interstices (4; 4a, 4a'; 4b, 4b') and in that the coating on the first surface and the coating on the second surface of a film layer are in direct contact with one of the coating on the first surface and the coating on the second surface of a previous or a subsequent film layer, respectively.

19. A bushing according to any of the preceding claims, characterized in that the bushing comprises at least one electrode with a sequence of several, in particular two, electrode layers arranged one on top of the other and separated in each case by non-coated interstices (4; 4a, 4a'; 4b, 4b').

20. A bushing according to claim 19, characterized in that the said electrode comprises at least one continuous conductively coated area (3, 3'; 3a, 3a'; 3b, 3b') extending over its whole length.

21. A bushing according to any of the preceding claims, characterized in that the bushing is a dry bushing.

22. A bushing according to any of the preceding claims, characterized in that the bushing comprises a winding of the at least one film (1; 1a, 1b), with the subsequent film layers arranged one on top of the other being formed by subsequent turns of the winding.

23. A method of using a bushing according to any of the preceding claims, characterized in that the potential difference between consecutive electrodes of the electrode configuration (9) is below the minimum of the Paschen curve.

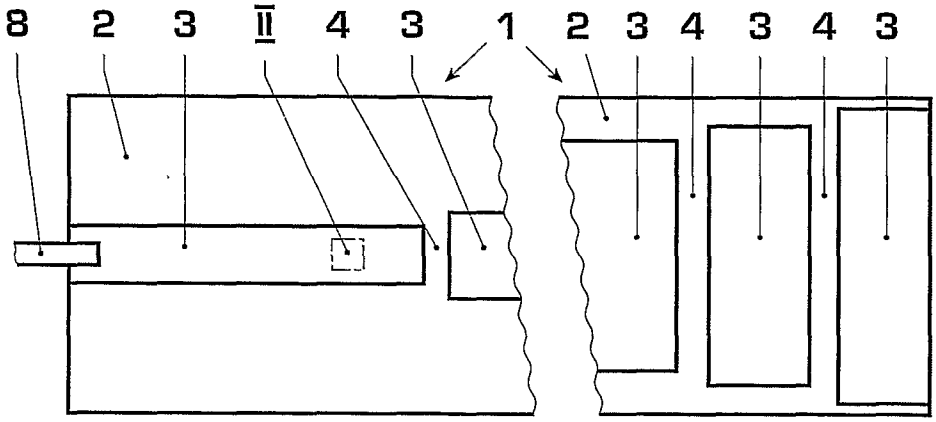

Fig. 1

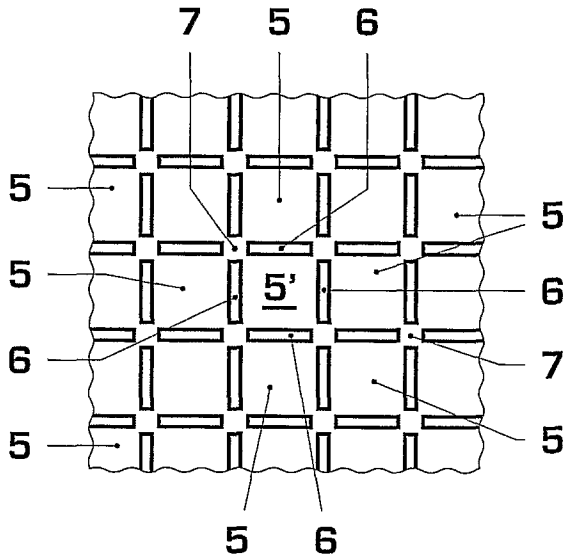

Fig. 2

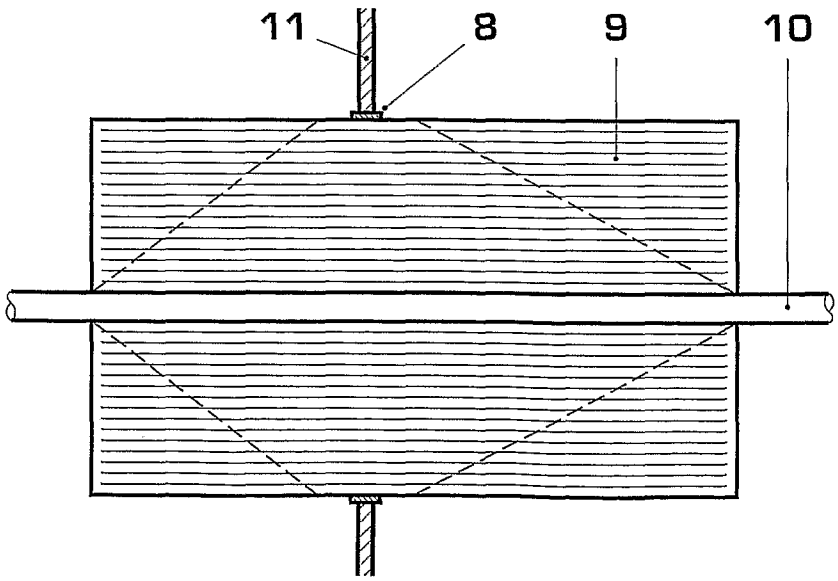

Fig. 3

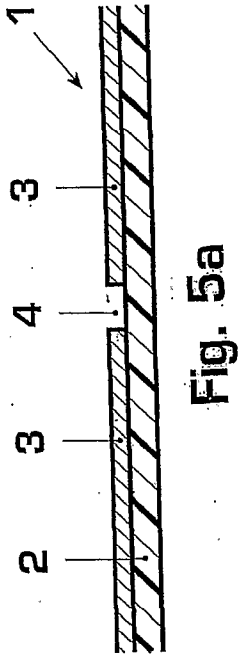

Fig. 5a

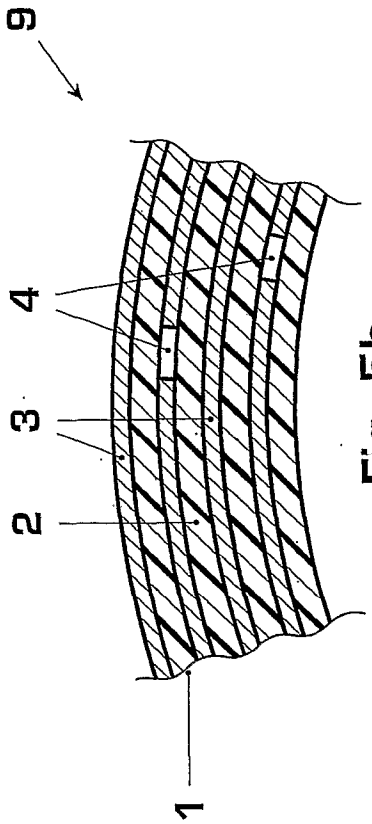

Fig. 5b

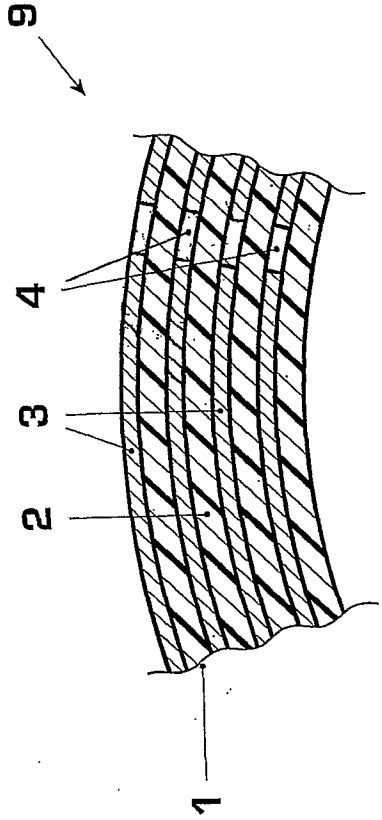

Fig. 5c

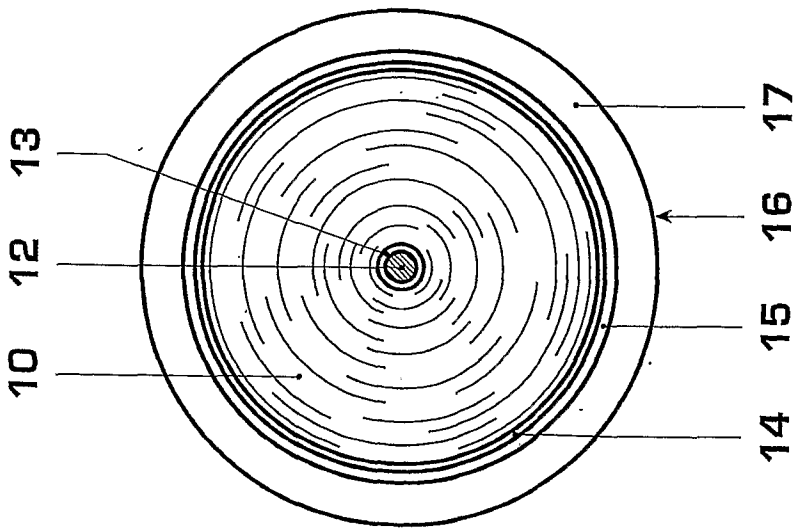

Fig. 4

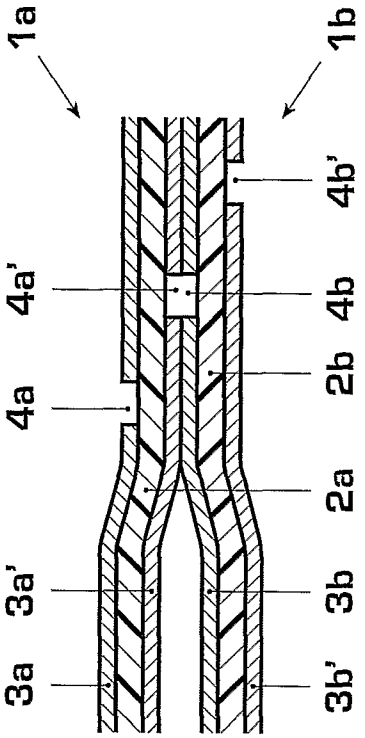

Fig. 7a

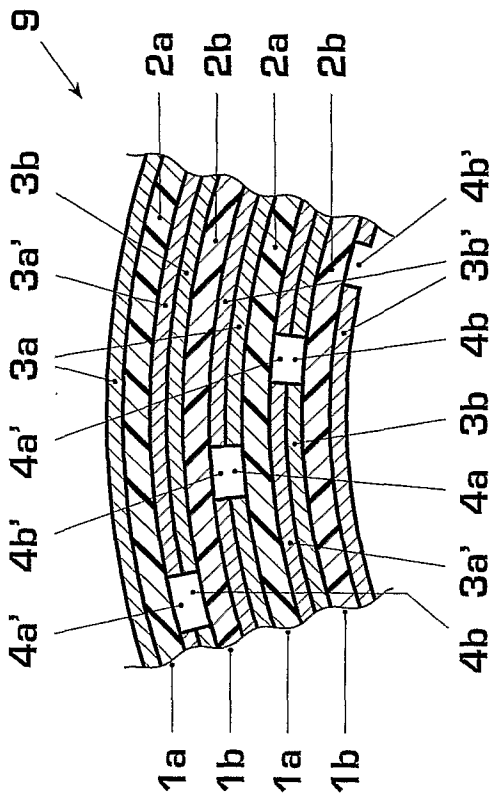

Fig. 7b

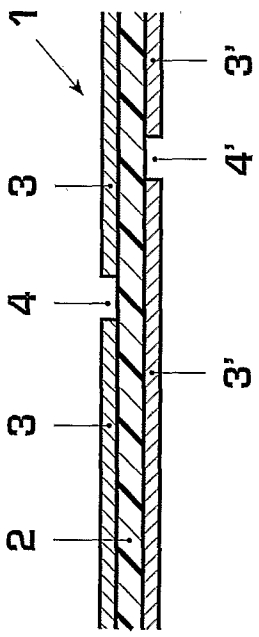

Fig. 6a

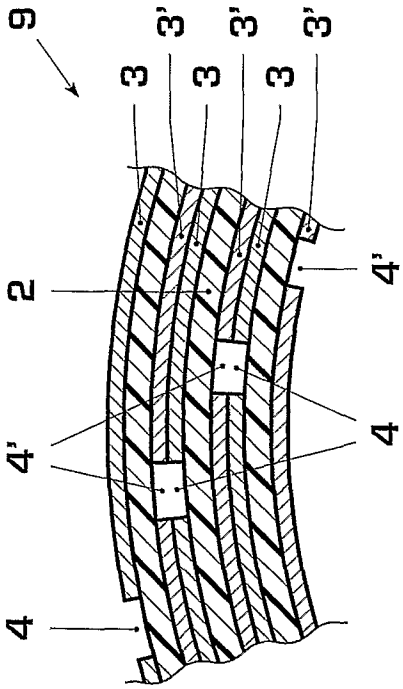

Fig. 6b

INTERNATIONAL SEARCH REPORT

International application No
PCT/CH2006/000722

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01G4/012 H01G4/228 H01B17/36

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B32B C23C H01G H05K G11C H01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 1 216 728 A (ELEK SITETSFORSYNINGENS FORSKN [NO]) 23 December 1970 (1970-12-23)	1
X	page 2; claim 1; figure 5	1,2,4, 7-10,13, 16,20-23
Y	page 2, lines 95-100; figures 1,4,5	3,11,12, 14,15, 17-19
Y	the whole document	5,6
X	US 2 301 882 A (KAPPELER HANS) 10 November 1942 (1942-11-10)	1
X	page 2; claims 1,3,8,12; figures 1-3	1,2,4, 7-10, 21-23
Y	page 2	3,5,6, 11,12,19
A	the whole document	13-18,20

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
16 February 2007	06/03/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Dessaux, Christophe

INTERNATIONAL SEARCH REPORT

International application No
PCT/CH2006/000722

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 31 48 360 A1 (DASZKOWSKI,ANDREAS,DR.-ING; DONSBACH,DIETER; LANGGUTH,KARL,DIPL.-ING) 9 June 1983 (1983-06-09)	1
X	claims 1,2,5,6; figures 1-4	1,3,4, 7-10,13, 16,19, 20,22,23
Y	pages 3,4; claims 1-3	5,6,11, 12,14, 15,17,18
A	the whole document	2,21

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/CH2006/000722

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 1216728 A	23-12-1970	NONE	
US 2301882 A	10-11-1942	NONE	
DE 3148360 A1	09-06-1983	NONE	