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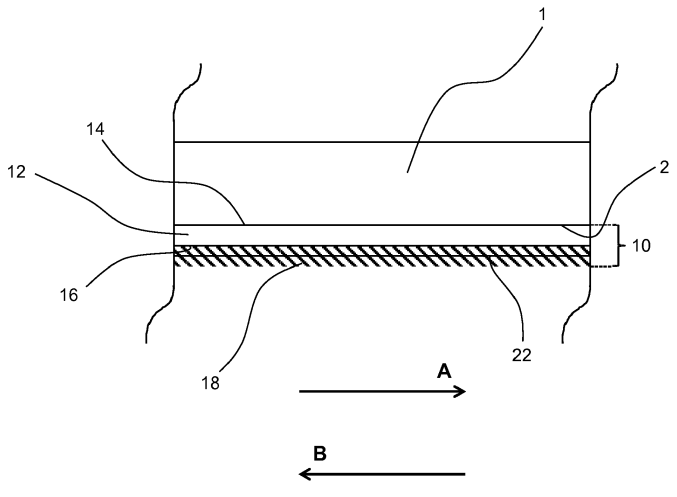
(54) UNIDIRECTIONAL FRICTION MATERIAL

(57) Material (10) for providing unidirectional friction, in particular for a ski skin, comprising a substrate-fabric (12) and plate-like structures (18) attached to the substrate-fabric (12), wherein the plate-like structures (18) are arranged on the fabric (12) such that they lie substantially flat against an operative surface (16) of the fabric (12) when a frictional force is applied to the structures (18) in a gliding direction (A) substantially parallel to the operative surface (16) of the fabric (12) and lift up from the operative surface (16) of the fabric (12) at one side when a frictional force is applied to the structures (18) in a gripping direction (B) substantially opposite to the gliding direction (A).

Fig. 1



EP 3 437 701 A1

Description

[0001] The present invention relates to a material for providing unidirectional friction, in particular for a ski skin, comprising a substrate-fabric and plate-like structures attached to the substrate-fabric.

[0002] Unidirectional frictional materials exist in various forms and are being used for various applications, the most relevant of which for the present invention is velvet. Velvet material consists of a densely woven fabric that entraps, through interweaving and cutting, standing fibres. These standing fibres are brushed so that they extend in the same direction, meaning that the feel is smooth in one direction but rough in the reverse direction. However, the problem of such velvet materials is that the difference in frictional behaviour between a forward and backward motion is not sufficiently high for some applications.

[0003] Other materials that create directional friction in a similar manner are in bristle form, wherein several applications use polymer or metallic bristles embedded in a solid substrate. These can be embedded at varying angles to give directionality. Some examples are tooth brush heads and hand combs.

[0004] Additionally, conveyor systems can benefit from directional friction to either aid in moving capabilities, for instance, polymer wedges or overlapping plates moving material to elevated positions, or in the reverse direction to slow movement and allow for slipping in the case of blockages.

[0005] Moreover, in the field of robotics there are efforts to emulate snake movement. These efforts focus mainly on the movements and the synchronisation of segments, however some research has focussed on the development of the skin surface. The aim is to provide low friction in the direction of movement and grip in the reverse direction as well as provide protection against abrasive surfaces.

[0006] Furthermore, on a smaller scale, material surfaces are being modified though laser texturing to affect directional friction.

[0007] In the field of skiing, plate-like structures for skiing ascent are well known in the sport with cross-country skis having a ridged bottom surface for many years. However, such skis do not provide the desired downhill performance as for example alpine skis or touring skis with a detachable ski skin.

[0008] In view of the above identified problem, it is an object of the present invention to provide a material, in particular for a ski skin, suitable to provide a friction as large as possible in one direction and as low as possible in the other direction.

[0009] According to an aspect of the present invention, this object is achieved by a material for providing unidirectional friction, in particular for a ski skin, comprising a substrate-fabric; and plate-like structures attached to the substrate-fabric, wherein the plate-like structures are arranged on the fabric such that they lie substantially flat against an operative surface of the fabric when a frictional force is applied to the structures in a gliding direction substantially parallel to the operative surface of the fabric and lift up from the operative surface of the fabric at one side when a frictional force is applied to the structures in a gripping direction substantially opposite to the gliding direction.

[0010] In comparison to velvet structures, for example, this arrangement increases the difference between the glide and grip phases of the material. In other words, the difference in frictional behaviour between the forward and backward motions of the material can be increased. In particular, the frictional resistance of the material, specifically of the plate-like structures, will be smaller in the gliding direction and greater in the gripping direction compared to current solutions. Therefore, a decrease in friction during gliding of the material (forward movement) in the gliding direction enables a more efficient forward motion and an increase in friction during gripping of the material in the gripping direction provides a better grip for the material such that a so-called unidirectional friction can be provided, which means a friction as large as possible in one direction (gripping direction) and as low as possible in the other direction (gliding direction). Such a material may be used in the fields of sports, in particular outdoor sports, robotics as well as manufacturing and is referred to as unidirectional friction material in the following. Furthermore, according to the above aspect, several aspects of the unidirectional friction material can be controlled, e.g. the design of the plate-like structures (i.e. size, shape, thickness, material), the backing material (substrate-fabric) and/or the arrangement of the plate-like structures.

[0011] Preferably, the plate-like structures may be one-sided tiltable such that the structures are suitable to allow the material to glide over a surface in one direction and to provide grip with respect to the surface in the opposite direction. If the plate-like structures are tiltable only on one side it is possible that only in one direction (the gripping direction) a significant friction is present between the unidirectional friction material and a surface of an underground, e.g. snow or the like, namely in the direction from a tiltable side of the plate-like structures towards a non-tiltable side of the plate-like structures which corresponds to the gripping direction. In this context it is to be noted that the plate-like structures may be provided such that the sides of each of the plate-like structures oriented in a same direction are designed either tiltable or non-tiltable. Hence, a side of the plate-like structures downstream the respective structure with respect to the gliding direction may lie substantially flat against the operative surface of the fabric and an opposite side of the plate-like structures upstream the respective structure with respect to the gliding direction may lift up from the operative surface of the fabric.

[0012] Advantageously, the plate-like structures may be arranged in order to at least partially overlap each other. An overlapping arrangement of the plate-like struc-

tures increases the possible number of plate-like structures that can be attached to the substrate fabric and therefore increases the number of contact points with the surface to be gripped which provides a better grip of the unidirectional friction material in the gripping direction.

[0013] On the one hand, there can be achieved optimal sliding properties of the unidirectional friction material, if an angle between the operative surface of the fabric and the plate-like structures is between 0° and 20°, preferably between 0° and 10°, when a frictional force is applied to the structures in the gliding direction. Such an angle between the operative surface of the fabric and the plate-like structures allows the material to slide over a surface of an underground, for example snow, or vice versa allows a surface of an object to slide over the material with a minimum of frictional resistance.

[0014] On the other hand, there can be achieved optimal gripping properties of the unidirectional friction material, if an angle between the operative surface of the fabric and the plate-like structures is between 5° and 60°, preferably between 30° and 45°, when a frictional force is applied to the structures in the gripping direction. Such an angle between the operative surface of the fabric and the plate-like structures provides a maximum of frictional resistance between the material and a surface of an underground to be gripped, for example snow, or a surface of an object to be transported, if the unidirectional frictional material is used as a conveyor belt or the like, for example.

[0015] In an appropriate embodiment the plate-like structures may be disks having a diameter between 3 mm and 100 mm, preferably between 3 mm and 15 mm. Diameters of this size turned out as involving the best balance between stability and gripping properties, since disks of a diameter too small are not engaging the surface to be gripped sufficiently deep, while disks of a diameter too large tend to easily break, when having a small thickness suitable for a lightweight construction, as for example suitable for a ski skin, and therefore do not offer sufficient stability. In the case of a ski skin, the plate-like structures may have a maximum width equal or less than the width of the ski skin.

[0016] In a further embodiment the plate-like structures may be provided with a hole such that for example a yarn, string, wire or other attachment means may be passed through such a hole for attaching the structures to the fabric.

[0017] Preferably, such an attachment of the structures to the fabric may be implemented by attaching the plate-like structures to the substrate-fabric via stitchings since stitchings allow an attachment of the structures to the fabric offering high stability, involving low weight and additionally generating low cost.

[0018] In a preferred embodiment the plate-like structures may be made of a stiff material, in particular of polymers, metals or laminates of combinations of polymers. Thereby, e.g. for ski touring, polyethylene, in particular high density polyethylene is of specific interest. However, other materials providing stiffness sufficiently high may be conceivable.

[0019] Preferably, the substrate-fabric may be an elongated element such that the unidirectional friction material is suitable for many different applications, e.g. in sports or outdoor industry as well as in material conveyance.

[0020] Likewise, the substrate-fabric may be made of a flexible material, in particular of woven, knitted or non-woven fabrics. These materials may be composed of natural, regenerated or manmade fibres and/or flexible polymers such as rubbers or a combination thereof.

[0021] In a further preferred embodiment the substrate-fabric may be suitable to be attached to a support part, in particular to a gliding surface of a ski. In this manner the substrate-fabric may provide grip only in one direction to any desired part, in particular to a gliding surface of a ski.

[0022] An advantageous connection to such a support part or ski may be obtained, if the substrate-fabric comprises an adhesive connection surface opposite to the operative surface by means of which the substrate-fabric is suitable to be attached to a support part, in particular to a ski.

[0023] Further, it is possible that the material may be a ski skin, since the use of the unidirectional friction material as ski skin entails many advantages desired in the field of ski touring where a friction as large as possible in one direction and as low as possible in the other direction facilitates walking with touring skis and supports a ski tourer in any slope.

[0024] According to a further aspect of the present invention, the above-mentioned object is achieved by using a plurality of plate-like structures attached to a substrate-fabric for providing unidirectional friction, in particular for a ski skin, wherein the plate-like structures are arranged on the fabric such that they lie substantially flat against an operative surface of the fabric when a frictional force is applied to the structures in a gliding direction substantially parallel to the operative surface of the fabric and lift up from the operative surface of the fabric at one side when a frictional force is applied to the structures in a gripping direction substantially opposite to the gliding direction.

[0025] In comparison to using velvet structures, for example, using an arrangement of a plurality of plate-like structures attached to a substrate-fabric increases the difference between the glide and grip phases of the material. In other words, the difference in frictional behaviour between the forward and backward motions of the material can be increased. In particular, the frictional resistance acting on the material, specifically on the plate-like structures, will be smaller in the gliding direction and greater in the gripping direction compared to current solutions. Therefore, a decrease in friction during gliding of the material (forward movement) in the gliding direction enables a more efficient forward motion and an increase in friction during gripping of the material in the gripping

direction provides a better grip for the material such that a so-called unidirectional friction can be provided, which means a friction as large as possible in one direction (gripping direction) and as low as possible in the other direction (gliding direction).

[0026] A Preferred embodiment of the present invention will now be described by way of example with reference to the accompanying drawings, in which

figure 1 is a partial side view of a material for providing unidirectional friction according to an embodiment of the present invention attached to a surface of a ski;

figure 2 shows a plurality of plate-like structures of the material viewed from below in two different configurations; and

figure 3 shows one of the plurality of plate-like structures of the material viewed from below in two different configurations.

[0027] Figure 1 shows a part of a unidirectional friction material 10 according to an embodiment of the present invention attached to a gliding surface 2 of a ski 1. For example, the material 10 may be attached via adhesive means to the gliding surface 2 of the ski 1.

[0028] The material 10 comprises a substrate-fabric 12 with a connection surface 14 via which the material is attached to the gliding surface 2 of the ski 1 and an operative surface 16 opposite to the connection surface 14 as well as plate-like structures 18 (disks 18 in the embodiment described) attached to the substrate-fabric 12. The substrate-fabric 12 may consist of any woven, knitted or nonwoven material. As mentioned above, in the preferred embodiment described herein the plate-like structures 18 are stiff disks 18 having a diameter of 3 mm to 15 mm and being provided with holes 20 (see figures 2 and 3) provided substantially in the middle of each disk 18. The disks 18 are arranged on the fabric 12 such that they lie substantially flat against the operative surface 16 of the fabric 12 when a frictional force is applied to the disks 18 in a gliding direction A substantially parallel to the operative surface 16 of the fabric 12 and lift up from the operative surface 16 of the fabric 12 at one side when a frictional force is applied to the disks 18 in a gripping direction B substantially opposite to the gliding direction A.

[0029] The state of the material 10 shown in figure 1 is a state during a gripping phase where a frictional force is applied to the disks 18 in the gripping direction B, wherein the angle between the operative surface 16 of the fabric 12 and the disks 18 is approximately 45°. In the illustrated embodiment, the disks 18 are attached to the operative surface 16 of the fabric 12 by a yarn 22 via a stitching technique.

[0030] Figures 2 and 3 show a plurality of plate-like structures 18 or disks 18 of the material 10 and one of the plate-like structures or disks 18 of the material 10, respectively, viewed from below in different configurations.

[0031] As illustrated in figure 2, the plurality of disks 18 are attached to the fabric 12 through a stitching technique in an overlapping design such that the structure grips a surface in one direction but slides over it in the other. The stitching 22 may be applied either manually or with an embroidery machine and the angle of the stitching yarn 22 and the tension of the stitch controls the extent to which each disk 18 will lift during a grip phase of the unidirectional friction material 10 (friction applied in gripping direction B). Thereby, a preferable stitching angle may be larger than 20° and smaller than 180°.

[0032] Further, figures 2 and 3 show how different design aspects can alter the friction properties of the unidirectional friction material 10.

[0033] In particular, figure 3 highlights the design aspect of different angles of the stitching yarn 22 via which the disks 18 are stitched to the fabric 12. The yarn 22 may be passed through the holes 20 of each of the disks 18 and on either side of the holes 20 stitched to the fabric 12, thereby forming an angle between the two ends of the yarn 22 at the opposite sides of the holes 20 of each disk 18. A wider angle of the stitching yarn 22 causes a smaller angle between the operative surface 16 of the fabric 12 and the plate-like structures or disks 18, thus restricting lifting at one end of the plate-like structures or disks 18. If the angle of the stitching yarn 22 is smaller, an angle between the operative surface 16 of the fabric 12 and the plate-like structures or disks 18 is wider, thus the lifting end of each disk 18 can lift up more from the operative surface 16 of the fabric 12.

[0034] This can further be controlled by the overlapping design of the plurality of disks 18 illustrated in figure 2 as well as the plate or disk design itself, such that one plate or disk 18 can impede the movement of its neighbouring plates or disks 18, or conversely initiate its movement.

[0035] Hence, as described above, several aspects of the unidirectional friction material 10 can be controlled, e.g. the design of the plates or disks 18 (i.e. size, shape, thickness, material), the stitching 22 (i.e. material, tension, angle in and out of the plate or disk 18, coarseness), the backing material (fabric 12) and the arrangement of the plates or disks 18.

[0036] It is to be noted, that the present invention is not being restricted to the above-mentioned exemplary embodiments. In particular, the plate-like structures 18 may have any shape suitable to lie substantially flat against the operative surface 16 of the fabric 12 when a frictional force is applied in the gliding direction A and to lift up from the operative surface 16 of the fabric 12 at one side when a frictional force is applied in the gripping direction B substantially opposite to the gliding direction A and to provide low friction in the direction of movement (gliding direction A) and grip in the reverse direction (gripping direction B). Further, the attachment of the plate-like structures 18 to the fabric 12 is not restricted to stitch-

ing techniques or the like and the use of the material 10 is not restricted to an application as a ski skin, since also applications in the fields of robotics and/or manufacturing, for example, are conceivable.

Claims

1. Material (10) for providing unidirectional friction, in particular for a ski skin, comprising:

   a substrate-fabric (12); and
   plate-like structures (18) attached to the substrate-fabric (12);
   wherein the plate-like structures (18) are arranged on the fabric (12) such that they lie substantially flat against an operative surface (16) of the fabric (12) when a frictional force is applied to the structures (18) in a gliding direction (A) substantially parallel to the operative surface (16) of the fabric (12) and lift up from the operative surface (16) of the fabric (12) at one side when a frictional force is applied to the structures (18) in a gripping direction (B) substantially opposite to the gliding direction (A).

2. Material (10) according to claim 1, **characterized in that** the plate-like structures (18) are one-sided tiltable such that the structures (18) are suitable to allow the material (10) to glide over a surface in one direction and to provide grip with respect to the surface in the opposite direction.

3. Material (10) according to claim 1 or 2, **characterized in that** the plate-like structures (18) are arranged in order to at least partially overlap each other.

4. Material (10) according to any one of the preceding claims, **characterized in that**, when a frictional force is applied to the structures (18) in the gliding direction (A), an angle between the operative surface (16) of the fabric (12) and the plate-like structures (18) is between 0° and 20°, preferably between 0° and 10°.

5. Material (10) according to any one of the preceding claims, **characterized in that**, when a frictional force is applied to the structures (18) in the gripping direction (B), an angle between the operative surface (16) of the fabric (12) and the plate-like structures (18) is between 5° and 60°, preferably between 30° and 45°.

6. Material (10) according to any one of the preceding claims, **characterized in that** the plate-like structures (18) are disks (18) having a diameter between 3 mm and 100 mm, preferably between 3 mm and 15 mm.

7. Material (10) according to any one of the preceding claims, **characterized in that** the plate-like structures (18) are provided with a hole (20).

8. Material (10) according to any one of the preceding claims, **characterized in that** the plate-like structures (18) are attached to the substrate-fabric (12) via stitchings (22).

9. Material (10) according to any one of the preceding claims, **characterized in that** the plate-like structures (18) are made of a stiff material, in particular of polymers, metals or laminates of combinations of polymers.

10. Material (10) according to any one of the preceding claims, **characterized in that** the substrate-fabric (12) is an elongated element.

11. Material (10) according to any one of the preceding claims, **characterized in that** the substrate-fabric (12) is made of a flexible material, in particular of woven, knitted or nonwoven fabrics.

12. Material (10) according to any one of the preceding claims, **characterized in that** the substrate-fabric (12) is suitable to be attached to a support part (1), in particular to a gliding surface (2) of a ski (1).

13. Material (10) according to any one of the preceding claims, **characterized in that** the substrate-fabric (12) comprises an adhesive connection surface (14) opposite to the operative surface (16) by means of which the substrate-fabric (12) is suitable to be attached to a support part (1), in particular to a ski (1).

14. Material (10) according to any one of the preceding claims, **characterized in that** the material (10) is a ski skin.

15. Use of a plurality of plate-like structures (18) attached to a substrate-fabric (12) for providing unidirectional friction, in particular for a ski skin,
    wherein the plate-like structures (18) are arranged on the fabric (12) such that they lie substantially flat against an operative surface (16) of the fabric (12) when a frictional force is applied to the structures (18) in a gliding direction (A) substantially parallel to the operative surface (16) of the fabric (12) and lift up from the operative surface (16) of the fabric (12) at one side when a frictional force is applied to the structures (18) in a gripping direction (B) substantially opposite to the gliding direction (A).

Fig. 1

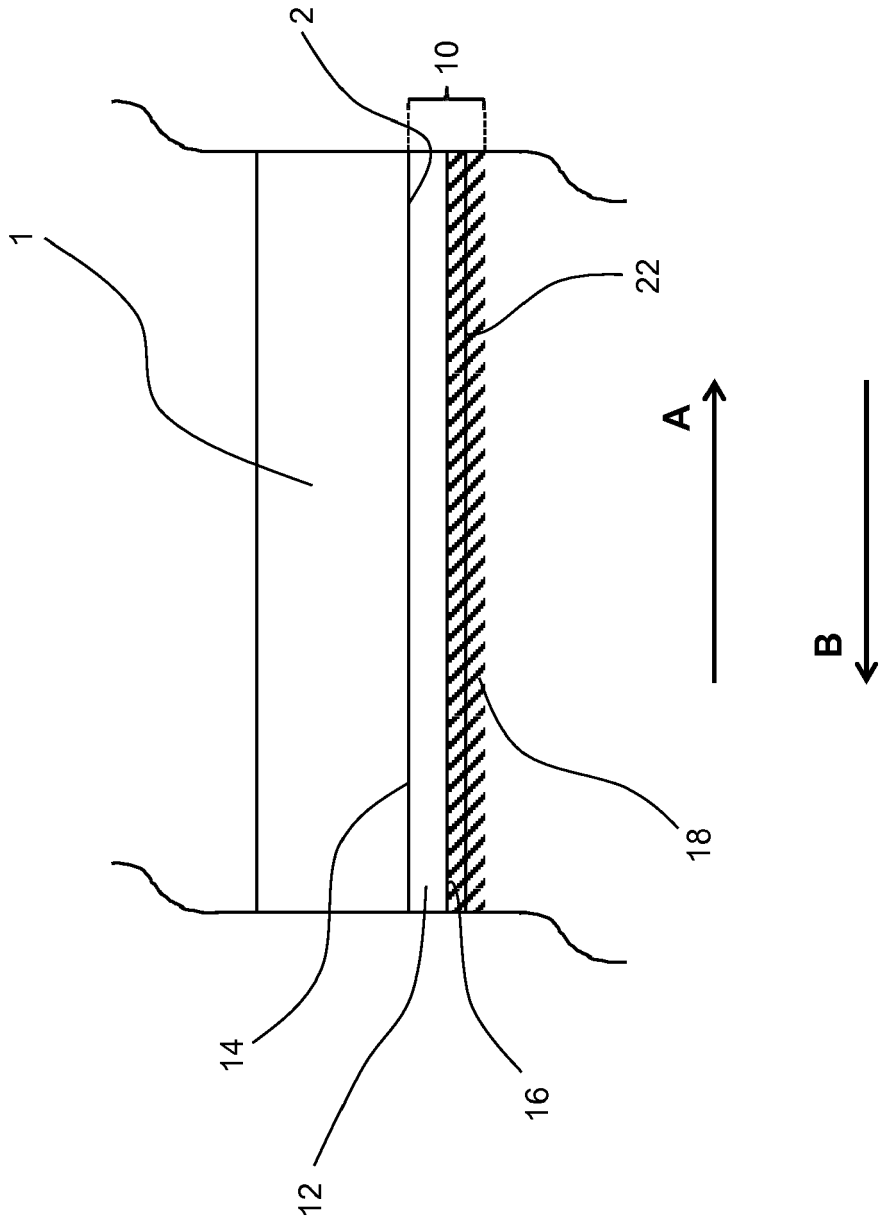


Fig. 2

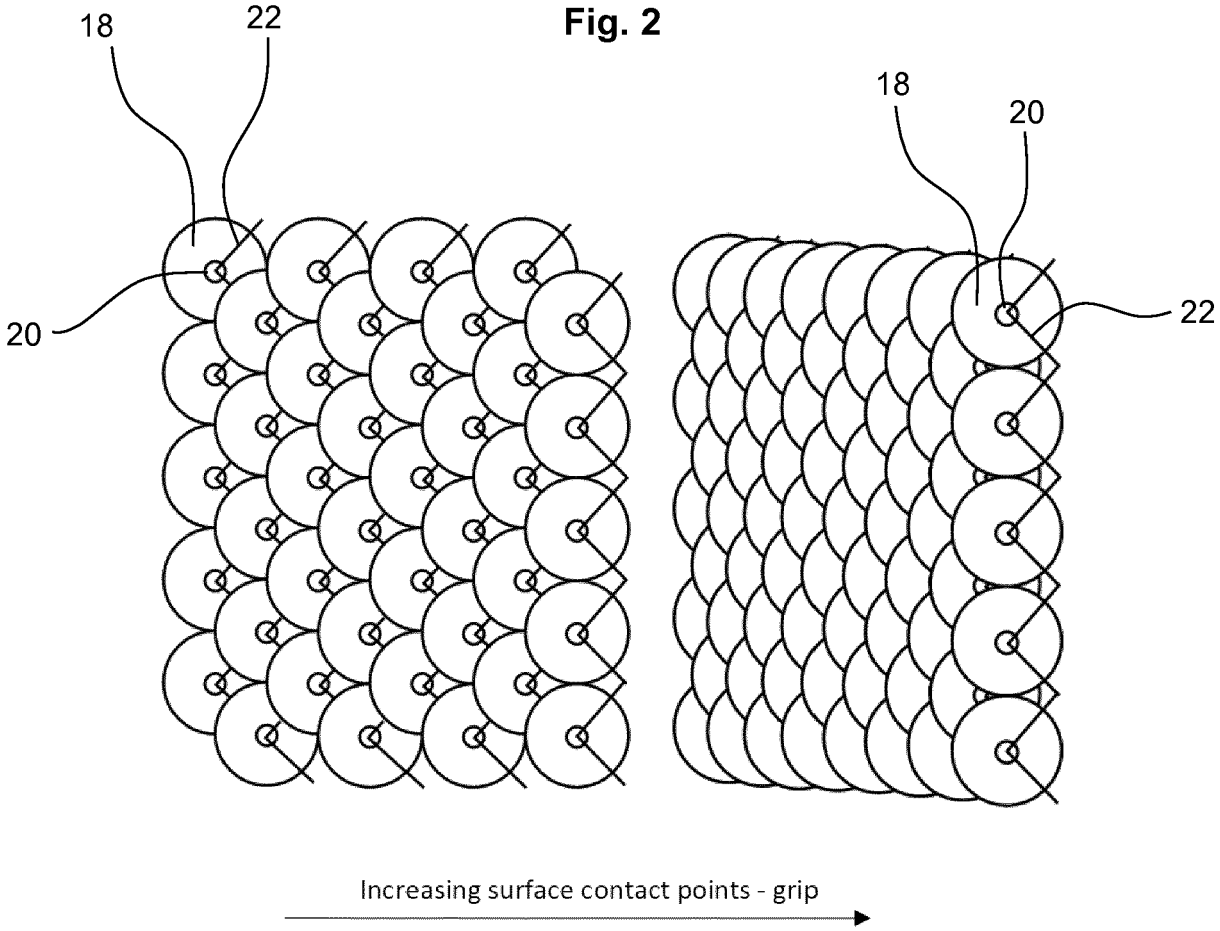
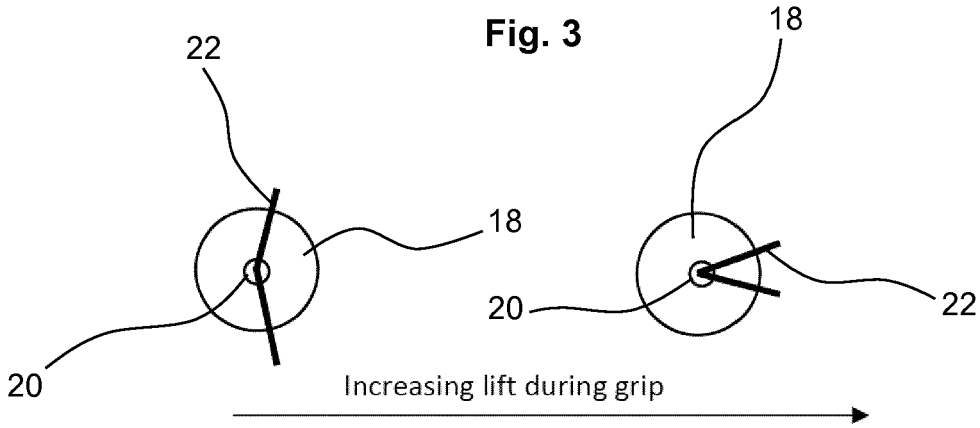

18
22
20
18
20
22
Increasing surface contact points - grip

Fig. 3


22
18
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18
20
22
Increasing lift during grip

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EUROPEAN SEARCH REPORT

Application Number
EP 17 18 4621

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	19 March 2018	Brunie, Franck

CATEGORY OF CITED DOCUMENTS

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