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## (54) METHOD FOR TREATING A SLIDING SURFACE OF A SLIDING DEVICE AND THE SLIDING DEVICE COMPRISING THAT SLIDING SURFACE

(57) Method for treating a base (11) able to be used in a sliding apparatus (10) and provided with at least a sliding surface (21); the method comprises at least a first step of cutting the base (11) by means of which a plurality of craters (22) with a controlled depth (P) and diameter (D) are made on the sliding surface (21), and at least a second step of structuring and finishing the sliding surface (21) in zones of said sliding surface (21) defined inside the craters (22) and/or in zones of the sliding surface (21) defined between one crater (22) and the other, so as to obtain a plurality of ridges (24) distributed on the sliding surface (21) of the base (11) in the craters (22) and/or between one crater (22) and the other.

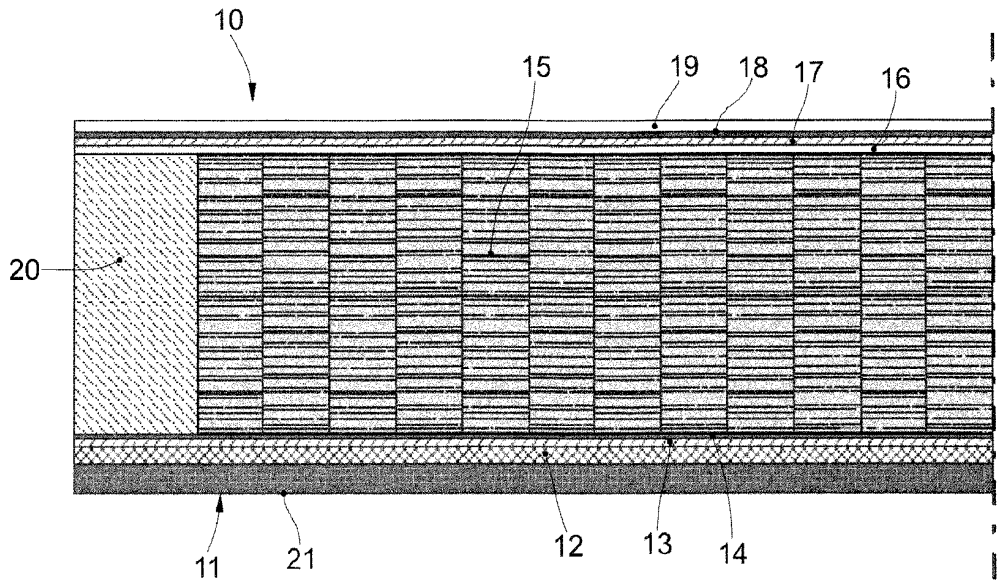


fig. 1

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## Description

### FIELD OF THE INVENTION

**[0001]** The present invention concerns a method for treating a base for sliding apparatuses, for example skis or suchlike, used in winter sports for sliding on snow-covered ground or suchlike, including ground prepared with artificial snow and similar materials, which have high sliding properties. The present invention also concerns a base for a sliding apparatus and the sliding apparatus itself, used in particular for winter sports.

**[0002]** In the case of a pair of skis, by the term "sliding apparatus" we mean, hereafter in the description, each of the skis used for sliding or gliding on snow-covered ground or suchlike.

### BACKGROUND OF THE INVENTION

**[0003]** It is known that modern sliding apparatuses used in particular in winter sports consist of a structure provided with layers of different materials overlapping on each other.

**[0004]** On a macroscopic level, the multi-layer structure that the sliding structure is made of is similar in most types of modern sliding apparatuses present on the market. However, the individual layers can be made with different geometries and materials or a different composition of materials, in order to obtain the desired characteristics, for example in terms of flexibility and manageability of the apparatus. The techniques for assembling and producing normal sliding apparatuses are also consolidated and used by most producers.

**[0005]** From a functional point of view, and especially in the practice of Alpine and Nordic skiing, the sliding properties of the sliding apparatus are a fundamental feature for performance, both in competitive sport and also in terms of the manageability and usability of the apparatus.

**[0006]** Therefore, the study of slidability and of the parameters that influence the dynamic sliding friction between the sliding apparatus and the snow-covered ground, and therefore, in short, between the base of the sliding apparatus and the snow-covered ground, is extremely important.

**[0007]** The tribology of the base of the sliding apparatus can be influenced by various parameters, including, principally, the characteristics of the material or materials it is made of, the sliding surface and the treatment of the base able in general to reduce to a minimum the dynamic friction between base and snow.

**[0008]** In order to improve the sliding characteristics of such sliding apparatuses on the snow, it is known, as mentioned above, to use various types of material and various surface working techniques, especially for the bases. However, known materials and working techniques for ski apparatuses do not allow to obtain ski apparatuses provided with optimum slidability and characteristics that allow optimum control during normal prolonged use, possibly for different morphologies of the snow cover.

**[0009]** Furthermore, known ski apparatuses can have various problems regarding the wear of the materials, and therefore it often needs different and costly maintenance operations, both for the base and also the edges.

**[0010]** Other limitations and disadvantages of conventional solutions and technologies will be clear to a person of skill after reading the remaining part of the present description with reference to the drawings and the description of the embodiments that follow.

**[0011]** There is therefore a need to perfect a method for treating a base of a sliding apparatus and to obtain a base suitable for a sliding apparatus which can overcome at least one of the disadvantages of the state of the art.

**[0012]** One purpose of the present invention is therefore to perfect an effective and precise method for treating a base for a sliding apparatus, in particular a sliding apparatus for sliding on snow-covered terrains, by means of which the base obtained has optimum sliding qualities on the snow and therefore by means of which the dynamic friction between the sliding apparatus in which it is installed and the snow-covered ground is reduced to a minimum.

**[0013]** Another purpose of the present invention is to perfect a method for treating a base for a sliding apparatus, in particular a sliding apparatus for sliding on snow-covered terrains, which allows to obtain a base and therefore in general a sliding apparatus which is durable and therefore in which the wear deriving from normal use is significantly reduced and which also requires minimum interventions in terms of maintenance compared with known bases and sliding apparatuses.

**[0014]** Another purpose of the present invention is to obtain a base for a sliding apparatus, in particular a sliding apparatus for snow-covered ground, which in its entirety is more efficient and performs better (greater precision in trajectories) compared with normal bases for sliding apparatuses known in the field.

**[0015]** Another purpose of the present invention is to obtain a sliding apparatus which is in its entirety is more efficient and long-lasting, and performs better in terms for example of precision in trajectories compared with known apparatuses.

**[0016]** The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

## SUMMARY OF THE INVENTION

**[0017]** The present invention is set forth and characterized in the independent claims, while the dependent claims describe other characteristics of the invention or variants to the main inventive idea.

**[0018]** In accordance with the above purposes and according to a first aspect of the invention, a method for treating a base able to be used in a sliding apparatus and provided with at least a sliding surface, comprises at least a first step of cutting the base by means of which a plurality of craters with a controlled depth and diameter are made on the sliding surface, and at least a second step of structuring and finishing the sliding surface in zones of the sliding surface defined inside the craters and/or in zones of the sliding surface defined between one crater and the other, so as to obtain a plurality of ridges distributed on the sliding surface of the base in the craters and/or between one crater and the other.

**[0019]** According to another aspect of the invention, the craters have micrometric sizes and the ridges have nanometric sizes.

**[0020]** Preferably, at the end of the first cutting step, the craters are distributed in a preferably regular pattern on the sliding surface of the base.

**[0021]** According to another aspect of the invention, the first cutting step is performed using a pulsed laser and allows to obtain craters of micrometric sizes.

**[0022]** Preferably, the craters have a depth variable between about 0.5 μm and about 50 μm.

**[0023]** Preferably, the craters have a diameter variable between about 5 μm and about 100 μm and preferably less than 50 μm.

**[0024]** The procedure for finishing and structuring the sliding surface is preferably a nanostructuring procedure performed by an ionic erosion process on the sliding surface.

**[0025]** The invention also concerns a sliding base comprising at least a sliding surface. According to one aspect of the invention a plurality of craters are made in the sliding surface with a controlled depth and diameter and a plurality of ridges distributed in zones of the sliding surface of the base inside the craters and/or in zones situated between one crater and the other.

**[0026]** Preferably, the base is made by at least one layer of metal material or metal alloys.

**[0027]** The base can have a thickness variable between about 0.2 mm and about 0.8 mm.

**[0028]** The invention also concerns a sliding apparatus comprising a plurality of overlapping layers and at least one base provided with at least one sliding surface. According to one aspect of the invention, the sliding surface comprises a plurality of craters with a controlled depth and diameter and a plurality of ridges distributed in zones of the sliding surface of the base inside the craters and/or in zones situated between one crater and the other.

**[0029]** Preferably the sliding apparatus comprises edges made in a single piece with the base.

**[0030]** These and other aspects, characteristics and advantages of the present disclosure will be better understood with reference to the following description, drawings and attached claims. The drawings, which are integrated and form part of the present description, show some forms of embodiment of the present invention, and together with the description, are intended to describe the principles of the disclosure.

**[0031]** The various aspects and characteristics described in the present description can be applied individually where possible. These individual aspects, for example aspects and characteristics described in the attached dependent claims, can be the object of divisional applications.

**[0032]** It is understood that any aspect or characteristic that is discovered, during the patenting process, to be already known, shall not be claimed and shall be the object of a disclaimer.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0033]** These and other characteristics of the present invention will become apparent from the following description of some embodiments, given as a non-restrictive example with reference to the attached drawings wherein:

- fig. 1 is a partial front view and in cross section of a sliding apparatus comprising a sliding base according to the present invention;
- fig. 2 is a schematic view from below of the base of the sliding apparatus;
- fig. 3 is a view on a larger scale compared to fig. 2 and relating to a zone of the surface of the base treated according to the present method;
- fig. 4 is a view on a larger scale compared to fig. 3 and relating to a group of craters made on the sliding surface of the base;
- fig. 5 is a schematic view in lateral elevation of a crater, in particular a micro crater, made on the sliding surface of the base;
- fig. 6 is a first image taken using an electronic scan microscope of one of the craters made on the sliding surface of the base at the end of working with pulsed laser (LST, Laser Surface Texturing);

- fig. 7 is a second image taken using an electronic scan microscope of the crater in fig. 5 at the end of another working using ionic erosion of the sliding surface of the base.

**[0034]** To facilitate comprehension, the same reference numbers have been used, where possible, to identify identical common elements in the drawings. It is understood that elements and characteristics of one embodiment can conveniently be incorporated into other embodiments without further clarifications.

DETAILED DESCRIPTION OF SOME EMBODIMENTS

**[0035]** We shall now refer in detail to the various embodiments of the present invention, of which one or more examples are shown in the attached drawings. Each example is supplied by way of illustration of the invention and shall not be understood as a limitation thereof. For example, the characteristics shown or described insomuch as they are part of one embodiment can be adopted on, or in association with, other embodiments to produce another embodiment. It is understood that the present invention shall include all such modifications and variants.

**[0036]** Before describing these embodiments, we must also clarify that the present description is not limited in its application to details of the construction and disposition of the components as described in the following description using the attached drawings. The present description can provide other embodiments and can be obtained or executed in various other ways. We must also clarify that the phraseology and terminology used here is for the purposes of description only, and cannot be considered as limitative.

**[0037]** With reference to the attached drawings, a sliding apparatus 10 comprises a structure in which can be distinguished, starting from the bottom, a series of overlapping layers of the desired thickness, that is to say: a sliding base 11; a layer 12 of glass fiber or carbon fiber located above the base 11 and made for example of cross-laminated glass; a layer 13 of glass fiber or carbon fiber located above layer 12, for example a layer of cross-laminated glass; a layer 14 with anti-vibration functions, made for example of rubber or suchlike; a central core 15, made for example of multi-layer wood; a layer 16 of glass fiber or carbon fiber, located above the central core 15 and made for example of unidirectional laminate; a layer 17 of glass fiber or carbon fiber located above layer 16 and made for example of cross-laminated glass; another layer 18 with anti-vibration functions, made of rubber or suchlike for example; and an upper layer 19, preferably made of plastic material, for example with a base of thermoplastic polymers.

**[0038]** On each side of the sliding apparatus 10 a sidewall 20 is also positioned, made for example of thermoplastic material, such as acrylonitrile-butadiene-styrene (ABS) or suchlike.

**[0039]** In the solution proposed according to the present invention, the base 11 of the sliding apparatus 10, which comprises a sliding surface 21 preferably made of metal material, integrates in a single piece the edges normally provided in any sliding apparatus and is produced starting from a strip with a thickness comprised between 0.2 and 0.8 mm for example, which therefore represents the thickness of the base 11.

**[0040]** By way of example, as materials for the basic strip from which the base 11 is obtained with standard cutting methods, it is possible to use different types of metal materials, for example a first alloy with the commercial name of Titanal®, which is substantially an aluminum alloy, or stainless steel INOX AISI 301, which gives a better mechanical performance, or other metal materials, also combined with each other.

**[0041]** To produce the base 11 of the sliding apparatus according to the invention, the strip is cut and shaped using a method similar to that used for conventional bases made of polymer such as UHMWPE (Ultra High Molecular Weight Polyethylene), then integrated into the sliding apparatus 10 using operations such as for example hot gluing and pressing.

**[0042]** At the end of these operations there follows a surface finishing step on the base 11, carried out with a level of precision such as to guarantee optimum efficiency and performance.

**[0043]** After the surface finishing step, a hierarchical structuring is prepared, which provides for example a nano and microscopic control of the surface of the base 11. The hierarchical structuring step is preferably divided into two working steps.

**[0044]** In the first step, a cutting process is made on the sliding surface 21, for example with a pulsed laser (Laser Surface Texturing, LST), using a known machine and suitable for the purpose, for example equipped with a nanosecond laser, which currently represents a good compromise between efficiency and total working costs.

**[0045]** As a result, on the sliding surface 21 of the base 11 a sequence of craters 22 is produced, therefore obtained by laser irradiation.

**[0046]** In this first working step another type of laser could also be used, for example a femtosecond ultrafast laser.

**[0047]** Alternatively, the craters 22 obtained at the end of the first cutting step could be made using different techniques, for example by rollers provided with suitably sized indentations.

**[0048]** Each of the craters 22 will have a predetermined and controlled depth P and diameter D, so as to optimize the sliding performance and durability of the base 11 and hence of the sliding apparatus 10 in its entirety.

**[0049]** It has been found that a depth P of the craters 22 which confers particular characteristics of slidability and efficiency on the base 11 applicable to the sliding apparatus 10 varies from about 0.5 μm to about 50 μm.

**[0050]** It has been found that a diameter D of the craters 22 which confers particular characteristics of slidability and efficiency on the base 11 applicable to the sliding apparatus 10 varies from about 5 μm and about 100 μm and is preferably less than 50 μm.

**[0051]** In any case, these values of the depth P and diameter D of the craters 22 can be modified according to the technical characteristics and the type of sliding apparatus 10 to be obtained, depending for example whether it is used for Alpine skiing, cross country or other disciplines. Moreover, the parameters must also take into account the conditions of morphological variability of the snow cover.

**[0052]** After this first working step (see also figs. 3 and 4), the sliding surface 21 is covered by craters 22 disposed preferably in an orderly manner and a regular pattern 23, so as to guarantee a uniform treatment of the sliding surface 21 of the base 11.

**[0053]** In this case, by way of example, we have shown a regular pattern 23 formed by craters 22 aligned in lines and columns but naturally this regular pattern 23 could be made with different distributions, for example irregular distributions.

**[0054]** In fig. 2 the craters 22 distributed in a regular pattern 23 are shown only in a circled zone of the sliding surface 21 of the base 11; however, preferably, the regular pattern 23 of craters 22 will be made uniformly over the whole sliding surface 21 of the base 11.

**[0055]** At the end of the first laser working step, it may be provided to smooth the base 11, to remove the flashes associated with the first working step.

**[0056]** At this point, once the craters 22 have been made with suitable depth P and diameter D on the sliding surface 21 of the base 11, the second step of finishing and structuring is begun, substantially comprising a nanostructuring of the sliding surface 21.

**[0057]** The operation to nanostructure the sliding surface 21 preferably takes place both in zones of the sliding surface 21 comprised inside the craters 22, and also in zones of the sliding surface 21 outside the craters 22, that is, defined between one crater and the other.

**[0058]** The purpose of this process is substantially to make a series of ridges 24, preferably of nanometric size, which are disposed inside and around each crater 22, uniformly, as shown schematically in fig. 4 and as shown by the image in fig. 6.

**[0059]** The finishing and nanostructuring operation can be performed by an ionic erosion process, where the target consists of the base 11 and in particular its sliding surface 21.

**[0060]** As is known, in ionic erosion processes, the target is inserted in an environment where a vacuum has been created and it is subjected to a bombardment of ions, for example argon ions, so that the surface atoms of the material it consists of, in this case the sliding surface 21, are expelled. In short the ridges 24 with nanometric sizes are obtained on the sliding surface 21.

**[0061]** The ionic erosion process can be performed by passive devices able to generate magnetic fields, by means of radiofrequency, or by maintaining a continuous current inside the vacuum environment where the target is positioned, hence the base 11 with its sliding surface 21.

**[0062]** For example, in the case of radiofrequency ionic erosion, the values of radiofrequency can be 13.56 MHz, as per international standards.

**[0063]** The pressure of the atmosphere inside the environment where the target is positioned, i.e. the sliding surface 21 of the base 11, is controlled in the range of tens of Pa, if necessary, starting from a reference vacuum in the range of $10^{-4}$ Pa.

**[0064]** The ionic erosion power varies according to the metal or metal alloy that the base 11 is made of, and can vary for example between 50 W and 125 W.

**[0065]** The nanostructuring process through ionic erosion can be carried out in a plurality of different steps, separated by pauses. Indeed it has been found that dividing the ionic erosion process into different steps allows to obtain a better nanostructuring of the sliding surface 21.

**[0066]** There can be, for example, three ionic erosion steps and each of them can have a predetermined duration of about 10 minutes. The intervals between one ionic erosion step and the next can also have a duration of about 10 minutes.

**[0067]** As a result therefore, a base 11 is obtained which is preferably treated with the operations as described above over the whole width of the sliding surface 21. As we said, advantageously, the sliding apparatus 10 on which the base 11 will be mounted will have the edges made in a single piece, that is, integrated with the base 11.

**[0068]** Experiments have been carried out to compare the solution with a known base made of polyethylene and the solution according to the present invention, made for example of Titanal® or stainless steel INOX AISI 301.

**[0069]** The experiments were conducted making a rectilinear descent on a course with an almost constant slope. The environmental conditions were normal (T = -1°C, RU = 73%). Two indexes were monitored:

- initial acceleration, strictly correlated to the friction of first departure;
- travel time, strictly correlated to the mean value of dynamic friction during the test.

**[0070]** The following Table shows the mean values (the tests were repeated several times) compared with the known solution of polyethylene base.

**[0071]** As can be seen, the base according to the present invention, both when made of Titanal® and when made of INOX AISI 301, has irrefutable advantages both in terms of initial acceleration and in terms of travel compared with known bases made of polyethylene.

| Solution | Initial acceleration | Travel time |
|---|---|---|
| Titanal® vs polyethylene | +15.9% | -7.1% |
| AISI301 vs polyethylene | +14.8% | -5.1% |

**[0072]** It is clear that modifications and/or additions of parts may be made to the method for treating a sliding apparatus and the sliding apparatus as described heretofore, without departing from the field and scope of the present invention.

**[0073]** It is also clear that, although the present invention has been described with reference to some specific examples, a person of skill in the art shall certainly be able to achieve many other equivalent forms of method for treating a sliding apparatus and the sliding apparatus itself, having the characteristics as set forth in the claims and hence all coming within the field of protection defined thereby.

**[0074]** In the following claims, the sole purpose of the references in brackets is to facilitate reading: they must not be considered as restrictive factors with regard to the field of protection claimed in the specific claims.

## Claims

1. Method for treating a base (11) able to be used in a sliding apparatus (10) and provided with at least a sliding surface (21), **characterized in that** it comprises at least a first step of cutting the base (11) by means of which a plurality of craters (22) are made on the sliding surface (21), said craters (22) having a controlled depth (P) and diameter (D), and at least a second step of structuring and finishing said sliding surface (21) in zones of said sliding surface (21) defined inside the craters (22) and/or in zones of said sliding surface (21) defined between one crater (22) and the other, so as to obtain a plurality of ridges (24) distributed on the sliding surface (21) of the base (11) in said craters (22) and/or between one crater (22) and the other.

2. Method as in claim 1, **characterized in that** said craters (22) have micrometric sizes and said ridges (24) have nanometric sizes.

3. Method as in claim 1 or 2, **characterized in that** at the end of said first cutting step said craters (22) are distributed in a preferably regular pattern (23) on the sliding surface (21) of the base (11).

4. Method as in any claim hereinbefore, **characterized in that** said first cutting step is performed using a pulsed laser.

5. Method as in any claim hereinbefore, **characterized in that** said craters (22) have a depth (P) variable between about 0.5 μm and about 50 μm.

6. Method as in any claim hereinbefore, **characterized in that** said craters (22) have a diameter (D) variable between about 5 μm and about 100 μm and preferably less than 50 μm.

7. Method as in any claim hereinbefore, **characterized in that** said finishing and structuring procedure on the sliding surface (21) is a nanostructuring procedure performed by an ionic erosion process on the sliding surface (21).

8. Sliding base comprising at least a sliding surface (21), **characterized in that** said sliding surface (21) comprises a plurality of craters (22) with a controlled depth (P) and diameter (D) and a plurality of ridges (24) distributed in zones of the sliding surface (21) of the base (11) inside said craters (22) and/or in zones situated between one crater (22) and the other.

9. Base as in claim 8, **characterized in that** said base (11) is made by at least one layer of metal material or metal alloys.

10. Base as in claim 8 or 9, **characterized in that** said base (11) has a thickness variable between about 0.2 mm and about 0.8 mm.

**11.** Sliding apparatus comprising a plurality of overlapping layers (12-19) and at least one base (11) provided with at least one sliding surface (21), **characterized in that** said sliding surface (21) comprises a plurality of craters (22) with a controlled depth (P) and diameter (D) and a plurality of ridges (24) distributed in zones of the sliding surface (21) of the base (11) inside said craters (22) and/or in zones situated between one crater (22) and the other.

**12.** Sliding apparatus as in claim 11, **characterized in that** it comprises edges made in a single piece with the base (11).

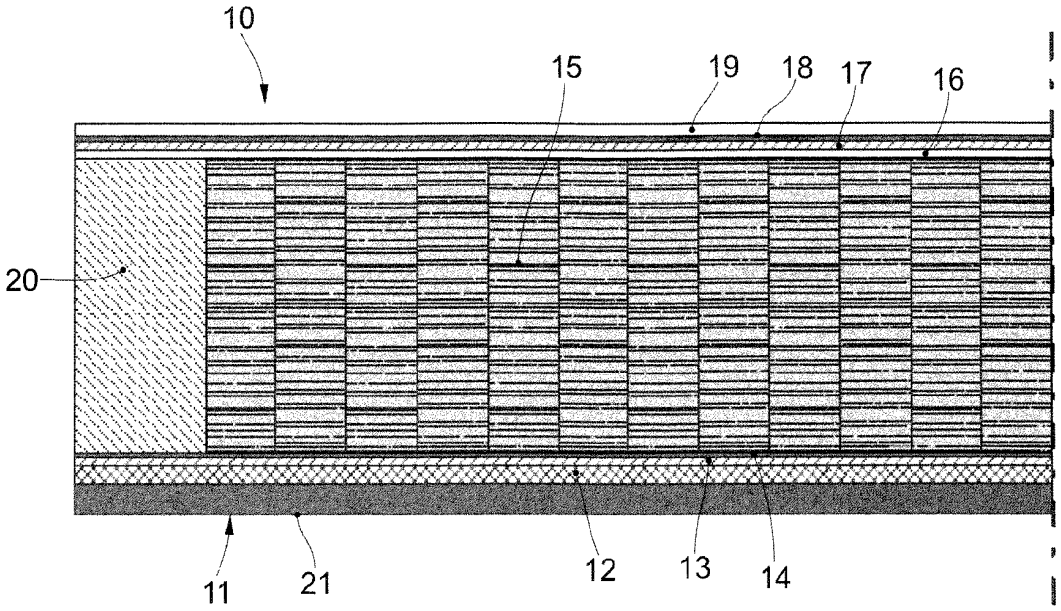


fig. 1

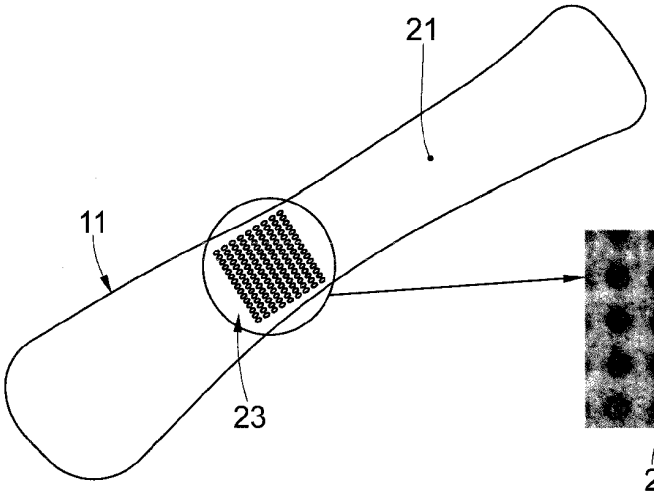


fig. 2

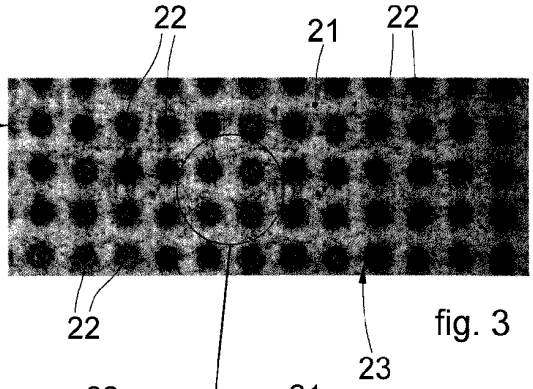


fig. 3

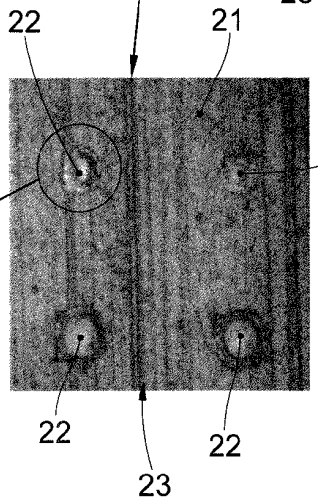


fig. 4

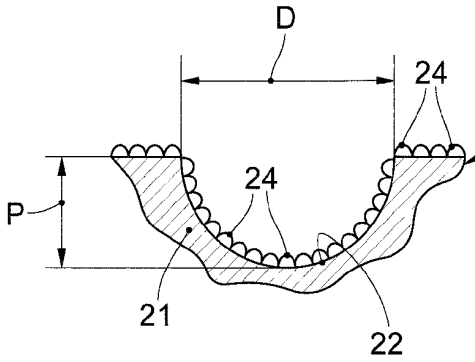


fig. 5

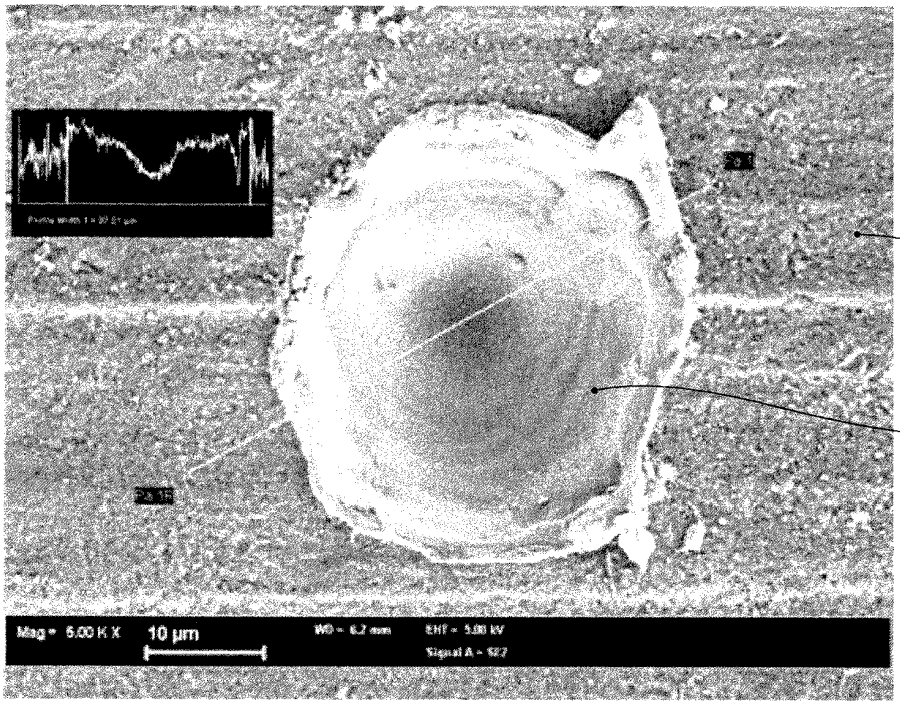


fig. 6

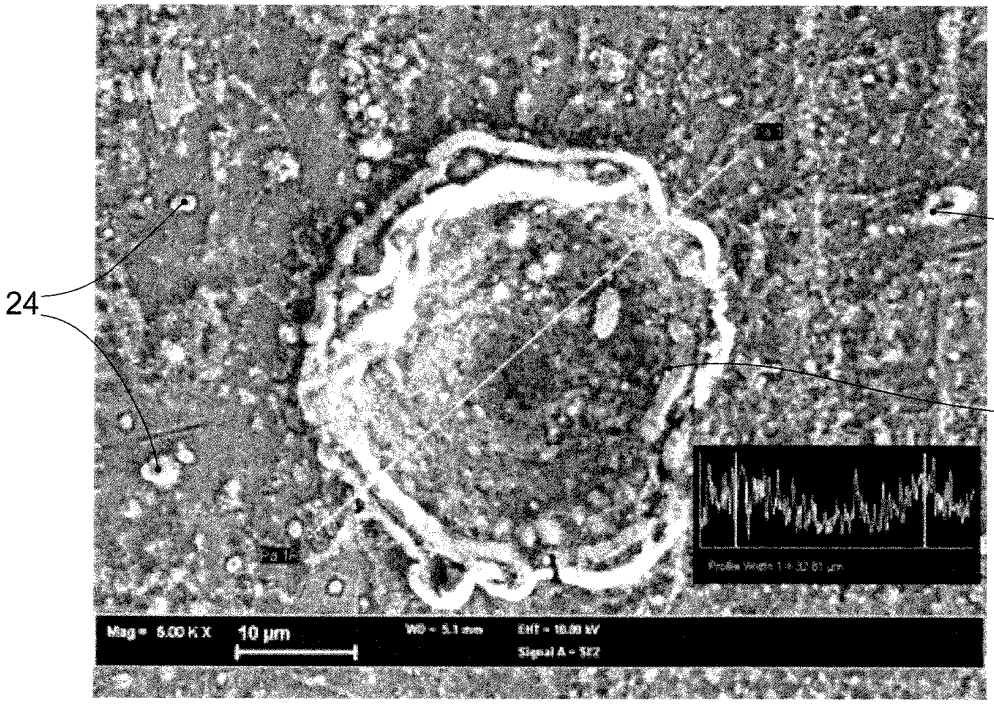


fig. 7

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# EUROPEAN SEARCH REPORT

Application Number
EP 17 16 8228

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X | EP 1 415 686 A1 (GST GLOBAL SPORTS TECH GES M B [AT]) 6 May 2004 (2004-05-06)<br>* the whole document * | 1-12 | INV.<br>A63C5/04<br>A63C5/044 |
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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 | 14 August 2017 | Haller, E |

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 16 8228

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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14-08-2017

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