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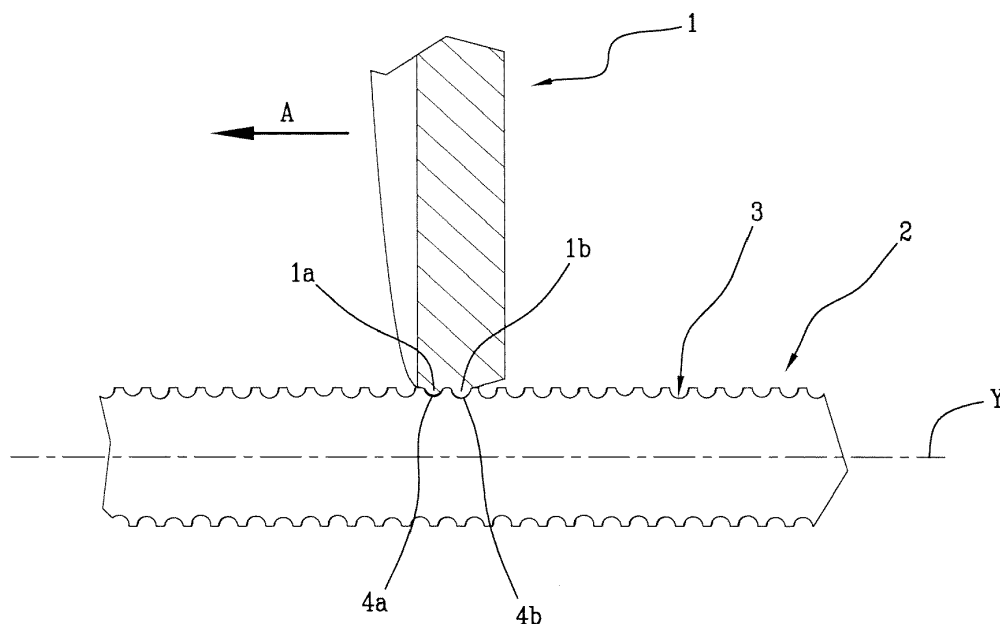
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(54) **GRINDING WHEEL FOR GRINDING SPIRAL-SHAPED PROFILES**

(57) Described is a grinding wheel for grinding spiral-shaped profiles, comprising a first abrasive disc (1a) and a second abrasive disc (1b), arranged side by side and positioned coaxially, the two discs (1a, 1b) being rigidly coupled to each other and each having an abrasive peripheral profile (5a, 5b) in such a way that the two abra-

sive discs (1a, 1b) engage inside two respective grooves (4a, 4b) of at least one spiral-shaped profile (3) of a mechanical member (2), wherein the two discs (1a, 1b) have different abrasive properties to define different levels of surface roughness of the grooves (4a, 4b).

Fig.4



Description

[0001] This invention relates to a grinding wheel for grinding spiral-shaped profiles, and in particular (but not necessarily) spiral-shaped profiles of recirculating ball screws.

[0002] As is known, the spiral-shaped tracks for the rolling of balls in recirculating ball screw couplings result in high pressures and require high machining precision, so it is often necessary to grind the tracks.

[0003] The grinding is usually achieved using a monolithic grinding wheel with a homogeneous grain and structure through which, by means of suitable parameters, roughing and finishing steps are performed with the same grinding wheel and the same positioning of the piece; obviously, it is necessary to find compromises to obtain the final roughness and the required accuracy on the thread at the expense of the processing times so as to avoid excessive elongation of the screw shaft which would adversely affect the requested precision and quality.

[0004] Alternatively, use is made of a first grinding wheel with a larger grain size, defining a roughing action, and a second grinding wheel with a smaller grain size, for finishing the track.

[0005] The known grinding process comprises a first step of grinding using the roughing grinding wheel and, when this process is completed, the roughing grinding wheel is replaced with the finishing grinding wheel and the process is repeated until the finishing of the track is completed.

[0006] The grinding of pairs of spiral-shaped tracks is also known, defining a so-called "double thread" by using double disc grinding wheels, wherein a first double disc grinding wheel, made with a material with large grain size, defines a first roughing step and this is then replaced with a finishing grinding wheel with a small grain size, which also has two discs alongside each other.

[0007] These intervention methods have the drawback of resulting in lengthy execution times, due to the need to provide at least two passes (one of roughing and one of finishing).

[0008] Moreover, during the finishing process the heating of the grinding wheel is accentuated to the point of locally deforming the geometry of the profile which can lose the correct original shape.

[0009] In this context, the technical purpose of the invention is to provide a grinding wheel for grinding spiral-shaped profiles which overcomes the above-mentioned drawbacks.

[0010] More specifically, the aim of the invention is to provide a grinding wheel for grinding spiral-shaped profiles which is suitable for achieving a greater operational efficiency.

[0011] Another aim of the invention is to provide a grinding wheel for grinding spiral-shaped profiles which has an optimum geometrical stability during use.

[0012] The technical purpose indicated and the aims

specified are substantially achieved by a grinding wheel for grinding spiral-shaped profiles comprising the technical features described in one or more of the accompanying claims.

[0013] This invention is described below with reference to the accompanying drawings, which illustrate a non-limiting embodiment and in which:

- Figures 1 and 2 are two views, from different angles, of a grinding wheel according to this invention in an operating configuration for grinding a spiral-shaped profile of a recirculating ball screw;
- Figure 3 shows a detail of the outer profile of the grinding wheel of Figure 1;
- Figure 4 shows an axial cross section of the outer profile of the grinding wheel of Figure 1 in an operating configuration for grinding a spiral-shaped profile of a recirculating ball screw.

[0014] In the accompanying drawings, the numeral 1 denotes in its entirety a grinding wheel for grinding spiral-shaped profiles according to this invention.

[0015] The grinding wheel 1 is used for grinding a spiral-shaped track (or spiral-shaped tracks in the case of screws with two or more threads) positioned on a recirculating ball screw. The aim of the grinding is to favour an optimum and efficient sliding of the balls in the track by reducing the friction and increasing the reliability of the coupling.

[0016] As shown in Figures 1 and 2, the grinding wheel 1 is positioned with the relative axis of rotation "X" almost parallel to the axis of rotation "Y" of the screw 2, in particular inclined at an angle substantially equal to the spiral angle of spiral-shaped profile (or spiral-shaped track) 3 of the screw 2. Moreover, the grinding wheel 1 comes into contact with the profile of at least two grooves 4a, 4b adjacent to the track 3, thus achieving the grinding.

[0017] In more detail, the grinding wheel 1 comprises two abrasive outer profiles 5, 6 having an arcuate shape, with an axisymmetric shape about the axis "X" of the grinding wheel 1 and axially positioned alongside each other in such a way that the two outer profiles 5, 6 are introduced, in a working step, in respective grooves 4a, 4b adjacent to the track 3. During a work cycle, the grinding wheel 1 moves along the axis "Y" of the screw 2 along a feed direction "A" into phase with the rotation of the screw 2 and, therefore, in phase with the ideal feeding of the respective grooves 4a, 4b along the axis "Y".

[0018] The two outer abrasive profiles 5, 6 define, at least virtually, two coaxial discs 1a, 1b forming the operational part of the grinding wheel 2, and coupled to each other in a rigid fashion in such a way that the grinding wheel 1 forms a rigid single block.

[0019] In the description which follows reference will be made to the two discs 1a, 1b, however the description may apply to the case in which reference is simply made to the two outer abrasive profiles 5, 6.

[0020] In accordance with a special aspect of the in-

vention, the two discs 1a, 1b have different abrasive properties to define different degrees of surface finishing of the grooves 4a, 4b.

[0021] Preferably, the abrasive discs 1a, 1b are made of abrasive material of the ceramic type.

[0022] Advantageously, this advantageous aspect results in the fact that the first disc 1a, positioned in front of the feed direction "A" of the grinding wheel 1 relative to the spiral-shaped track 3, defines a roughing disc whilst the other disc 1b defines a finishing disc.

[0023] More specifically, the two discs 1a, 1b have different grain size and/or abrasive type of and/or different density and/or structure in such a way as to obtain different surface roughness values of the grooves 4a, 4b. According to an example embodiment, the roughing disc has a grain size of between 80 and 100, whilst the finishing disc 1b has a grain size of between 120 and 140.

[0024] The two discs 1a, 1b may also or alternatively have structures and/or binders which are different to each other, so as to obtain different surface roughness effects, as the first disc 1a achieves a roughing effect whilst the second disc 1b achieves a finishing effect.

[0025] According to a variant embodiment, one of the abrasive discs 1a, 1b, preferably, the abrasive roughing disc 1a, is made of ceramic material whilst the other abrasive disc 1b is made of rubber.

[0026] In accordance with another advantageous aspect of the invention, and in a first embodiment (not illustrated), the two abrasive discs 1a, 1b are coupled to each other by reversible connecting means.

[0027] For example, the reversible connecting means comprise one or more connecting screws.

[0028] In a different embodiment, the abrasive discs 1a, 1b are coupled to each other in a permanent fashion, for example by a single moulding process from which a grinding wheel 1 having a single one-piece structure is obtained. In other words, in this solution the grinding wheel 1 is defined by a single-block achieved by means of a single moulding process wherein the two discs are formed one on the other, in a permanent and irreversible fashion.

[0029] Alternatively, the abrasive discs members 1a, 1b are coupled to each other in a permanent fashion by gluing.

[0030] In accordance with another advantageous aspect of the invention, the abrasive discs 1a, 1b have outer profiles, in transversal cross-section along a plane passing through the axis of rotation X" of the grinding wheel 1, which are geometrically different to each other. In particular, according to a preferred embodiment, the finishing disc 1b has a nominal outer profile, corresponding to the transversal profile of the groove 4a, 4b to be formed, whilst the roughing disc has a compensated outer profile, having a geometrical shape compensated relative to the transversal profile of the groove 4a, 4b to be obtained.

[0031] In use, the two discs 1a, 1b (that is, the two outer abrasive profiles 5, 6) are engaged in respective grooves 4a, 4b adjacent to the spiral-shaped track 3 of

the screw 2. The screw 2 is then rotated about a relative axis "Y" and simultaneously rotates the grinding wheel 1 about the relative axis "X" and the feeding of the grinding wheel 1 along the axis "Y" of the screw 2 determines a permanent engaging of the grinding wheel 1 with the spiral-shaped track 3, and in particular with different stretches in succession of the spiral-shaped track 3.

[0032] As a result, whilst the roughing disc 1a operates on a first stretch of the spiral-shaped track 3, the finishing disc 1b forms a finishing of a second stretch of the spiral-shaped track 3 previously roughed by the roughing disc 1a.

[0033] This operation is made possible where on the screw 2 there are preferably made infeed and outfeed zones which are recessed relative to the spiral-shaped track 3, or alternatively, an additional turn of the thread at the infeed and outfeed, in such a way as to house the finishing disc 1b at the infeed and the roughing disc 1a at the outfeed.

[0034] The invention described, even though it refers to a screw with a spiral-shaped track for recirculating ball screws, is applicable to many other solutions where there is a spiral-shaped profile to be ground, for example threads of female screws, trapezoidal screws, ACME screws, tapping tools (to be subjected to sharpening) and other items. For this reason, although in the embodiment illustrated the two outer abrasive profiles have a curved shape which substantially follows the spiral-shaped track for the balls to be obtained, these outer abrasive profiles may also have a different shape (for example trapezoidal, or others).

[0035] The present invention achieves the preset aims, overcoming the drawbacks of the prior art.

[0036] The grinding wheel 1 according to the invention allows the achievement of a complete processing (roughing + finishing) in a single pass, considerably reducing the operating times and also avoiding positioning problems which could arise, in the prior art, upon replacement of the roughing grinding wheel with the finishing grinding wheel.

[0037] Moreover, the structure of the grinding wheel according to the invention increases the thermal capacity and the capacity to dissipate heat outwards, thus reducing the problems of heating and eliminating the risk of dimensional irregularities in the ground profiles.

Claims

1. A grinding wheel for grinding spiral-shaped profiles, comprising a first abrasive disc (1a) and a second abrasive disc (1b), arranged side by side and positioned coaxially, the two discs (1a, 1b) being rigidly coupled to each other and each having an abrasive peripheral profile (5a, 5b) in such a way that the two abrasive discs (1a, 1b) engage inside two respective grooves (4a, 4b) of at least one spiral-shaped profile (3) of a mechanical member (2), **characterised in**

that the two discs (1a, 1b) have different abrasive properties to define different levels of surface roughness of the grooves (4a, 4b).

2. The grinding wheel according to claim 1, wherein one of the two abrasive discs (1a, 1b) is a roughing disc (1a) whilst the other disc is a finishing disc (1b). 5
3. The grinding wheel according to claim 1 or 2, wherein the abrasive discs (1a, 1b) are both made from ceramic material. 10
4. The grinding wheel according to any one of the preceding claims, wherein the two abrasive discs (1a, 1b) have different grain sizes and/or different densities. 15
5. The grinding wheel according to any one of the preceding claims, wherein the two abrasive discs (1a, 1b) have a different structure and/or a different binder and/or a different type of abrasive, for making different values of surface roughness of the grooves (4a, 4b). 20
6. The grinding wheel according to claim 1 or 2, wherein one of the abrasive discs (1a, 1b), preferably the abrasive disc (1a) defining a greater level of roughness, is made of ceramic material whilst the other abrasive disc (1b) is made of rubber. 25
7. The grinding wheel according to any one of the preceding claims, wherein the two abrasive discs (1a, 1b) are coupled to each other by reversible connecting means. 30
8. The grinding wheel according to claim 7, wherein the reversible connecting means comprise one or more connecting screws. 35
9. The grinding wheel according to any one of claims 1 to 6, wherein the two abrasive discs (1a, 1b) are coupled to each other by permanent connecting means. 40
10. The grinding wheel according to any one of claims 1 to 6, wherein the two abrasive discs (1a, 1b) define a single one-piece structure obtained by a single moulding process or connected to each other permanently by gluing. 45
11. The grinding wheel according to any one of the preceding claims, wherein the two abrasive discs (1a, 1b) are positioned relative to each other in such a way as to perform the grinding of corresponding adjacent grooves (4a, 4b) of the mechanical member (2). 50
12. The grinding wheel according to any one of the pre-

ceding claims, wherein the abrasive discs (1a, 1b) have outer profiles, in transversal cross-section along a plane passing through the axis of rotation (X) of the grinding wheel (1), which are geometrically different to each other.

13. The grinding wheel according to claim 12, wherein the disc (1b) configured to obtain a lower surface roughness, or finishing, has a nominal outer profile corresponding to the transversal profile of the groove (4a, 4b) to be formed, and wherein the disc (1a) configured to obtain a greater surface roughness, or roughing, has a compensated outer profile having a geometrical shape compensated relative to the transversal profile of the groove (4a, 4b) to be obtained.
14. A method for grinding a spiral-shaped profile of a mechanical member, performed using a grinding wheel (1) according to any one of the preceding claims in such a way that a first (1a) of the discs (1a, 1b), positioned in front of the feed direction (A) of the grinding wheel (1) relative to the spiral-shaped profile (3), makes a roughing of a first stretch of the spiral-shaped profile (3) and that, simultaneously, the other disc (1b) makes a finishing of a second stretch of the spiral-shaped profile (3) previously roughed by the first disc (1a).

Fig.1

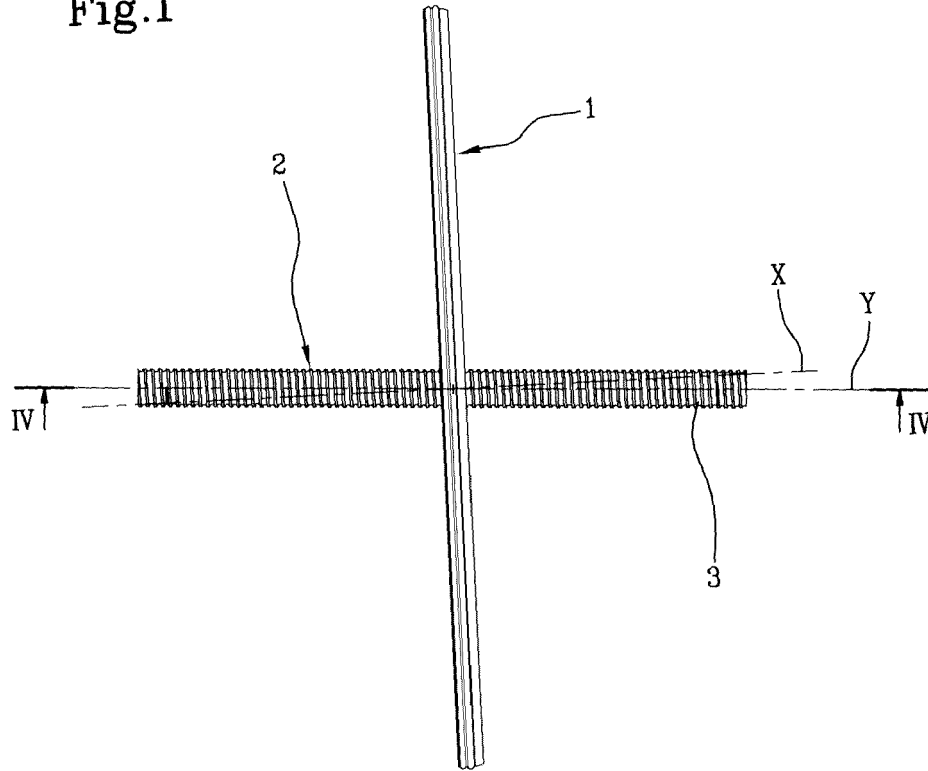
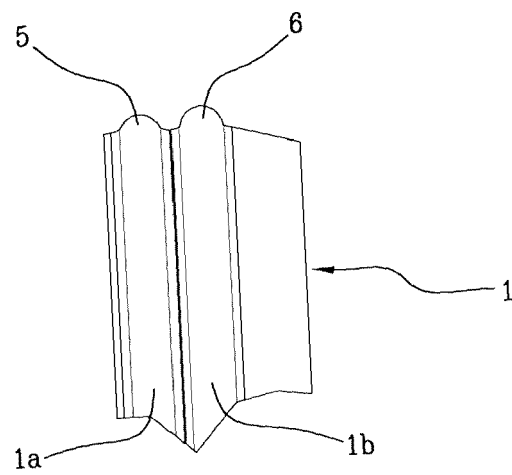


Fig.3



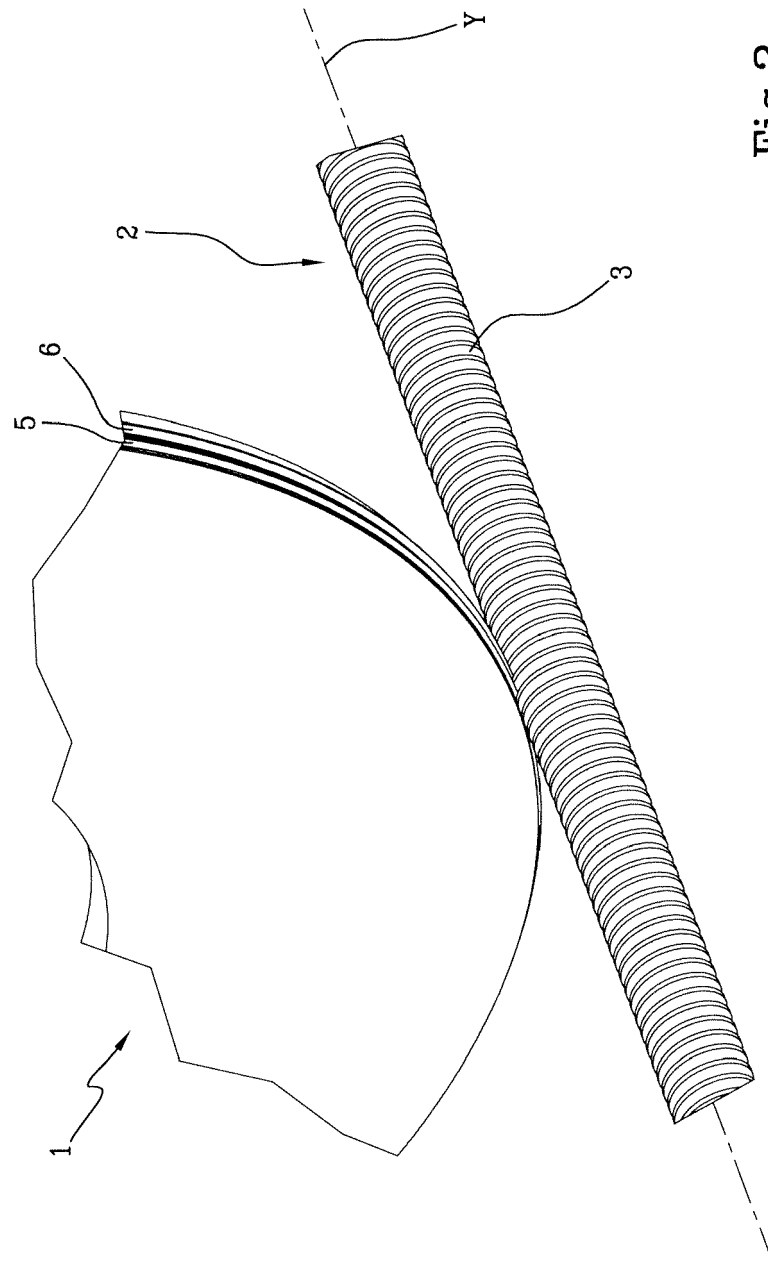
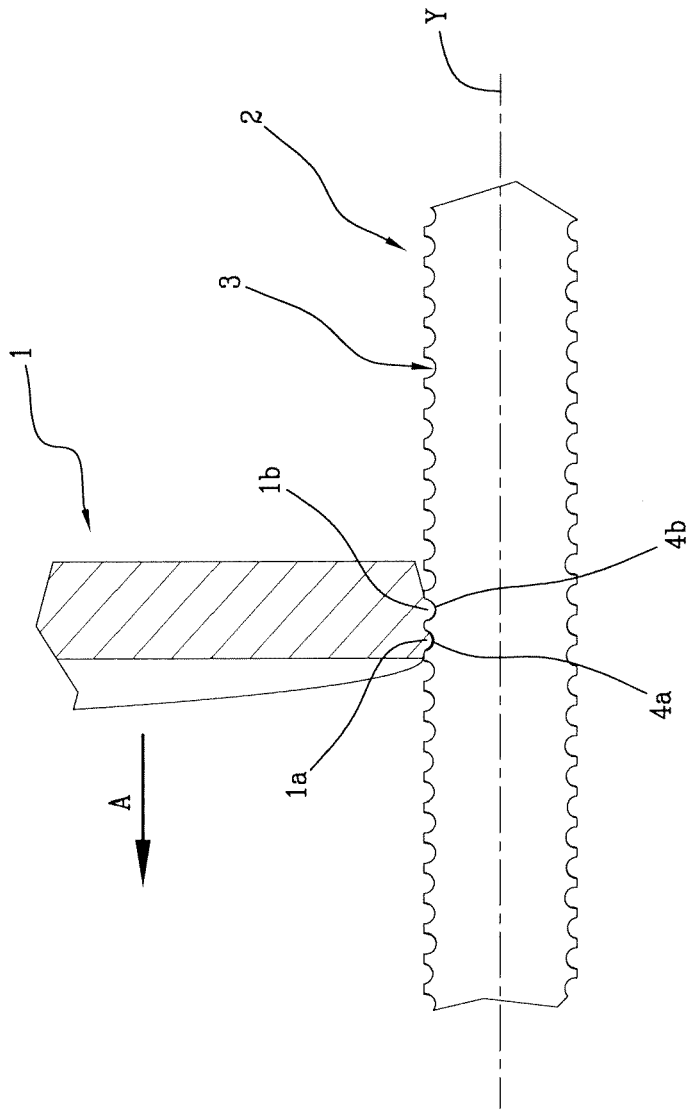


Fig. 2

Fig.4





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 EP 17 42 5033

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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