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(54) ARRANGEMENT FOR SHAPING OR RESHAPING A DIAMOND GUIDE BODY

(71) We, TED BILDPLATTEN AKTIENGESELLSCHAFT AEG-TELEFUNKEN TELDEC, of Hanibuhl 8, Postfach 126, CH-6301 Zug, Switzerland, a Body Corporate organised under the laws of Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an arrangement for shaping or reshaping a diamond guide body for a scanning system for scanning a record carrier which is moved relative to the guide body wherein the diamond guide body bears on the upper surface of the record carrier.

It has been shown that during scanning of a record carrier carrying very densely stored signals, a profile-ground bearing surface of the diamond guide body wears rapidly.

It is known to counter the wear of the bearing surface by aligning the diamond guide body during scanning in such a manner that one of the most wear-resistant crystallographic directions of the diamond points approximately in the direction of the movement of the record carrier relative to the guide body. Reference is made in this respect to the examples described in British Patent Specification No. 1,377,399.

Although the relative running direction of the guide body is aligned with one of the most wear-resistant crystallographic directions, the quality of the scanned signals, falls off markedly after a short period of use.

The cause of the premature reduction in the scanning quality was not due to the wear of the bearing surface but the rendering, during the pressure scanning, of the running edge, which is present on the diamond between the bearing surface and a limiting surface, ineffective owing to wear.

The guide body is provided with a profile grinding to provide a bearing surface for the pressure scanning of the record carrier, the profile of which grinding lies in a sectional plane approximately at right angles to the scanning direction. In order to retain this exact profile grinding and the scanning quality, the diamond guide body has its bearing surface shaped or reshaped.

This can be undertaken only in the time between play back operations, i.e. in scanning pauses, and it has been shown that shaping or reshaping according to this known method is time-consuming.

The invention seeks to shorten the time in which the bearing surface of a diamond guide body can be shaped or reshaped by means of a processing means.

According to the invention, there is provided an arrangement for shaping or reshaping a diamond guide body for a scanning system for scanning a record carrier by contact therewith in which the guide body is arranged to scan in a direction of high wear-resistance of the guide body, wherein, during pauses between the scanning, the bearing surface of the diamond guide body which is intended to contact the record carrier is shaped or re-shaped by processing means for profile grinding which are located adjacent the scanning system and which are moved relative to the guide body in a direction of low wear-resistance of the diamond guide body.

Preferably, the angle between the direction of movement of the record carrier relative to the guide body and the direction of relative movement of the processing means is not equal to 180° and said directions desirably extend in a plane lying at right angles to the surface of the record carrier.

According to a preferred embodiment of the invention, the two directions lie approximately in the same plane which is at right angles with respect to both a crystallographic cubic surface and to a crystallographic dodecahedral surface which includes with the cubic surface an angle of 45°, and wherein the direction of relative movement of the processing means is directed from the cubic surface to said dodecahedral surface and lies in an angle range of between 0° and 30° with respect to the cubic surface whereas the direction of relative movement of the record car-

rier is directed from said dodecahedral surface to the cubic surface and lies in an angle range of 10° to 45° with respect to the cubic surface.

The guide body may be so arranged that one of the four most wear-resistant directions within a crystallographic cubic surface extends from an apex on the bearing surface of the guide body at an angle to the record carrier which is not equal to 90°, and wherein said direction of relative movement of the processing means extends from said apex in a hemisphere limited by a plane including said one wear-resistant direction, said hemisphere being that in which the reaction force to the bearing force of the guide body points.

Preferably, the diamond guide body is provided with a sharp edge or corner by profile grinding of the bearing surface between the bearing surface and an adjacent surface of the guide body. The said adjacent surface desirably extends from the leading edge of the bearing surface and is arranged to be inclined to the record carrier at a steeper angle than that of the bearing surface.

The angle between the wear-resistant direction and the direction of relative movement of the processing means is desirably not less than 160° and is preferably approximately equal to 168°.

The advantages achieved with the invention consist particularly in that by the alignment of a wear-resistant direction of the diamond relative to the record carrier surface during the play back operation a low wear takes place on the diamond guide body and during the shaping or reshaping with the processing means a higher wear per unit time (wear rate) takes place on the diamond guide body. In this way the waiting time between play back operations can be kept small.

Preferably the direction [110] or an equivalent direction within a crystallographic cubic surface is used as the wear resistant direction, because, in this direction, the greatest wear resistance occurs and because for this case a natural octahedral point can be ground in a simple manner on the guide body or scanning element.

In order to increase the useful life of a diamond guide body used for pressure scanning, the guide body may be so aligned that, at the apex, said one wear-resistant direction points into the angle region lying outside the guide body between the bearing surface of the guide body and the record carrier and lies substantially in the plane which contains the direction of force bearing on the record carrier and the direction of relative movement of the record carrier, said one wear-resistant direction having a component in the said direction of relative movement of the record carrier. The edge formed between the bearing surface and a limiting surface extending from the apex of the diamond guide body is least worn as a result of this alignment.

The invention will now be described in greater detail, by way of example, with reference to the drawings, in which:

Figure 1 shows in a regular system a diamond octahedron with the wear-resistant direction [110], a cubic surface (001) and a dodecahedral surface (011);

Figure 2 shows this diamond octahedron cut along the wear-resistant direction [110] and the z-axis;

Figure 3 shows this diamond octahedron cut along the wear-resistant direction [011] in one dodecahedral surface and the z-axis;

Figure 4 is a graphical diagram showing the rate of wear which occurs at various angles δ between the processing direction of the guide body and the wear-resistant direction [110], as well as the wear rate in the play back operation in dependence on the angle γ between the wear-resistant direction and the surface of the record carrier;

Figure 5 likewise is a diagram of the rate of wear which occurs at various angles δ and γ, but in this case the wear-resistant direction $[0\bar{1}1]$ of a dodecahedron surface is used as the zero point of the abscissae;

Figure 6 shows a guide body or scanning skid in longitudinal section with the alignments in accordance with the invention in playback operation as well as in the shaping or reshaping operation; and

Figure 7 shows an embodiment of a shaping or reshaping device for a pressure scanner.

Figure 1 shows a diamond octahedron in a Cartesian coordinate system with the coordinates x, y, z, wherein one of the crystallographic directions, in which the diamond is particularly wear-resistant, is given the Miller's index [110]. This direction is in the x-y-plane or any other plane running parallel thereto; these planes are crystallographic cubic surfaces, e.g. (001). The Figure further shows on the diamond octahedron a dodecahedral surface (011) which is associated with the cubic surface (001) and extends at an angle of 45° to the cubic surface.

The wear rate values, determined by investigations, plotted on the graphs shown in Figures 4 and 5 are explained by reference to the diamond shown in Figures 2 and 3.

In Figure 2 the direction of movement B of the shaping or processing means, relative to the diamond guide body, the so-called processing direction, extends into the first quadrant at a positive angle δ to the direction $[\bar{1}\bar{1}0]$ which is parallel and opposite to the wear-resistant direction [110]. In this case, the diamond guide body is processed from below ,that is to say the processing means act in the z-direction. In Figure 4, the wear rate at $(\mu m)^3$/minute of the diamond during

processing is plotted on the ordinate for different values of the angles δ and γ which are plotted on the abscissae in directions opposite each other. The most favourable wear rates are thus achieved in the case of a positive angle δ of 12°.

If, in Figure 2, on the other hand, the processing direction B extends into the 2nd quadrant, then the angle δ is likewise positive for reasons of symmetry (because $[\bar{1}10]$ is a wear-resistant direction like [110]). If the angle δ is negative, i.e. the processing direction B extends into the 3rd. or 4th. quadrants, then substantially reduced wear rates result as shown in Figure 4.

Positive angles γ and $\gamma \approx 0$ between the wear resistant direction and the direction P of relative record movement give the region in a diamond in which the stress direction can lie, in order to achieve a low wear in the play back operation. According to Figure 2 positive γ points into the 3rd. or 4th. quadrants. The angle γ is in both cases positive for reasons of symmetry and in the diagram of Figure 4 a small wear rate can be read off. In this case the most favourable wear rate in the play back operation on the diamond lies at an angle of $\gamma \approx 0°$, the wear-resistant direction [110] then runs parallel to the surface 2 of the record carrier 3 according to Figure 6.

If the direction P, of the relative movement of the record carrier points, relative to the diamond, into the 1st. or 2nd. quadrants of Figure 2, then the angle γ is negative and in the diagram according to Figure 4 a high wear rate in the diamond can be read off for the play back operation.

The same situation as for the above-described angles δ and γ and the wear-resistant directions $[\bar{1}10]$ and $[\bar{1}\bar{1}0]$ in a cubic surface of the diamond according to Figure 2 and the diagram according to Figure 4 applies for the angles δ' and γ' and the wear-resistant direction $[0\bar{1}1]$ and $[0\bar{1}\bar{1}]$ in a dodecahedral surface of the diamond. In the diagram according to Figure 5 the most favourable values of the angles δ' and γ' for the stressing direction P and the processing direction B of a dodecahedral surface can be read off. The greatest wear on the diamond is achieved at an angle of δ' of approximately 35°, and the lowest wear rate for a play back operation lies at an angle δ' of $\approx 30°$.

The values indicated in the diagrams also give a good picture as to how large or how small the manufacturing tolerances of a diamond guide body have to be. Further explanation and clarification of the interrelationship of these values is given with reference to Figure 6.

So that the quality of guidance or scanning during the scanning or play back remains unobjectionable for a long period of time and in order to increase the useful life of the profile-ground diamond guide body, the bearing surface of the diamond must be shaped before the first playing operation and subsequently reshaped between two playing operations, by profile grinding with a processing means, which moves in a longitudinal direction of the bearing surface 4, which direction lies in the plane of the drawing of Figure 6. In order that an as high as possible wear rate results, the diamond guide body is aligned in a special manner.

The guide body according to Figure 6 is stressed by frictional forces when a record carrier 3 is moved relative thereto in the direction P. On the other hand the guide body, during profile grinding, is stressed in another direction, namely in the direction B of relative movement of the processing means, in which the wear resistance is lower. Both directions B and P which lie in a plane lying at right angles to the surface 2 of the record carrier 3, enclose an angle not equal to 180°. The guide body has two surfaces 5 and 6 limiting its bearing surface 4. The macroscopic surface, i.e. not taking into account the wave dales and peaks 12, of the record carrier is given the reference numeral 2. The wave valleys and peaks incorporate the stored information. The bearing surface 4 is at a certain angle β to the surface 2 of the record carrier 3. The surface 5 meets the bearing surface 4 at one edge or corner 7 at such an angle that engagement of the surface 5 on a wave peak 12 of the record carrier 3 is avoided, so that an unobjectionable pressure scanning is ensured by the edge or corner 7 of the diamond (*cf.* British Patent Specifications Nos. 1,266,202 and 1,266,203).

The diamond guide body 1 according to Figure 6 is aligned according to a wear-resistant crystallographic direction A. This wear-resistant direction A must lie substantially in a cubic dodecahedral or octahedral plane of the diamond. The direction [110] or $[\bar{1}10]$ in a cubic surface, the direction $[0\bar{1}1]$ or $[0\bar{1}\bar{1}]$ in a dodecahedral surface or an equivalent direction are suitable as the direction A.

If a wear-resistant direction of a dodecahedral surface is used for the scanning body, then the processing direction and the wear-resistant direction lie approximately in a y, z-plane of the diamond i.e. the drawing plane of Figure 6 is laid in a drawing plane of Figure 3. This plane is both perpendicular to a cubic surface [001] and to a dodecahedral surface [011], which encloses an angle of 45° with the cubic surface. In this case, the direction B of relative movement of the processing means is directed from the cubic

surface [001] to the dodecahedral surface [011] at an angle range of approximately 0° to at most 30° with respect to the cubic surface (corresponding in Figure 3 to

$$45° \geqslant \delta' \geqslant 15°).$$

On the other hand, the direction P of relative movement of the record carrier is directed from the dodecahedral surface [011] to the cubic surface [001] at an angle range of from 10° to 45° with respect to the cubic surface (corresponding to $-35° < \gamma \leqslant 0°$).

If, on the other hand, the relationships of Figures 2 and 4 are taken as a base, i.e. if the drawing plane of Figure 6 is laid on the drawing plane of Figure 2, then the following is true:

The angle γ between the direction P on the surface 2 of the record carrier 3 and of the wear-resistant direction A is assumed in Figure 6 to be 30°.

It should not be left unmentioned that it is known to process the diamond guide body for $\gamma \approx 0$ approximately in its wear-resistant direction A by profile grinding, oppositely to the direction B of the relative movement of the processing means. However the times, which are necessary in this case for the processing, are too high. A transverse grinding with which the times could be reduced, is not possible in the case of a diamond guide body which has to be profile ground. In accordance with the invention therefore, the bearing surface 4 of the diamond is so ground that a high wear is achieved on processing in order to keep the processing time as small as possible.

In the example according to Figure 6, particularly if γ is small, the processing direction B runs aprpoximately opposite the wear-resistant direction A and opposite to the direction P of relative movement of the record carrier 3. In the case of a profile-ground guide body 1 shown in Figure 6 the bearing surface 4 is limited in the direction P by the surface 5. The antiparallel $-A$ (broken line) to the wear-resistant direction A is also a wear-resistant direction in a cubic or in a dodecahedral surface. The acute angle δ is located between the direction $-A$ formed by the antiparallel to the wear-resistant direction A and starting from the corner or edge 7 and the direction B, likewise starting from the corner or edge 7, of relative movement of the processing means. The angle δ amounts to up to 20°, preferably 12° in a cubic surface, as Figure 4 shows. The wear-resistant direction A and the antiparallel direction $-A$ in each case starting from the corner or edge 7 forming the apices of all angles drawn in, should in the case of the exemplary embodiment according to Figure 6 lie outside the guide body (wherein the direction A has a component in the direction P but also in the direction of the pressing force of the processing means) because the guide body then works in a self-sharpening manner.

As can be seen from the diagrams shown according to Figures 4 and 5, there exists a close correlation between the angle γ or γ', the positive values of which give the preferred region, in which the direction P of relative movement of the record carrier can be found, and the angles δ or δ', which is limited by the bearing surface 4 and the antiparallel to the wear-resistant direction A, preferably

$[\bar{1}10]$ or $[0\bar{1}1]$ or equivalent directions, and in each case in the example according to Figure 6 concomitantly encloses the processing angle β. In the alignment according to a wear-resistant direction of the cubic surface, the ideal case would, in this example, be given with the most favourable wear rates in the processing according to Figure 4, if the wear-resistant direction A would coincide with the direction of the arrow P. Then a processing with the greatest wear rate could be undertaken at an angle of $\delta = 12°$. The processing angle β is the angle which is located according to Figure 7 between the processing surface 9 and the surface 2 of the record carrier 3 (the surface 2 coincides in Figure 7 with the chassis surface 13). In this ideal case the angle δ would coincide with the angle located between the bearing surface 4 and the antiparallel to the wear-resistant direction and thus the angle γ would be zero.

Other favourable angle combinations between the angles γ or γ' and δ or δ' can be seen from the diagrams according to Figures 4 and 5, wherein care must be taken that the limb of the angle γ formed by the surface 2 must always lie outside the guide body.

The processing means 11 according to Figure 7 for a diamond guide body 1 is in this example pivoted about the angle β, which is located between the bearing surface 4 and the surface 2 of the record carrier 3. What is also conceivable is a pivoting of the guide body 1 about the angle β so that the processing means 11 lie in the surface 2. A ring-shaped groove 10 with which a shaping or reshaping of the guide body 1 is possible, is arranged in the surface 9 of the processing means 11.

In the case of a preferred use of a wear-resistant direction forming the said direction A, it is particularly surprising that, as a result of the selection of the processing direction in such a manner that it almost runs in the opposite direction to the direction of the relative movement of the record carrier, the processing can be effected substantially more quickly than in the case of a processing direction lying approximately in the direction of the relative movement.

WHAT WE CLAIM IS:—

1. An arrangement for shaping or reshaping a diamond guide body for a scanning system for scanning a record carrier by contact therewith in which the guide body is arranged to scan the record carrier in a direction of high wear-resistance of the guide body, wherein, during pauses between the scanning, the bearing surface of the diamond guide body which is intended to contact the record carrier is shaped or reshaped by processing means for profile grinding which are located adjacent the scanning system and which are moved relative to the guide body in a direction of low wear-resistance of the diamond guide body.

2. An arrangement according to Claim 1, wherein the angle between the direction of movement of the record carrier with respect to the guide body and the direction of relative movement of the processing means is not equal to 180° and wherein said directions extend in a plane lying at right angles to the surface of the record carrier.

3. An arrangement according to Claim 2, wherein the two directions lie approximately in the same plane which is at right angles with respect to both a crystallographic cubic surface and to a crystallographic dodecahedral surface, which includes with the cubic surface an angle of 45°, and wherein the direction of relative movement of the processing means is directed from the cubic surface to said dodecahedral surface and lies in an angle range of between 0° and 30° with respect to the cubic surface whereas the direction of relative movement of the record carrier is directed from said dodecahedral surface to the cubic surface and lies in an angle range of 10° to 45° with respect to the cubic surface.

4. An arrangement according to Claim 1 or Claim 2, wherein the guide body is so arranged that one of the four most wear-resistant directions within a crystallographic cubic surface extends from an apex on the bearing surface of the guide body at an angle to the record carrier which is not equal to 90° and wherein said direction of relative movement of the processing means extends from said apex in a hemisphere limited by a plane including said one wear-resistant direction, said hemisphere being that in which the reaction force to the bearing force of the guide body points.

5. An arrangement according to any preceding Claim, wherein the diamond guide body is provided with a sharp edge or corner by profile grinding of the bearing surface between the bearing surface and an adjacent surface of the guide body.

6. An arrangement according to Claim 5, wherein said adjacent surface extends from the leading edge of the bearing surface and is arranged to be inclined to the record carrier at a steeper angle than that of the bearing surface.

7. An arrangement according to Claim 6, wherein the processing means have direction of relative movement with a predominant component extending opposite to the direction of relative movement of the record carrier.

8. An arrangement according to Claims 4 and 7, wherein the angle between said wear-resistant direction and the direction of relative movement of the processing means is not less than 160°.

9. An arrangement according to Claim 8, wherein the said angle is approximately equal to 168°.

10. An arrangement according to Claims 4 and 7, wherein the angle between said wear-resistant direction and the direction of relative movement of the record carrier is within the range of between 0° and 10°.

11. An arrangement according to Claims 2, 4 and any one of Claims 7 to 10, wherein the guide body is so aligned that, at the apex, said one wear-resistant direction points into the angle region lying outside the guide body between the bearing surface of the guide body and the record carrier and lies substantially in the plane which contains the direction of force bearing on the record carrier and the direction of relative movement of the record carrier, said one wear-resistant direction having a component in the said direction of relative movement of the record carrier.

12. An arrangement according to any preceding Claim, wherein means are provided for moving the processing means under the guide body during the scanning pauses.

13. An arrangement for shaping or reshaping a diamond guide body substantially as described herein with reference to the accompanying drawings.

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