# United States Patent [19]

**Shibata**

[11] **3,774,918**

[45] **Nov. 27, 1973**


[54] **PHONOGRAPH PICKUP STYLUS**


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[73] Assignee: **Victor Company of Japan, Ltd.**, Yokohama-City, Kanagawa-ken, Japan



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[21] Appl. No.: **232,892**

[30] **Foreign Application Priority Data**

| | | |
|---|---|---|
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| Oct. 12, 1971 | Japan | 46/79845 |
| Oct. 12, 1971 | Japan | 46/79846 |

[52] **U.S. Cl.** ..... **274/38**

[51] **Int. Cl.** ..... **G11b 3/46**

[58] **Field of Search** ..... 274/38; 33/18 R; 30/164.9



[56] **References Cited**

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| | | | |
|---|---|---|---|
| 2,534,735 | 12/1950 | Roberts et al. | 274/38 |
| 2,699,720 | 1/1955 | Howey | 274/38 |

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| | | | |
|---|---|---|---|
| 768,414 | 2/1957 | Great Britain | 274/38 |



*Primary Examiner*—Louis R. Prince
*Assistant Examiner*—Steven L. Stephan
*Attorney*—Louis Bernat



[57] **ABSTRACT**

A portion of a conical stylus body is partitioned from the remainder of the structure by one or two planes inclined at a specific angle relative to a centerline axis passing through the vertex of the conical stylus body. That portion is cut off and removed by one or two cutting steps thereby forming one or two cut faces on the body. An edge line part is formed at the intersection of the one or two cut faces and the outer conical surface of the body. Suitable points on the two lateral sides at the lower part of the edge line part and the parts in the vicinity thereof contact the opposed side walls of the sound groove of a record disc. The curve of the edge line part at the side points and the parts in the vicinity thereof having a large radius of curvature.


**8 Claims, 13 Drawing Figures**

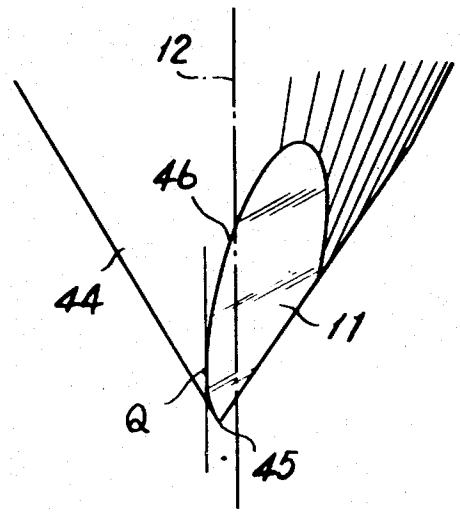


FIG. 1

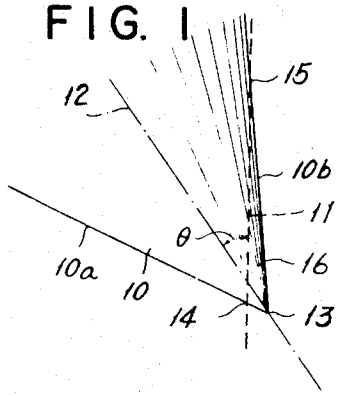



FIG. 2A

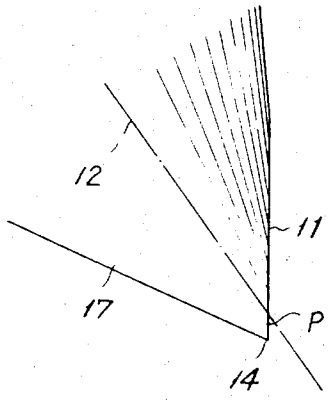



FIG. 2B

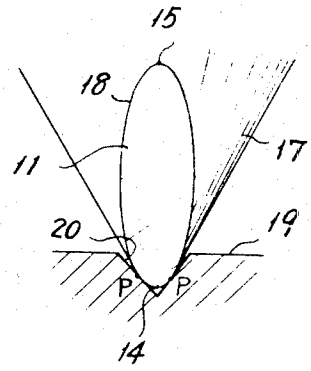



FIG. 3

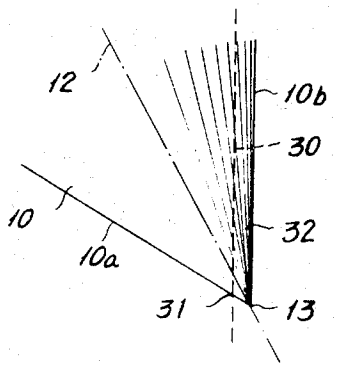


FIG. 4A

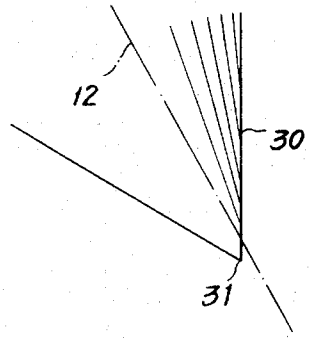



FIG. 4B

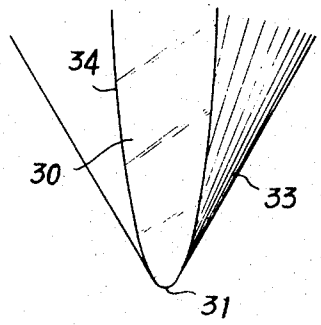



FIG. 5

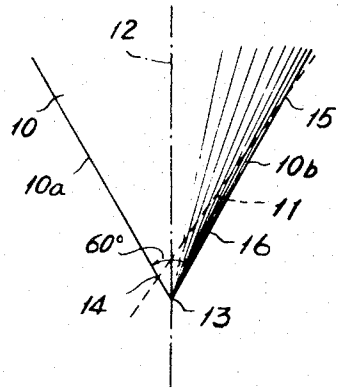



FIG. 6

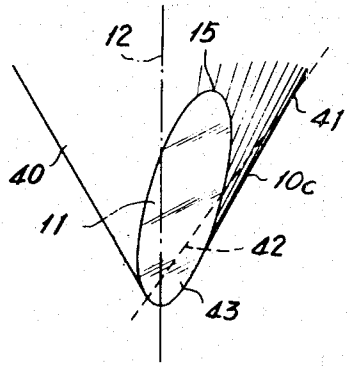


FIG. 7A

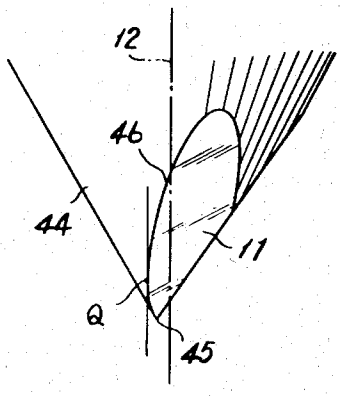



FIG. 7B

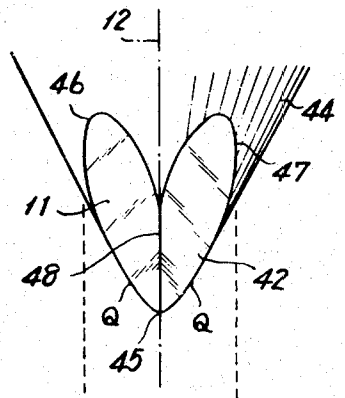



FIG. 7C

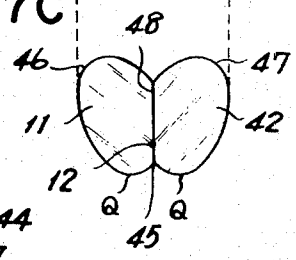



FIG. 8A

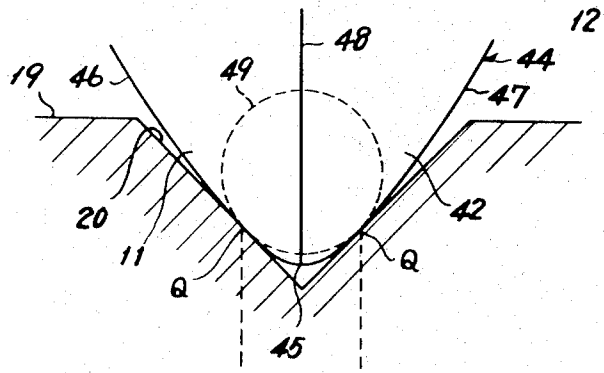
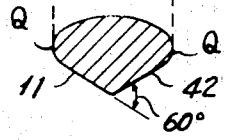



FIG. 8B



# PHONOGRAPH PICKUP STYLUS

## BACKGROUND OF THE INVENTION

This invention relates to a phonograph pickup stylus, and more particularly to a phonograph pickup stylus for reproducing sound from a record disc. The stylus is capable of contacting each of the two walls of a sound groove of the record disc with a contact surface figure which is short in the longitudinal direction of the groove and long in the transverse or depth direction extending toward the bottom of the groove.

Among the phonograph pickup styluses known heretofore, there have been those called round styluses and elliptical styluses. A round stylus has a tip of spherical shape. For this reason, the perimeter of the contact surface of the stylus and each record groove wall has a circular contour. The term "contact surface contour" is herein used to designate the surface contour where the stylus contacts the groove wall when it is held in the groove with a specific stylus pressure. This pressure causes the part of the groove wall thus contacted to undergo a plastic deformation, whereby the stylus is in a state wherein it is pressing into the groove wall. In the case of a round stylus, the contact surface contour is a relatively large circular figure. For this reason, a round stylus cannot reproduce, in a fully satisfactory manner, signals of relatively high frequencies recorded in the form of small waveforms in the groove walls.

To overcome this disadvantage of round styluses, an elliptical stylus has been proposed and used. This elliptical stylus has a shape produced by grinding the front and rear sides of a round stylus thereby giving the cross section thereof an elliptical shape. The term "front and rear sides" is herein used to designate the front side and rear side of the stylus advancing relatively to the sound groove. When this elliptical stylus is placed in a record groove, the length of the contact surface contour in the groove longitudinal direction is short, whereby the stylus is capable of reproducing signals of relatively high frequencies. However, the area of the above mentioned contact surface figure also becomes small. For this reason, the elliptical stylus can easily bite into the groove walls. Consequently, the wall surfaces tend to be damaged after several uses. Furthermore the recorded signals cannot be reproduced with good signal to noise ratio (S/N). Particularly in a four-channel record which the present applicant has previously proposed, in which a high-frequency component of from 40 to 50 KHz is recorded. Therefore, when a record of this character is played back or reproduced with a conventional elliptical stylus, the parts of the groove walls with small waveform undulations are particularly subject to severe damage, whereby the signal to noise ratio of the reproduced signals becomes small.

As one measure to overcome this disadvantage, the contact surface contour of the stylus and each groove wall is made an elongated ellipse with its shorter dimension in the longitudinal direction of the groove. Its longer dimension, in the transverse direction or the depth direction extending toward the bottom of the groove along the groove wall (hereinafter referred to simply as depth direction), and the area of this contact surface contour is made large. Hence, the stylus does not bite into the groove walls. By the use of the stylus which forms a contact surface figure of the above described shape, it is possible to reproduce signals of high frequency with excellent signal to noise ratio.



One example of such a stylus is the gramophone needle proposed and disclosed in the specification of British Pat. No. 768,414, filed Apr. 13, 1955, entitled "Improvements in and relating to Gramophone Needles". In this specification, however, it is merely indicated theoretically that the shape of the needle (stylus) described therein is desirable. In actual practice, it is difficult to form the shape by grinding a curved part of a large radius of curvature in the vertical section. Accordingly, the reduction into practice of this proposed pickup has been impossible.

## SUMMARY OF THE INVENTION

Accordingly, it is a general object of the present invention is to provide a novel and useful phonograph pickup stylus wherein the above described disadvantages accompanying prior art styluses and the above described proposed needle are overcome.

Another object of this invention is to provide a phonograph pickup stylus of a shape whereby it can contact each wall of the sound groove of the record disc with a contact surface contour of a shape which is short in the longitudinal direction of the groove and long in the depth direction.

A further object is to provide a phonograph pickup stylus, having a curved surface part for making contact with a record groove wherein the surface is made by merely subjecting it to a plane cutting. These curved parts have a large radius of curvature in the vertical section of the stylus in its state of use. The phonograph pickup stylus according to the invention can be produced easily and at low cost.

Other objects and features of the invention will be apparent from the following detailed description when read in conjunction with the accompanying drawings, in which like parts are designated by like reference numerals and characters.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. **1** is a side view of the tip of a stylus, showing how it is cut during fabrication, for illustrating a first embodiment of a phonograph pickup stylus according to the invention;

FIGS. **2A** and **2B** are respectively a side view and a front view showing a fabricated stylus of the first embodiment;

FIG. **3** is a side view of the tip of a stylus, showing how it is cut during fabrication, for illustrating a second embodiment of a stylus according to the invention;

FIGS. **4A** and **4B** are respectively a side view and a front view showing a fabricated stylus of the second embodiment;

FIGS. **5** and **6** are respectively side views of the tip of a stylus showing how it is cut during fabrication, for illustrating a third embodiment of a stylus according to the invention;

FIGS. **7A**, **7B** and **7C** are respectively a side view, a front view and a bottom view of the fabricated stylus of the third embodiment; and

FIGS. **8A** and **8B** are respectively a vertical cross section showing the stylus of the third embodiment in the state of contact with the walls of a sound groove of a record disc, and a developed cross-sectional view of a section of the stylus of the third embodiment taken perpendicularly to the groove walls at the contact surface between the stylus and the groove walls.

## DETAILED DESCRIPTION

Referring first to FIGS. **1**, 2A and 2B, the first embodiment of the stylus according to the present invention, is fabricated by first grinding the extreme end of a diamond stylus body of the initial shape of a square bar into a cone of a vertex angle of 60°. The tip of the conical part thus ground is shown in FIG. **1**. The conical stylus body **10** thus obtained is orientated by tilting its axis **12** so that the plane **11** along which it is to be cut is vertical.

The cut plane **11** is inclined by a specific angle $\theta$ (less than 90°) relative to the axis **12**. Plane **11** then passes through a point **14** which is offset by a distance in the order of from **12** to **15** microns on the profile line **10***a* on one side, as shown in FIG. **1**. This distance is measured from the vertex **13** of the conical stylus body **10**. At the same time, plane **11** passes through a point **15** spaced apart by a substantial distance from the vertex and disposed on the conical profile line **10***b* on the other side of the stylus body **10**. The portion of the conical stylus structure including the vertex **13** and partitioned by the cut plane **11** is then ground off and removed.

As a result of this cutting operation, a stylus **17** is shaped as indicated by the side view of FIG. 2A and by the front view of FIG. 2B. As indicated in FIG. 2B, the shape of the resulting contour along the cut plane **11** on the stylus body is an ellipse. An elliptical edge line **18** is thus defined by the cut plane **11** and the conical outer surface of the stylus. In and along the lower portion of this edge line **18**, the edge thereof is rounded with a small, constant radius of curvature of the order of from 5 to 10 microns, for example, in planes perpendicular to the edge, whereupon the phonograph pickup stylus **17** is completed.

This pickup stylus **17** is placed in a sound groove **20** of a record disc **19** with an orientation such that the cut plane **11** is vertical and perpendicular to the groove as shown in FIG. 2B,. Points P, P, and the parts in the vicinity thereof on the two sides in the lower portion of the elliptical edge line **18**, make contact against the two opposite walls of the sound groove **20**. The angle formed by the tangent lines at the points P, P of the stylus **17** is substantially equal to the angle between the two walls of the groove **20**. The radius of curvature of the curve of the edge line **18** at each point P and the parts in the vicinity thereof is large, being of the order of **75** microns, for example. Accordingly, the stylus **17** contacts each wall of the groove **20** with a contact surface figure of a shape which is short in the longitudinal direction of the groove and long in the depth direction thereof.

Next the second embodiment of the pickup stylus, according to the invention, will be described with reference to FIGS. **3**, **4**A and **4**B.

A stylus body **10** is first prepared with a conical end, in the same manner as described above with respect to the first embodiment. Then it is orientated by tilting its axis **12** as that a plane **30** is vertical. The stylus structure is to be cut along this path. The cut plane **30** is inclined relative to the axis **12** by a specific angle $\theta'$ (equal to ½ of the vertex angle of the stylus, namely 30° in this embodiment). Furthermore, this cut plane **30** passes through a point **31** which is offset by a distance in the order of from 12 to 15 microns on the profile line **10***a* on one side from the vertex **13** of the conical stylus body **10**. At the same time, cut plane **30** is parallel to th profile of **10***b* on the other side of the stylus body. The portion of the stylus body including the vertex **13** is cut off where partitioned by the cut plane **30**. The cut off is preferably removed by grinding. As a result of this cutting operation, a stylus **33** as indicated by the side view of FIG. **4**A and the front view of FIG. **4**B is obtained. As indicated in FIG. **4**B, the shape of the resulting figure along the cut plane **30** on the stylud body is a parabola. A parabolic edge line **34** is thus defined by the cut plane **30** and the conical outer surface of the stylus. In and along the lower portion of this edge line **34**, the edge thereof is rounded with a small, constant radius of curvature in the order of from 5 to 10 microns, for example, in planes perpendicular to the edge, whereupon the phonograph pickup stylus **33** is completed.

There is a large radius of curvature of the parabolic edge line **34** at the points P, P and the parts in the vicinity thereof of contact with the groove walls of the record disc. This is substantially the same as that of the radius of the same parts in the case of the preceding first embodiment.

An extremely important feature of the present invention is that in both of the above described first and second embodiments, the curve of large radius of curvature including the points P, P and the parts in the vicinity thereof of the edge lines **18** and **34** can be obtained by the very simple procedure of making a single plane cutting with respect to the cut planes **11** and **30** of the stylus body **10**.

In order to cause the edge line portions at the points P, P and the parts in the vicinity thereof of the styluses **17** and **33** in the above described two embodiments to conform to the record groove walls in the depth direction thereof, it is necessary to orientate the styluses so that the cut faces **11** and **30** are vertical. For this purpose, it is necessary to use the styluses in a state wherein their axes **12** are inclined as indicated in FIGS. **1** and **3**, and when the styluses are to be installed in their pickups, the setting of the inclinations of these styluses presents a difficult problem.

The present invention solves this problem in a third embodiment thereof as described below.

As indicated in FIG. **5**, a stylus body **10** with a conical end of a vertex angle of 60° is prepared similarly to the above described embodiments and is disposed so that its centerline axis **12** is vertical. Next, similarly as in the first embodiment, the portion **16** including the vertex **13** is cut off along the line partitioned by the cut plane **11** passing through the points **14** and **15**. The cut off part is removed by grinding, whereupon a cut face **11** is obtained on the stylus. A resulting stylus **40** appears as shown in FIG. **6** when it is rotated toward the viewer through an angle of 60° from its state as shown in FIG. **5**.

The stylus **40** is then subjected to another cutting operation. A part **43** thereof is cut off and removed by grinding along a cut plane **42** passing through a point **41** of the same height as the point **15** on the profile line **10**c as shown in FIG. **6**. The two cuts form a dihedral angle of **60** degrees with the extrapolated extension of the cut face **11**. As a result, there is obtained a pickup stylus **44** as shown in side view, front view and bottom view in FIGS. 7A, 7B and 7C, respectively.

This stylus **44** is rounded as indicated at its lower tip **45**, and the lower parts of the edge lines **46** and **47**

formed as intersections of the cut faces **11** and **42.** The conical outer surface of the stylus structure are rounded therealong with a constant small radius of curvature of the order of from 5 to 10 microns with curvature centers lying in planes perpendicular to the edge lines, whereupon the stylus is completed. A two-plane section of this stylus **44,** taken along dihedral planes perpendicular to the contact surfaces at points Q, Q as shown in FIG. **8**A, appears as shown in FIG. **8**B when developed flat in a single plane. This section has a somewhat fan-like shape.

The edge lines **46** and **47** are symmetrical with respect to the intersection line between the cut planes **11** and **42.** When the stylus **44** is lowered into the groove **20** of the record disc **19,** as indicated in FIG. **8**A, the two side points Q, Q and the parts in the vicinity thereof, on these edge lines **46** and **47,** make contact with the opposite walls of the groove. The radius of curvature of the curved edge lines **46** and **47** at these points Q, Q and the parts in the vicinity thereof is greater than, for example, the corresponding radius of curvature (approximately 75 microns) in each of the preceding embodiments. Of course, it is also greater than the radius of an imaginary circle **49** tangentially in contact with tangent lines passing through the points Q, Q as viewed in FIG. **8**A. Accordingly, the stylus **44** makes contact with the record groove **20** along a contact surface contour which is short in the longitudinal direction of the groove and long in the depth direction thereof.

As indicated in FIG. **7**A, when the centerline axis **12** of the stylus **44** is in a state wherein it is perpendicular to the record disc, the tangent to the edge line **46** (or **47**) at the point Q is perpendicular to the record disc and parallel to the axis **12.** Accordingly, in order to cause the stylus **44** make contact with the record groove, in a manner which conforms to the groove walls in the depth direction thereof, without tilting the points Q, Q and the parts in the vicinity thereof of the edge lines **46** and **47,** the stylus is held in a position wherein its axis **12** is vertical.

Therefore, the stylus **44** of this third embodiment differs from the styluses **17** and **33** of the preceding embodiments in that the procedure of installing the stylus **44** in the pickup cartridge is greatly facilitated since the points Q, Q and the parts in the vicinity thereof conform accurately to the groove wall contour in the depth direction thereof when the stylus is used with its axis vertically orientated.

In this third embodiment, two plane cuttings are made to produce the cut faces **11** and **42** respectively inclined relative to profile side lines of the stylus body. Alternatively, the cutting procedure of the second embodiment may be applied to cause a cut fact to be parallel to a side line of the stylus body. In this case, the edge line formed by the cut face and the outer conical surface of the stylus body constitutes a part of a parabola.

By the practice of the invention according to this third embodiment thereof as described above, it is possible to obtain a curve of large radius of curvature in the vertical section of the stylus at its part where it contacts the record groove. Moreover, the stylus can be used with its centerline axis in vertical state.

In each of the foregoing embodiments, the plane cutting of the stylus body can be accomplished by any suitable known grinding method. That is, for example, the grinding can be carried out by applying the stylus body against a rotating grinding disc on which an abrasive such as powdered diamond has been deposited.

The principal features of the phonograph pickup stylus according to the present invention may be enumerated as follows.

1) By merely making a simple plane cut only once or twice with respect to the conical end part of the stylus, a pickup stylus can be very easily produced with a curve of large radius of curvature in its parts in contact with a record groove in a vertical section.

2) Since the pickup stylus makes contact with the walls of the record groove with a contact surface contour which is short in the longitudinal direction of the groove and long in the depth direction thereof, the stylus can reproduce even high-frequency signals with a large signal to noise ratio. Moreover, since the contact area is large, there is little possibility of damage to the record groove, whereby the serviceable life of the record disc is prolonged.

3) Since the area of the contact surface contour between the stylus and the groove walls is relatively large, the result is equivalent to an increase in the stiffness of the record disc, and the resonance frequency of the vibrator becomes a high frequency. Accordingly, the frequency characteristics capable of reproducing recorded sound in an excellent manner are extended to a high frequency band.

4) As is known, the record disc softens when its temperature becomes high, and the above mentioned resonance frequency fluctuates greatly with temperature. For this reason, in the case of a conventional stylus, the resonance frequency is readily affected by the temperature since is is a relatively low frequency. In contrast, in the case of the stylus of this invention, the resonance point which fluctuates with temperature is outside of the frequency band used and, as a result, is not subject to the effect of temperature variations.

Further, this invention is not limited to these embodiments but various variations and modifications may be made without departing from the scope and spirit of the invention.

What I claim is:

**1.** A phonograph pickup stylus comprising a conical stylus body having at least one plane cut face formed by removing material from said conical body along at least a single cut portion of the stylus body, the removed material including the conical vertex thereof and being partitioned from the remainder of the body by at least one intersecting plane inclined at a specific angle $\theta$ (less than 90°) relative to the centerline axis of the body passing through the vertex, an edge line being formed at the intersection between said plane cut face and the outer conical surface of the body, the angle between tangents at two side points of said edge line near the tip part thereof being substantially equal to the dihedral angle between the opposed side walls of a record disc groove in which the stylus is placed in operation whereby said side points and the parts in the vicinity thereof contact said groove, and the radius of curvature of the edge line at the side points and the parts in the vicinity thereof being greater than the radius of an imaginary circle tangentially inscribed between the edge line at the two side points.

**2.** The phonograph pickup stylus as claimed in claim **1** in which at least one cut face passes through a point disposed near said vertex and on one of the side profile

lines of the stylus body as viewed laterally and perpendicularly relative to the direction of its travel, said cut face also passes through a point disposed remotely from the vertex and on the other side profile line, and said edge line between said cut face and the outer conical surface of the stylus body outlines a substantially elliptical figure.

**3.** The phonograph pickup stylus as claimed in claim **1** in which at least one cut face passes through a point disposed near said vertex and on one of the side profile lines of the stylus body as viewed laterally and perpendicularly relative to the direction of its travel, said cut face is parallel to the other side profile line, and said edge line between said cut face and the outer conical surface of the stylus body outlines a substantially parabolic figure.

**4.** The phonograph pickup stylus as claimed in claim **1** in which the stylus body at least at said two side points and the parts in the vicinity thereof of said edge line is rounded along the edge line with a constant radius of curvature with centers of curvature lying in a plane perpendicular to the edge line.

**5.** A phonograph pickup stylus comprising a conical stylus body having two cut faces formed by removing a portion of the stylus body, the removed portion including the conical vertex thereof and being partitioned from the remainder of said body by two intersecting planes inclined at a specific angle $\theta$ (less than 90°) each relative to the centerline axis of the body passing through the vertex, said two intersecting planes forming a dihedral angle therebetween at their intersection, the intersections between the two edge lines formed by said two cut faces and the edge lines at the outer conical surface of the body having a symmetrical shape with respect to said intersection between said two planes, the angle between tangents at two side points of said edge lines near the tip part thereof being substantially equal to the dihedral angle between the opposed side walls of a record disc groove in which the stylus is placed in operation whereby said side points and the parts in the vicinity thereof make contact with said groove, and the radius of curvature of the edge lines at the side points and the parts in the vicinity thereof being greater than the radius of an imaginary circle tangentially inscribed between the edge lines at the two side points.

**6.** The phonograph pickup stylus as claimed in claim **5** in which said conical stylus body has a vertex angle of 60°, and the angle between one of said two cut faces and the extrapolated extension of the other cut face is 60°, the stylus being used in operation with the centerline axis thereof maintained perpendicular to the record disc.

**7.** A phonograph stylus comprising an initially conical tip having a portion of the cone removed, said portion having at least one flat surface forming an elliptical conical section dividing the vertex of said cone from the stylus.

**8.** The stylus of claim **7** wherein there are two of said flat surfaces set at an angle with respect to each other so that the two edges created by the intersections of the flat surfaces with the conical surface tangentially conform to the angle made by the walls of a phonograph groove.

* * * * *