

AN INNER ROTARY CUTTER FOR AN ELECTRIC SHAVER
AND A PROCESS FOR MANUFACTURING SUCH A CUTTER

The present invention relates to an inner rotary
5 cutter for an electric shaver, and to a process for manufacturing such a cutter.

It is known to provide an inner rotary cutter for an electric shaver having a plurality of blades positioned at generally regular intervals on the circumference of a rotatable disk.
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The process for manufacturing such an inner rotary cutter is illustrated in Figs. 19 to 22 of the accompanying drawings, and will be described below. Figs. 19 to 21 show inner cutter blanks corresponding to various steps in the manufacturing process; in each of these figures is shown a
15 plan view (A) of the inner cutter blank and a front view (B) of one blade-forming section. Fig. 22 shows a side view of one blade-forming section.

As a first step, a flat cutter blank 50 shown in
20 Fig. 19 is punched out from a plate material (not shown). This cutter blank 50 consists of a circular section 51 and a number of blade-forming sections 52 extending radially from the circumference of the circular section 51.

In the second step (as shown in Fig. 20(B)), an
25 outer half section 52a of the blade-forming section 52 is bent, by a press to a line R1 inclined to the radial direction; the angle of the bend being close to 90°.

Discharge holes 53 are bored on the circular section 51 simultaneously with this bending step. Subsequently, as shown in Fig. 21(B), a part of the blade-forming section 52 close to the circular section 51 is bent by a press to an angle of about 90° in a direction opposite to the bending of the half section 52a. The cutter blank is then subjected to a heat treatment to a Vickers hardness of ca. 650.

In the third step, the blade-forming section 52 (Fig. 15(B)) is ground so as to be cut to a horizontal line R2 shown in Fig. 22 and is polished to form a sharp edge and simultaneously subjected to plane processing. Thus, a blade section 54 is formed at the tip of the blade-forming section 52 (see Fig. 18).

In the last step, both the outer diameter D_o and the inner diameter D_i formed by the blade sections 54 (Fig. 18) are made uniform by grinding both the inner side (the central side) 54a and the outer side 54b of the blade section 54. Thus, an inner cutter 60 is formed.

Most of the known inner cutters are manufactured as described above and have the form shown in Fig. 18, which is disclosed, for example, in Japanese Laying-open Patent Gazette No. 54-81956.

However, such known inner cutters have been found to have the following disadvantages:

Firstly, if the so-called progressive press system, usually effective for cost reduction, is used for producing

the known cutters, much waste material will be produced so that the cost of material is raised. Also the blade-forming sections 52 will catch one another so that automatic material supply by means of a parts feeder, etc. is
5 disturbed. In addition, when the number of blades is increased and hence the intervals between the blade-forming sections 52 are reduced, the mould used needs to have such a small thickness that its service life is reduced.

Secondly, since bending by a press needs to be
10 applied at least twice, spring-back of the material will cause irregular positioning of the blade sections 54. Also, since the complicated bending process is followed by heat treatment, not all the blade sections 54 will experience the same thermal strain nor the same strain in the
15 roll direction, so that they do not have the same level of cutting ability.

Thirdly, since blade sections 54 have positional scatter and blade-forming sections 52 have height scatter, due to the thermal strain, a large amount of material (52b
20 in Fig. 22) needs to be ground off in order to make all blade surfaces flush to the same plane. Moreover, since (as seen from the plan view of one blade-forming section 52 shown in Fig. 18), neither the inner diameter D_i nor the outer diameter D_o of the cutter 60 formed by the blade
25 sections 54 in Fig. 18 is exactly circular, an additional grinding process is required to put all the blade sections 54 in alignment. This grinding processing takes up much

time since there exist spaces between blade sections 54 and since each blade section 54 has been made brittle by thermal treatment.

Fourthly, blade-forming sections 52, having been bent with a press, are apt to contain local strains which lower mechanical strength. This means that the blade-forming sections 52 are easily breakable, etc.

Fifthly, as seen from Fig. 18, since the blade section 54 is formed by grinding the end of the half section 52a of blade-forming section with a relatively wide area, shaved bristles, skin oil, etc. tend to stick to the back of the half section 52a in large quantities and cleaning is then difficult.

Sixthly, ceramic blades cannot be used, which are now considered to be a suitable material for cutting blades which have long service life, high hardness, complete resistance against rusting, etc. They cannot be used because many bending processes are applied and because the inner cutter is so complex in shape and so small in size that the manufacture using bending processing is made difficult. In fact, no ceramic blades are being utilized for inner cutters for electric shavers.

The present invention seeks to overcome, or at least ameliorate, these disadvantages. Accordingly, in a first aspect the present invention provides an inner rotary cutter for an electric shaver, having a cup shaped base with a cylindrical section and a circular section, the

circumference of the base having, integral therewith, first extending sections projecting approximately in the axial direction of the cylindrical section of the base, each of the first extending sections being integral with a second
5 extending section projecting approximately in the radial direction, a blade being provided on an edge of each of the second extending sections.

The aspect of the invention may provide the following advantages:

- 10 1. As is evident from a comparison between a possible blade section of an inner cutter according to the present invention shown in Fig. 7 of the accompanying drawings, and the blade section (the blade-forming section) of a known inner cutter shown in Fig. 18 of the accompanying drawings
15 the blade section of the inner cutter according to this invention is formed on the second (horizontally) extended section which projects outwards and may have a relatively small area at its front portion. Hence, shaved bristles and skin oil do not adhere to the blade section and the
20 horizontally extended section to a significant extent; this makes the cleaning of the inner cutter very easy. Moreover, since the horizontally extended section may project further outwards than the first (vertically) extended section and the vertically extended section may
25 extend outwards stepwise, shaved bristles, etc. go down the inner cutter for discharge through the blade groove without adhering to the inner cutter.

2. The cup-shaped base section allows the cylinder section to be positioned outward. Therefore, the weight distribution may extend toward the outside as compared with the known cutter, with increased force of inertia, which in turn prevents temporary loads from changing the number of revolutions. Thus, stable performance may be displayed.

3. Since the vertically extended section is designed to rise from the circumference of the cylinder section positioned outside the base section, the vertically extended section may be made as short as possible and need not be bent near its root, as is necessary for the known structure. This leads to an increase in mechanical strength and maintenance of stable performance against the temporary loads discussed above.

4. Ceramic blades may be adopted, which are an excellent cutting material. They are endowed with a number of advantages such as high hardness resulting in excellent cutting ability and long service life and no rusting.

In a second aspect of the present invention, there is provided a process for manufacturing an inner rotary cutter for an electric shaver comprising:

(a) a punch step where a cup-shaped inner cutter blank, having a cylindrical section extending from the circumference of a circular section to a prescribed length in the axial direction, is punched out from a plate material;

(b) a drawing step where the cylindrical section is

drawn to form a small cylindrical section with reduced diameter and the open-mouthed end of the cylindrical section is pressed to form a ring plate section bent outwardly in the radial direction; and

- 5 (c) a blade cutting step where a grinding tool is applied to the ring plate section and the small cylindrical section to form blade grooves at predetermined intervals, which grooves are inclined relative to the intended direction of rotation of the cutter.

10 This aspect of the invention may provide the following advantages:

1. The inner cutter blank may be in the simple form of a cup, and accordingly the mould for the press may be very inexpensive and have a long service life. In addition,
15 automatic material supply becomes possible by means of a parts feeder, etc.
2. The simple form of the inner cutter blank may prevent the press work from causing shape distortion or spring-back, etc. inherent in the known conventional
20 process. This allows high-precision processing effective for providing constant cutting ability. In particular, the intersecting angle between the blade section and the outer cutter blade may be kept substantially constant, in contrast to the conventional press system which causes the
25 intersecting angle to scatter in the angle range 0 to 20°.
3. Since the ring plate section is formed by means of a press, the plate surface of the ring plate section which

provides the blade face may easily be made flat. This facilitates application of automatic grinding to surface finishing, may reduce the ground quantity, and may shorten the grinding time. The high dimensional precision provided
5 may eliminate after-treatment such as grinding for positional adjustment of all the blade sections, which results in great improvement of the grinding steps.

4. The maximum number of blades handled by the conventional press sytem is about 16, whereas the process
10 according to this invention is capable of handling up to 36 blades by using grinding tools with reduced thickness.

5. According to the manufacturing process of this invention, a ceramic plate may be first glued on a metal surface and then subjected to grinding. Therefore, even a
15 ceramic blade which alone is too brittle to be subjected to grinding, may be processed easily without getting broken.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings in which:

20 Fig. 1 shows a plan view of a first embodiment of an inner cutter for an electric shaver according to the present invention;

Fig. 2 shows a front view, partly in cross-section, of the inner cutter of Fig. 1;

25 Figs. 3-6 show an inner cutter blank at various steps in the process for manufacturing an inner cutter for an electric shaver according to this invention, in which

figures view A shows a front view, partly in cross-section, and view B shows a bottom view;

Fig. 7 shows a plan view of one blade section of the inner cutter shown in Figs. 3-6.

5 Fig. 8 shows a plan view of a second embodiment of an inner cutter for an electric shaver according to the present invention;

Fig. 9 shows a front view, partly in cross-section, of the inner cutter of Fig. 8;

10 Figs. 10-12, 14 and 15 show an inner cutter blank at various steps in the process for manufacturing an inner cutter for an electric shaver according to the second embodiment shown in Fig. 8, and Fig. 13 shows a ceramic plate, in which figures view A shows a front view, partly
15 in cross-section, and view B shows a bottom view;

Fig. 16 shows a plan view of one blade section of the inner cutter of Figs. 10-15;

Fig. 17 shows a front view of the blade section of Fig. 16;

20 Fig. 18 shows a plan view of one blade section of a known inner cutter for an electric shaver and has already been discussed;

Figs. 19-21 show an inner cutter blank at various steps in the process of manufacturing a known inner cutter
25 for an electric shaver, in which figures view A shows a plan view of the inner cutter blank and view B shows a front view of one blade-forming section and have already

been described; and

Fig. 22 shows a side view of one blade-forming section of the inner cutter blank of Figs. 19-21, and has already been described.

5 Embodiment 1

To understand the structure of a first embodiment of an inner cutter according to the present invention, a process for the manufacture of such a cutter will now be described with reference to Figs. 3-6. In those figures,
10 views A and B respectively show a front view, partly in cross-section, and a bottom view.

Punch step

In this step, a cup-shaped inner cutter blank 10 shown in Fig. 3 is punched out from a plate material (not
15 shown). The inner cutter blank 10 consists of a circular section 2 and a cylindrical section 11 extending from the circumference of this circular section 2 in the axial direction to a predetermined length. In this punch step, a punch is also made for an attaching hole 20 positioned at
20 the centre of the circular section 2 and discharge holes 21 disposed around the centre.

The first drawing step

As shown in Fig. 4, the cylindrical section 11 of the above-described blank 10 is drawn to form a small
25 cylindrical section 12 with reduced diameter and at the same time to form a flange-shaped ring plate section 13 bent outwardly in the radial direction on the circumference

of the open-mouthed end. The width L1 of the ring plate section 13 is equal to the width of a blade section 7.

Accordingly, the width of the blade section 7 may be changed with the diameter of the cylindrical section 11,

5 and reduced by press drawing.

The second drawing step

The small cylindrical section 12, having been drawn in the first drawing step, is subjected, as shown in Fig. 5, to further drawing on the portion from an intermediate
10 position toward the side of the circular section 2 to form a second small cylindrical section 22. Note that this second drawing step may be omitted, i.e. the second small cylindrical section 22 need not be provided; the provision of this cylindrical section 22 helps shaved bristles go down-
15 wards to permit smooth discharge.

Heat treatment step

A heat treatment (hardening) is applied to harden the inner cutter blank 10. The hardness is brought to a Vickers hardness of ca. 650.

20 Grinding step

After heat treatment, the inner cutter blank 10 has the plate surface 14 of the ring plate section 13 ground and polished. After this treatment the plate surface 14 undergoes a plane finish treatment, so that it is com-
25 pletely flat.

Blade cutting step

As shown in Fig. 6, after grinding and polishing,

the inner cutter blank 10 is ground with a grinding tool 23, such as a rotary grinder or a cutter in the form of a disk with rounded circumference, to form blade grooves 15. Each blade groove 15 is in the form of a cut extending from the ring plate section 13 to the boundary between the small cylindrical section 12 and the second small cylindrical section 22. Note that, although it is optimal for the cut to have this depth, other depths, may be adopted, for example, such that the groove 15 reaches the circular section 2. The blade groove 15 (and hence the grinding tool 23) should be inclined by a predetermined angle in the intended direction of rotation of the inner cutter; the angle of inclination θ_1 is optimally 25 to 35° as shown in Fig. 6. In addition, the blade groove 15 (and the grinding tool 23) should be slightly inclined relative to the radial direction; the angle of inclination θ_2 (Fig. 1), making an intersecting angle relative to the outer cutter which is optimally about 12°.

The inner cutter 1 shown in Figs. 1 and 2 is completed when a catching member 31, which engages a driving shaft (not shown), is press attached to the attaching hole 20 of the inner cutter proper 30 having been prepared by the foregoing steps.

The inner cutter 1 of this embodiment manufactured by the foregoing process will now be described by reference to Figs. 1, 2 and 7. Fig. 1 shows a plan view of the inner cutter, Fig. 2 shows a front view, partly in cross-section, and Fig. 7 shows a plan view of one blade section of the

inner cutter .

The inner cutter 1 is integrally composed of a circular section 2, a cup-shaped base 4 having a cylindrical section 3 extending from the circumference 2a of the circular section 2 in the axial direction to a predetermined length, and a plurality of first (vertically) extended sections 5 projecting from the circumference of the base 4 in the axial direction. These vertically extended sections 5 extend from near the end of the second small cylindrical section 22 in a direction inclined to the direction of rotation, and each vertically extended section 5 is in the form of a peak with its tip side narrowed and at the same time is extended outwards stepwise.

Each vertically extended section 5 is integrally provided with a second (horizontally) extended section 6 projecting outwards in the radial direction, and each horizontally extended section 6 is provided with a blade section 7 at its front edge in the direction of rotation.

The horizontally extended section 6 is approximately a parallelogram in its longitudinally vertical cross-section as shown in Fig. 2, and approximately trapezoidal in its horizontal shape as shown in Fig. 7. The outside width L2 of the horizontally extended section 6 thus formed is approximately equal to the thickness of the plate material used.

The embodiment has been described in detail. This invention is of course, not restricted to this embodiment.

Thus, the second drawing step may be omitted, a similar third drawing step may be added, or the magnitude of θ_1 , θ_2 , L1, or L2 may be selected arbitrarily.

Embodiment 2

5 A suitable process for manufacturing an inner cutter according to a second embodiment of the present invention will now be described with reference to Figs. 10 to 15. Figs. 10 to 12, 14, and 15 show an inner cutter blank at respective processing steps and Fig. 13 shows a ceramic
10 plate. In these figures, view A shows a front view, partly in cross-section, and view B shows a bottom view.

Punch step

 In this step, a cup-shaped inner cutter blank 110 shown in Fig. 10 is punched out from a plate material (not
15 shown). The inner cutter blank 110 consists of a circular section 110a and a cylindrical section 110b extending from the circumference of this circular section 110a in the axial direction to a prescribed length. In this punch step, a punch is also made for an attaching hole 120
20 positioned at the centre of the circular section 110a and discharge holes 121 disposed around the centre.

The first drawing step

 As shown in Fig. 11, the cylindrical section 110b of the above-described blank 110 is drawn to form a small
25 cylindrical section 112 with reduced diameter and at the same time to form a flange-shaped ring plate section 113 bent outwardly in the radial direction around the circum-

ference of the open-mouthed end. The width L1 of the ring plate section 113 is equal to the width of a blade section 105. Accordingly, the width of the blade section 105 may be changed with the diameter of the cylindrical section 110b to be reduced by press drawing.

The second drawing step

The small cylindrical section 112, having been drawn in the first drawing step, is subjected, as shown in Fig. 12, to further drawing on the portion from an intermediate position toward the side of the circular section 110a to form the second small cylindrical section 122. Note that the second drawing step may be omitted, i.e. the second small cylindrical section 122 need not be provided; the provision of this cylindrical section 122 helps shaved bristles go downwards to permit smooth discharge.

Ceramic-plate gluing step

A ring-shaped ceramic plate 107 shown in Fig. 13 is prepared by hand. This ceramic plate 107 is approximately 0.2 mm thick and the outer and inner diameters of the ring are equal, respectively, to the outer and inner diameters of the ring plate 113.

The ceramic plate 107 is glued by adhesive onto the plate surface 114 of the ring plate 113.

Blade cutting step

As shown in Fig. 15, the inner cutter blank 110 is ground with a grinding tool 123, such as a rotary grinder (e.g., a diamond grinder) in the form of a disk with

rounded circumference, to form blade grooves 115. Each blade groove 115 is in the form of a cut extending from the plate surface of the ceramic plate 107 via the ring plate section 113 to the boundary between the small cylindrical section 112 and the second small cylindrical section 122. 5 The blade groove 115 (and hence the grinding tool 123) should be inclined by a predetermined angle in the intended direction of rotation of the inner cutter; the angle of inclination θ_1 is optimally 25 to 35° as shown in Fig. 13. 10 In addition, the blade groove 115 (and the grinding tool 123) should be slightly inclined relative to the radial direction; the angle of inclination θ_2 (Fig. 8), making an intersecting angle relative to the outer cutter which is optimally about 12°.

15 The inner cutter 101 shown in Figs. 8 and 9 is completed when a catching member 131, which engages a driving shaft (not shown), is press attached to the attaching hole 120 of the inner cutter proper 130 having been prepared by the foregoing steps.

20 The inner cutter 101 manufactured by the foregoing process will now be described by reference to Figs. 8, 9, 16, and 17. Fig. 8 shows a plan view of the inner cutter, Fig. 9 shows a front view, partly in cross-section, Fig. 16 shows a plan view of one blade section of the inner cutter 25 of Fig. 8, and Fig. 17 shows a front view of the blade section of Fig. 16.

The inner cutter 101 is integrally composed of a

circular section 110a, a cup-shaped base 110c having a cylindrical section 110b extending from the circumference of the circular section 110a in the axial direction to a predetermined length, and a plurality of first (vertically) extended sections 104 projecting from the circumference of the base section 110c in the axial direction. These vertically extended sections 104 extend from near the end of the second small cylindrical section 122 in a direction inclined to the direction of rotation, and each vertically extended section 104 is in the form of a peak with its tip side narrowed and at the same time is extended outwards stepwise.

Each vertically extended section 104 is integrally provided with a second (horizontally) extended section 109 projecting outwards in the radial direction. Each horizontally extended section 109 has a ceramic blade 106 glued on its top surface. Each ceramic blade 106 is provided with a blade section 105 at its front edge in the direction of rotation.

The horizontally extended section 109, together with the ceramic blade 106, is approximately a parallelogram in its longitudinally vertical cross-section as shown in Figs. 9 and 17, and is approximately trapezoidal in its horizontal shape as shown in Fig. 16.

Again the present invention is not restricted to this embodiment, and, the second drawing step may be omitted, a similar third drawing step may be added, or the

magnitude of θ_1 , θ_2 , or L_1 may be selected arbitrarily.

Moreover, this invention may be embodied by separately preparing ceramic blades 106 shown in Fig. 17 and gluing each ceramic blade 106 on the flat end face 103 of each vertically extended section 104.

**CLAIMS:**

1. An inner rotary cutter for an electric shaver, having a cup-shaped base with a cylindrical section and a circular section, the circumference of the base having, integral therewith, first extending sections projecting approximately in the axial direction of the cylindrical section of the base, each of the first extending sections being integral with a second extending section projecting approximately in the radial direction, a blade being provided on an edge of each of the second extending sections.
2. An inner rotary cutter according to claim 1 wherein each of the first extended sections are inclined in the intended direction of rotation of the cutter.
3. An inner rotary cutter according to claim 2 wherein the angle of inclination of the first extended sections is 25 to 35°.
4. An inner rotary cutter according to any one of claims 1 to 3 wherein the first extended sections are outwardly stepped.
5. An inner rotary cutter according to any one of claims 1 to 4 wherein the second extended sections project outwards relative to the first extended sections.
6. An inner rotary cutter according to any one of the preceding claims wherein the second extended sections are slightly inclined relative to the radial direction.
7. An inner rotary cutter for an electric shaver



according to claim 6 wherein the angle of inclination of the second extended sections is approximately 12°.

8. An inner rotary cutter for an electric shaver according to any one of the preceding claims wherein the
5 circular section of the base is provided with discharge holes.

9. An inner rotary cutter for an electric shaver according to any one of the preceding claims wherein a plate-shaped ceramic blade is glued to the end face of the
10 second extended section and an edge of the ceramic blade forms the blade.

10. An inner rotary cutter for an electric shaver substantially as herein described, with reference to, and as illustrated in Figs. 1 to 7, or Figs. 8 to 16 of the
15 accompanying drawings.

11. A process for manufacturing an inner rotary cutter for an electric shaver comprising:

(a) a punch step where a cup-shaped inner cutter blank, having a cylindrical section extending from the circumference of a circular section to a prescribed length in the
20 axial direction, is punched out from a plate material;

(b) a drawing step where the cylindrical section is drawn to form a small cylindrical section with reduced diameter and the open-mouthed end of the cylindrical
25 section is pressed to form a ring plate section bent outwardly in the radial direction; and

(c) a blade cutting step where a grinding tool is



applied to the ring plate section and the small cylindrical section to form blade grooves, at predetermined intervals, which grooves are inclined relative to the intended direction of rotation of the cutter.

- 5 12. A process according to claim 11, wherein a grinding step is carried out after the drawing step, comprising grinding and polishing the plate face of the ring plate section.
- 10 13. A process according to claim 11, wherein a gluing step is carried out after the drawing step, in which a ceramic plate is glued to the flat face of the ring plate section.
- 15 14. A process according to any one of claims 11 to 13 wherein the drawing step is followed by a heat treatment for hardening said inner cutter blank.
- 15 15. A process according to any one of claims 11 to 14 wherein discharge holes also are formed on the circular section in the punch step.
- 20 16. A process according to any one of claims 11 to 15, wherein the drawing step forms the small cylindrical sections in a stepped form.
- 25 17. A process according to any one of claims 11 to 16, wherein the blade cutting step forms blade grooves inclined both in the intended direction of rotation and in the radial direction.
18. A process for manufacturing an inner rotary cutter for an electric shaver substantially as any one herein



described with reference to Figs. 1 to 7 or Figs. 8 to 16
of the accompanying drawings.
