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(54) **IMPROVED OSTEOTOME**

VERBESSERTES OSTEOTOM

OSTEOTOME AMELIORE

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Description

[0001] The present invention relates to a tool for cutting into or through bone, for example during orthopaedic surgery. More particularly, but not exclusively, it relates to a tool for cutting through cortical or cancellous bone, for example to separate a joint prosthesis from surrounding bone as part of a revision procedure.

[0002] A frequently required procedure in orthopaedic surgery is revision of a joint arthroplasty, for example revision of a hip joint replacement, should an implanted prosthesis break or wear unacceptably over its articulating surface. The invention will be described in relation to its use in hip joint revision, but is equally applicable to other joints and the terms "hip", "pelvis" and "femur" may be replaced as necessary. In many cases, an implanted prosthesis is secured in a cavity within a bone, such as a femur, using polymeric organic cement such as polymethylmethacylate. Tools have been devised to soften and remove this cement and to allow convenient removal of a worn or damaged prosthesis, followed by implantation of a replacement.

[0003] However, there has been a recent increase in the use of press-fit prostheses. No cement is used to hold these in place within the femur, pelvis, etc. Instead, the implanted portions of the prostheses have porous surfaces or surfaces coated with hydroxy-apatite, which encourage ingrowth of bone, leading to stable, well-anchored implants. This formation of cancellous bone may also occasionally occur with cement-anchored implants. While not as strong as the structural bone of the wall of the femur, the pelvis or other bone, cancellous bone is not easily susceptible to cutting using the tools devised for revising cement-anchored implants, and it has become necessary to attack cancellous bone mechanically in order to revise such implants.

[0004] Furthermore, in order to remove a prosthesis, it may be necessary to remove portions of cortical bone, which cannot be achieved without using mechanical means.

[0005] A manual osteotome is effectively a specialised form of chisel, which is forced longitudinally through the bone between a prosthesis and surrounding structural bone. The force required can be so great as to compromise the directional accuracy of the technique, and may thereby damage surrounding structural bone, especially if it is weakened by osteoporosis or the like.

[0006] Another approach is to use powered burrs to drill out the bone. These may also be difficult to guide accurately, and flexure in their elongate rotating drive shafts may lead to unacceptable collateral damage in surrounding structural bone. This approach also produces inconveniently large quantities of bone swarf, which must be removed to allow clear visualisation of the point at which the burr is cutting. Furthermore, high-speed burrs lead to significant localised frictional heating, which may also harm adjacent bone, tissue or marrow.

[0007] Manual sawing through bone is a slow, tiring process, also leading to localised heating and copious bone swarf. In any case, conventional bone saws could not easily be inserted or operated between a hip or other joint prosthesis shaft and an inner wall of a femur, or between a part-spherical acetabular shell and a pelvic bone, for example.

[0008] EP 0 456 470 describes a surgical ultrasonic horn comprising a horn body and an end plate portion. Cutting portions are provided on an edge and an end of the end portion. A passage for irrigation solution extends in the horn body and the end plate portion. At least one bore opens at the cutting portions by a jet angle of 5° to 90° in respect of a plane of the end plate portion. The irrigation solution passage communicates with the bore so that the irrigation solution is sprayed through the bore.

[0009] It is hence an object of the present invention to provide a tool for cutting bone, particularly bone adjacent an arthroplasty implant, that obviates the above disadvantages and allows accurate, rapid and convenient removal of such implants as part of a revision procedure.

[0010] According to a first aspect of the present invention, there is provided a tool adapted to cut bone, comprising means of generating ultrasonic vibrations and elongate blade means operatively connectable thereto, the blade means comprising an elongate substantially planar member having two substantially oppositely facing lateral cutting edges each provided with a plurality of serrations, each serration being generally triangular, having a first cutting facet extending substantially orthogonally to a local alignment of the cutting edge and a second facet extending obliquely to said local alignment, said serrations being so disposed that each first facet of a first lateral cutting edge faces towards a distal tip of the blade mans and each first facet of a second opposite lateral cutting edge faces towards a proximal root of the blade means.

[0011] In a first embodiment, the tool is adapted to be vibrated by longitudinal mode ultrasonic vibrations, for example directed substantially parallelly to a longitudinal axis of the blade means.

[0012] Advantageously, said lateral edges each extend substantially parallelly to the longitudinal axis of the blade means.

[0013] The elongate member may further comprise a rounded distal tip.

[0014] Said distal tip may extend between a distal end of a first said lateral edge and a distal end of a second said lateral edge.

[0015] The cutting edge may extend around all or part of the rounded distal tip.

[0016] A continuous cutting edge may extend around at least a distal portion of each lateral edge and the distal tip extending therebetween.

[0017] Preferably, at least part of the blade means has a cross-sectional profile tapering towards one or each lateral edge.

[0018] Advantageously, the blade means has a cross-sectional profile adjacent its distal tip tapering towards said tip.

[0019] Said tapering profile may comprise at least one angled surface located on each opposite face of the blade means.

[0020] A single angled surface may extend adjacent each lateral edge and the distal tip on each said face.

[0021] Said angled surfaces may be connected at their respective outer peripheries by an edge surface extending transversely to the general plane of the blade member.

[0022] Said edge surface may be substantially narrower than an overall thickness of the blade means.

[0023] Preferably, said tapering profile is at least co-extensive with the cutting edge of the blade means.

[0024] Each pair of neighbouring serrations may be so relatively aligned that a first facet of one serration of said pair is adjacent a second facet of the next serration of said pair.

[0025] Preferably, each serration extends outwardly from the cutting edge, substantially in the plane of the elongate member.

[0026] In an arrangement outside the scope of the invention, the tool is adapted to be vibrated by torsional mode ultrasonic vibrations.

[0027] The blade means then preferably comprises an elongate member having a curved cross-section, optionally substantially comprising an arc of a circle.

[0028] Advantageously, said cross-section is substantially constant along a whole of the elongate member.

[0029] The tool may be so adapted as to be torsionally vibratable about an longitudinal axis extending through the centre of said circle.

[0030] Preferably, a distal tip of the elongate member comprises the cutting edge of the tool.

[0031] The serrations of the cutting edge may be generally triangular.

[0032] The serrations may extend distally from the tip of the member.

[0033] A portion of the elongate member adjacent its tip may taper longitudinally towards said tip.

[0034] The tapered portion may comprise an angled surface located on a concave face of a curved elongate member.

[0035] In each device described above, the generator means is advantageously adapted to generate ultrasonic vibrations at a frequency within the range of twenty to seventy-five kilohertz.

[0036] A method of cutting bony material useful for understanding the invention comprises the steps of providing a tool as described in the first aspect above, applying a cutting edge of the tool to a surface of bony material to be cut, causing the tool to vibrate at an ultrasonic frequency and drawing the cutting edge of the tool across said surface.

[0037] Preferably, the cutting edge is drawn reciprocally across said surface.

[0038] Advantageously, the bony material comprises cancellous and/or cortical bone holding an orthopaedic implant to a bone of a living body, and the method comprises the step of cutting the bone as described above until the implant is separable therefrom.

[0039] The present invention will now be more particularly described by way of example and with reference to the accompanying drawings in which:

> **Figure 1** is a perspective view of a first tool embodying the present invention;
> **Figure 2A** is a plan view of a distal portion of the tool shown in Figure 1;
> **Figure 2B** is a schematic plan view of an intermediate part of the distal portion shown in Figure 2A;
> **Figure 3A** is a partial perspective view of a second tool;
> **Figure 3B** is an elevation of a distal end of the tool shown in Figure 3A;
> **Figure 4** is a perspective view of a third tool embodying the present invention;
> **Figure 5** is a cross-sectional elevation of a blade of the tool shown in Figure 4, taken along the line V - V; and
> **Figure 6** is a cross-sectional elevation of a blade of the tool shown in Figure 4, taken along the line VI - VI.

[0040] Referring now to the Figures and to Figure 1 in particular, a first osteotomy tool 1 comprises a cylindrical connecting body 2 provided at a proximal end with a threaded spigot 3, by which the tool 1 may detachably be connected to a generator of ultrasonic vibrations (not shown). An elongate blade portion 4 of the tool 1 extends from a distal end of the connecting body 2, and is aligned generally coaxially therewith.

[0041] The blade portion 4 comprises a proximal blade root 5 having a substantially rectangular cross-section and linked by a tapered portion 6 to a thin, flat elongate blade 7 with a generally rounded distal tip 8. A distal portion of the blade 7 has two oppositely-facing lateral cutting edges 9, 10. Each of the lateral cutting edges 9, 10 and the tip 8 is provided with a plurality of teeth 13, as shown in more detail in Figures 2A and 2B. A proximal portion of the blade 7 is toothless, although the relative lengths of the toothed and toothless portions may vary from that shown.

[0042] The cylindrical connecting body 2 is provided with spanner flats 11 to allow application of tightening torque sufficient to bring the tool 1 into secure contact with the ultrasound generator, allowing effective vibrational coupling through a contact surface 12 of the body 2. The tool 1 is preferably made of titanium or stainless steel.

[0043] As Figures 2A and 2B illustrate, the teeth 13 of the blade 7 are preferably shaped generally as conventional saw teeth, having a first edge 14 substantially orthogonal to a longitudinal axis of the blade 7 and a second edge 15 at a relatively shallow angle thereto. In a conventional saw, the first edge 14 would be sharpened, and the saw would cut when pulled (or sometimes pushed) in a longitudinal direction in which the first edge 14 is a leading edge of the tooth 13. In the present invention, it is believed to be unnecessary to sharpen the teeth 13.

[0044] In the tool 1 shown, the teeth 13 extend in a continuous array along a first cutting edge 9, around the tip 8 and along a second cutting edge 10, without the relative dispositions of the first and second edges 14, 15 of the teeth 13 changing. Thus, the first cutting edge 9 is adapted to cut on a longitudinal pull stroke as indicated by arrow 16 and the second cutting edge 10 is adapted to cut on a longitudinal push stroke as indicated by arrow 17.

[0045] Were the tool 1 a conventional mechanical saw, this arrangement would not be particularly effective, a push cut being particularly difficult to control in direction or force. Manual sawing at bone, even cancellous bone, produces significant frictional heating and requires considerable effort on the part of the user.

[0046] However, when the blade 7 is subjected to longitudinal mode ultrasonic vibrations, directed parallelly to the longitudinal axis 18 of the tool 1, the effectiveness of both the pull stroke 16 and the push stroke 17 is greatly improved. The velocity amplitude of the first edge 14 of each tooth 13 as it contacts the bone is much greater than the speed of the stroke 16, 17 alone. This leads to much more rapid cutting through the bone, with much less friction, and hence much less heating. The user does not need to force the tool 1 through the bone, allowing much greater accuracy and control in the cut, for both the push and pull strokes 16, 17. The tip 8 may be sunk longitudinally into the bone with only small lateral movements of the tool 1.

[0047] The tool 1 is connected to an ultrasound generator operating in the frequency range 20-75kHz.

[0048] Thus, for a replacement hip joint prosthesis held in a cavity within a femur by friction or by interaction with cancellous bone, and requiring revision, it is relatively straightforward to sink the tool 1 between the stem of the prosthesis and the femur itself, tip first and extending generally parallelly to the stem. The tool 1 can then be moved laterally around the stem, with a gentle sawing motion, cutting through the bone and freeing the prosthesis.

[0049] Compared to the alternative approach of using powered burrs, the ultrasonically-vibrated tool 1 is significantly more accurate, and does not flex when it meets increased resistance, which might cause unacceptable collateral bone damage. Frictional heating is lower with the tool 1 shown than with powered burrs, and the amount of bone swarf produced is significantly lower.

[0050] Manual (chisel-like) osteotomes require considerable force to drive between the prosthesis and the femur, which could damage a weakened femur wall and frequently compromises the directional accuracy of the technique.

[0051] The tool 1 may also be of use in other surgical procedures where rapid and accurate bone cutting is required, such as bone grafting or amputations.

[0052] A second osteotomy tool 21 is shown in Figure 3A. As for the first 1, it comprises a cylindrical body 2 with a proximally-mounted threaded spigot 3 by which it is connectable to a generator of ultrasonic vibrations. However, in this case, the generator produces torsional mode ultrasonic vibrations. As for the longitudinally-vibrated first tool 1, vibrations in the frequency range 20-75kHz are preferred.

[0053] The second tool 21 is provided with a generally hemicylindrical blade 27, aligned coaxially with the connecting body 2 along a longitudinal axis 18 of the tool 21. A distal tip 28 of the hemicylindrical blade 27 is provided with a plurality of teeth 23. The teeth 23 are shown as symmetrical, although they may be asymmetrical as for the teeth 13 of the first tool 1, set in either sense or even set in alternating senses. The tip 28 thus comprises a generally semicircular cutting edge, as shown in Figure 3B.

[0054] The torsional mode ultrasonic vibrations transmitted through the connecting body 2 to the blade 27 thus vibrate the tip 28 as shown by arrows 26. The user rotates the second tool 21 manually about the axis 18, without needing to exert significant longitudinal force, and the ultrasonic vibrations cause the tool 21 to cut rapidly and accurately into the bone to which it is applied.

[0055] As well as being useful for cutting between a prosthesis and a concave inner wall of a long bone, the second tool 21 may also be usable to cut circular bone samples, or in cranial surgery. Although a generally hemicylindrical blade 27 is probably optimal for arthroplasty revision work, blades comprising greater or lesser proportions of a hollow cylinder may be appropriate in other applications.

[0056] A third osteotomy tool 31, shown in Figure 4, is a preferred variant of the first tool 1, shown in Figure 1. As for the first tool 1, the third tool 31 comprises a connecting body 2 having a threaded spigot 3, by which the tool 31 may detachably be connected to a generator of ultrasonic vibrations. An elongate blade portion 4 extends from a distal end of the connecting body 2, generally coaxially aligned therewith.

[0057] The blade portion 4 comprises a proximal blade root 5 of generally rectangular cross-section, linked by a tapered portion 6 to a thin, elongate blade 37 with a generally rounded distal tip 8. As for the blade 7 of the first tool 1, this comprises a distal portion having two oppositely-facing lateral cutting edges 9, 10. A plurality of teeth 13 extend along each cutting edge 9, 10 and the rounded tip 8 that joins them.

[0058] The blade 37 of the third tool 31 differs in cross-sectional profile from that of the first tool 1. Whereas the blade 7 has a rectangular cross-section, the blade 37 has a substantial bevelled region 32 extending longitudinally of the blade 37 adjacent each edge 33 thereof and around its distal tip 8. (A corresponding bevelled region 32 is provided on a reverse face of the blade 37 to that visible in Figure 4).

[0059] Thus, as shown more clearly in Figure 5, the blade 37 has an octagonal cross-section. Respective bevelled regions 32 on each face of the blade 37 define a narrow edge 33 extending between them. It is preferable that the edge 33 is not actually sharpened, to reduce the likelihood of it cutting anything accidentally while the tool 31 is not ultrasonically activated.

[0060] As shown in Figure 6, the indentations between the teeth 13 of the blade 37 extend only partially across the bevelled regions 32. They are thus both triangular in plan view (see Figures 2 and 3) and generally triangular in profile.

[0061] The teeth 13 of the blade 7 of the first tool 1 have a substantially rectangular cross-section, and it is believed that the outer corners thereof may be prone to damage. It is probable that an activated tool 1 would at some point come into contact with a prosthesis being removed and the corners of the teeth 13 would tend to impact thereon. There would be a significant chance of these corners being knocked off, notched or chipped as a result. It is important to balance an ultrasonically-vibratable blade, and significant loss of material from the teeth 13 might require the whole blade 7 to be rebalanced or even disposed of. Also, if damage occurs at a region of the blade 7 that is under raised stress, fatigue fractures of the blade 7 might quickly follow, originating from the damage.

[0062] The blade 37 with bevelled regions 32 avoids such problems to a great extent. While a face of the blade 37 might contact the prosthesis in use, its teeth 13 (and particularly the narrow edge 33 forming the tips of the teeth 13) are set back from the face and less likely contact the prosthesis. Even if they did, the profile created means that such contacts would be more glancing and less liable to cause damage. Nevertheless, the tooth 13 profile of the blade 37 of the third tool 31 is just as effective as that of the first tool in cutting through cancellous bone.

[0063] A similar tapered profile may also be created around the cutting distal tip 28 of the second tool 21.

Claims

1. A tool (1,31) adapted to cut bone, comprising means of generating ultrasonic vibrations and elongate blade means (7,37) operatively connectable thereto, the blade means (7,37) comprising an elongate substantially planar member having two substantially oppositely facing lateral cutting edges (9,10) each provided with a plurality of serrations (13), ***characterised in that*** each said serration (13) is generally triangular, having a first cutting facet (14) extending substantially orthogonally to a local alignment of the cutting edge (9,10) and a second facet (15) extending obliquely to said local alignment, wherein said serrations (13) are so disposed that each first facet (14) of a first lateral cutting edge (9) faces towards a distal tip (8) of the blade means (7,37) and each first facet (14) of a second opposite lateral cutting edge (10) faces towards a proximal root (5) of the blade means (7,37).

2. A tool (1,31) as claimed in claim 1, ***characterised in that*** the elongate substantially planar member of the blade means (7,37) further comprises a rounded distal tip (8) extending between a distal end of a first lateral edge (9) and a distal end of a second lateral edge (10).

3. A tool (1,31) as claimed in claim 2, ***characterised in that*** a cutting edge of the blade means (7,37) extends around all or part of the rounded distal tip (8).

4. A tool (1,31) as claimed in claim 3, ***characterised in that*** the serrations (13) extend in a continuous array along the first lateral cutting edge (9), around the distal tip (8) and along a second lateral cutting edge (10), without the relative dispositions of the first (14) and second (15) facets of the serrations (13) changing, such that the first lateral cutting edge (9) is adapted to cut in a pull stroke (16) and the second lateral cutting edge (10) is adapted to cut in a push stroke (17).

5. A tool (1,31) as claimed in any one of the preceding claims, ***characterised in that*** the means to generate ultrasonic vibrations produces longitudinal mode ultrasonic vibrations directed substantially parallelly to a longitudinal axis (18) of the blade means (7,37).

6. A tool (1,31) as claimed in any one of the preceding claims, ***characterised in that*** said lateral edges (9,10) extend substantially parallelly to a longitudinal axis (18) of the blade means (7,37).

7. A tool (31) as claimed in any one of the preceding claims, ***characterised in that*** at least part of the blade means (37) has a cross-sectional profile (32) tapering towards one or each lateral edge (33).

8. A tool (31) as claimed in claim 7, ***characterised in that*** the blade means (37) has a cross-sectional profile adjacent its distal tip (8) tapering towards said tip (8).

9. A tool (1,31) as claimed in any one of the preceding claims, ***characterised in that*** the means of generating ultrasonic vibrations is adapted to generate said vibrations at frequencies of 20-75kHz.

Patentansprüche

1. Werkzeug (1,31), angepasst zum Schneiden von Knochen, das ein Mittel für die Erzeugung von Ultraschallschwingungen und ein längliches Klingenmittel (7,37) umfasst, das operativ damit verbunden

werden kann, wobei das Klingenmittel (7,37) ein längliches im Wesentlichen planares Teil umfasst, das im Wesentlichen zwei seitliche Schneidkanten, die sich gegenüberliegen, aufweist (9,10), die jeweils mit einer Vielzahl von Kerbverzahnungen (13) bestückt sind, **dadurch gekennzeichnet, dass** jede besagte Kerbverzahnung (13) generell dreieckig ist, und eine erste Schneidfassette (14) hat, die sich im Wesentlichen orthogonal zu einer lokalen Ausrichtung der Schneidkante (9,10) erstreckt und eine zweite Fassette (15), die sich schräg zu der lokalen Ausrichtung erstreckt, wobei die Kerbverzahnungen (13) so angeordnet sind, dass jede erste Fassette (14) einer ersten seitlichen Schneidkante (9) in Richtung einer distalen Spitze (8) des Klingenmittels (7,37) zeigt und jede erste Fassette (14) einer zweiten gegenüberliegenden, seitlichen Schneidkante (10) einer proximalen Wurzel (5) des Klingenmittels (7,37) zugewandt ist.

2. Werkzeug (1,31) nach Anspruch 1, **dadurch gekennzeichnet, dass** das längliche im Wesentlichen planare Teil des Klingenmittels (7,37) ferner eine abgerundete, distale Spitze aufweist, (8) die sich von einem distalen Ende einer ersten Seitenkante (9) bis zum distalen Ende einer zweiten Seitenkante (10) erstreckt.

3. Werkzeug (1,31) nach Anspruch 2, **dadurch gekennzeichnet, dass** eine Schneidkante des Klingenmittels (7,37) sich ganz oder teilweise um die abgerundete, distale Spitze (8) herum erstreckt.

4. Werkzeug (1,31) nach Anspruch 3, **dadurch gekennzeichnet, dass** die Kerbverzahnungen (13) sich entlang der ersten seitlichen Schneidkante (9) in eine kontinuierliche Reihe erstrecken, um die distale Spitze (8) herum und entlang einer zweiten seitlichen Schneidkante (10), ohne die relativen Anordnungen der ersten (14) und zweiten (15) Fassetten der Kerbverzahnungen (13) zu verändern, sodass die erste seitliche Schneidkante (9) so angepasst ist, dass sie über einen Zug-Hub (16) schneidet und die zweite seitliche Schneidkante (10) so angepasst ist, dass sie über einen Schub-Hub (17) schneidet.

5. Werkzeug (1,31) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Mittel für die Erzeugung von Ultraschallschwingungen Ultraschallschwingungen in Longitudinalmode produziert, die im Wesentlichen parallel zu einer Längsachse (18) des Klingenmittels (7, 37) ausgerichtet sind.

6. Werkzeug (1,31) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die besagten seitlichen Kanten (9,10) sich im Wesentlichen parallel zu einer Längsachse (18) des Klingenmittels (7,37) erstrecken.

7. Werkzeug (31) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** zumindest ein Teil des Klingenmittels (37) ein Querschnittsprofil (32) hat, das sich in Richtung einer oder jeder Seitenkante (33)verjüngt

8. Werkzeug (31) nach Anspruch 7, **dadurch gekennzeichnet, dass** das Klingenmittel (37) ein Querschnittsprofil hat, das sich benachbart zu seiner distalen Spitze (8) befindet und sich in Richtung auf die besagte Spitze (8) verjüngt.

9. Werkzeug (1,31) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Mittel für die Erzeugung von Ultraschallschwingungen so angepasst ist, um die Schwingungen mit Frequenzen von 20-75kHz zu erzeugen.

Revendications

1. Outil (1, 31) adapté pour couper l'os, comprenant un moyen visant à générer des vibrations ultrasonores et un moyen de lame allongé (7, 37) pouvant être raccordé fonctionnellement à ce dernier, le moyen de lame (7, 37) comprenant un élément allongé sensiblement plan présentant deux bords tranchants sensiblement latéralement opposés (9, 10) pourvus chacun d'une pluralité de dents (13), **caractérisé en ce que** chacune desdites dents (13) est globalement triangulaire, présentant une première facette coupante (14) s'étendant de manière sensiblement orthogonale à un alignement local du tranchant (9, 10) et une seconde facette (15) s'étendant à l'oblique dudit alignement local, lesdites dents (13) étant disposées de telle manière que chacune des premières facettes (14) d'un premier bord tranchant latéral (9) est tournée vers une extrémité distale (8) du moyen de lame (7, 37) et chacune des premières facettes (14) d'un second bord tranchant latéral opposé (10) est tournée vers une racine proximale (5) du moyen de lame (7, 37).

2. Outil (1, 31) selon la revendication 1, **caractérisé en ce que** l'élément allongé sensiblement plan du moyen de lame (7, 37) comprend en outre une extrémité distale arrondie (8) s'étendant entre une extrémité distale d'un premier bord latéral (9) et une extrémité distale d'un second bord latéral (10).

3. Outil (1, 31) selon la revendication 2, **caractérisé en ce qu'**un bord tranchant du moyen de lame (7, 37) s'étend totalement ou partiellement autour de l'extrémité distale arrondie (8).

4. Outil (1, 31) selon la revendication 3, **caractérisé**

en ce que les dents (13) s'étendent selon un ensemble continu le long du premier bord tranchant latéral (9), autour de l'extrémité distale (8) et le long d'un second bord tranchant latéral (10), sans modification de la disposition relative des première (14) et seconde (15) facettes des dents (13), de manière que le premier bord tranchant latéral (9) est adapté pour couper au tirer (16) et que le second bord tranchant latéral (10) est adapté pour couper au pousser (17).

5. Outil (1, 31) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le moyen générant les vibrations ultrasonores produit des vibrations ultrasonores en mode longitudinal dirigées de manière sensiblement parallèle à un axe longitudinal (18) du moyen de lame (7, 37).

6. Outil (1, 31) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** lesdits bords latéraux (9, 10) s'étendent de manière sensiblement parallèle à un axe longitudinal (18) du moyen de lame (7, 37).

7. Outil (31) selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**au moins une partie du moyen de lame (37) présente un profil de section transversale (32) effilé vers le ou les bords latéraux (33).

8. Outil (31) selon la revendication 7, **caractérisé en ce que** le moyen de lame (37) présente un profil de section transversale à proximité de son extrémité distale (8) qui est effilé vers ladite extrémité (8).

9. Outil (1, 31) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le moyen visant à générer des vibrations ultrasonores est adapté pour générer lesdites vibrations à des fréquences de 20-75 kHz.

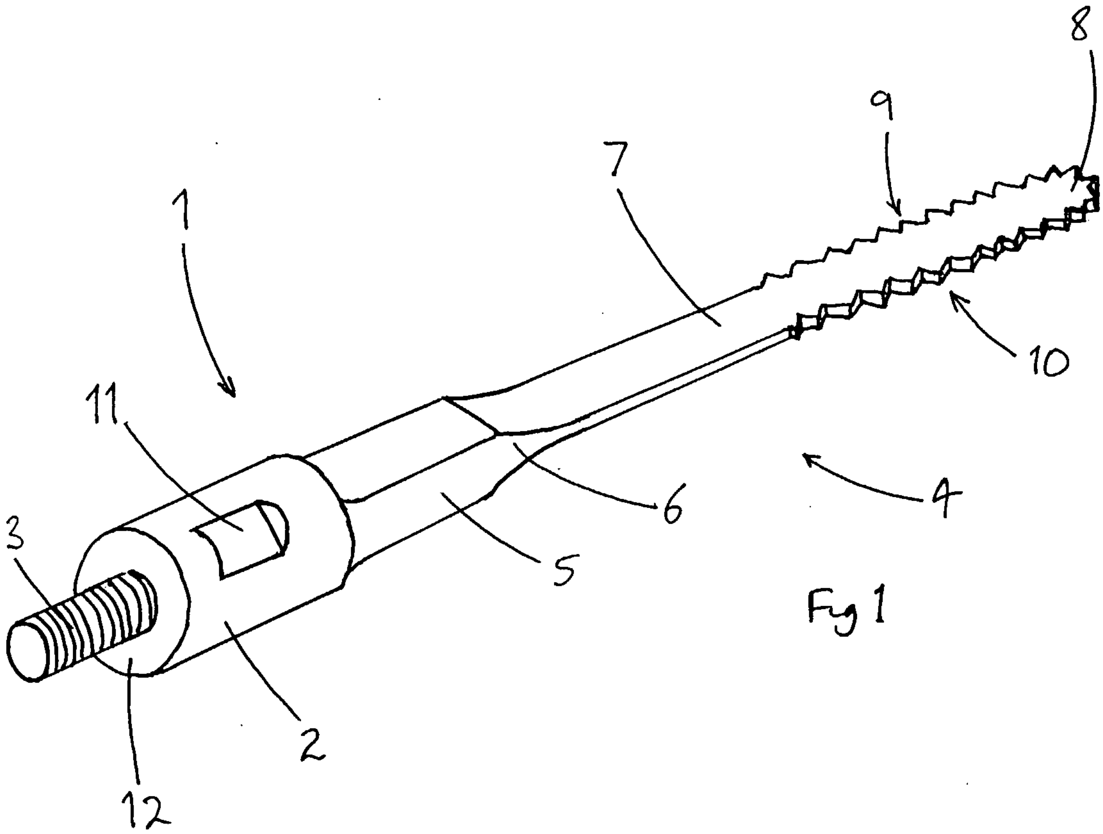

Fig 1

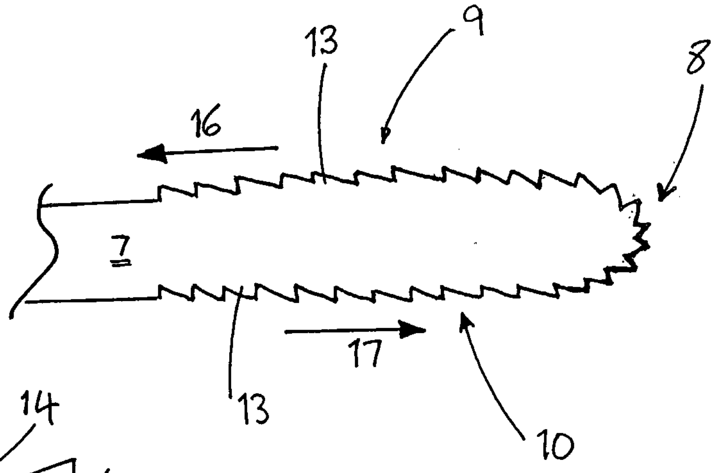

Fig 2A

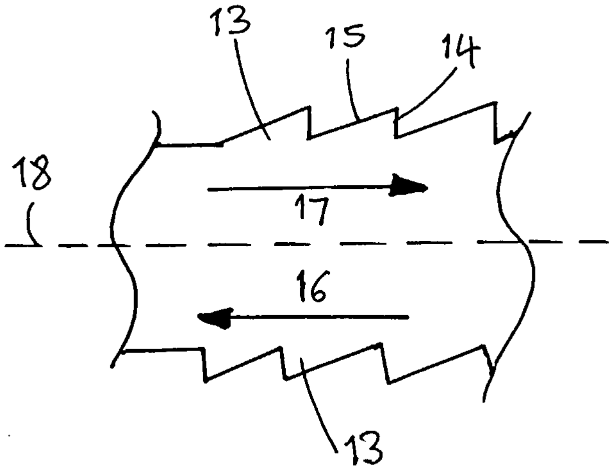

Fig 2B

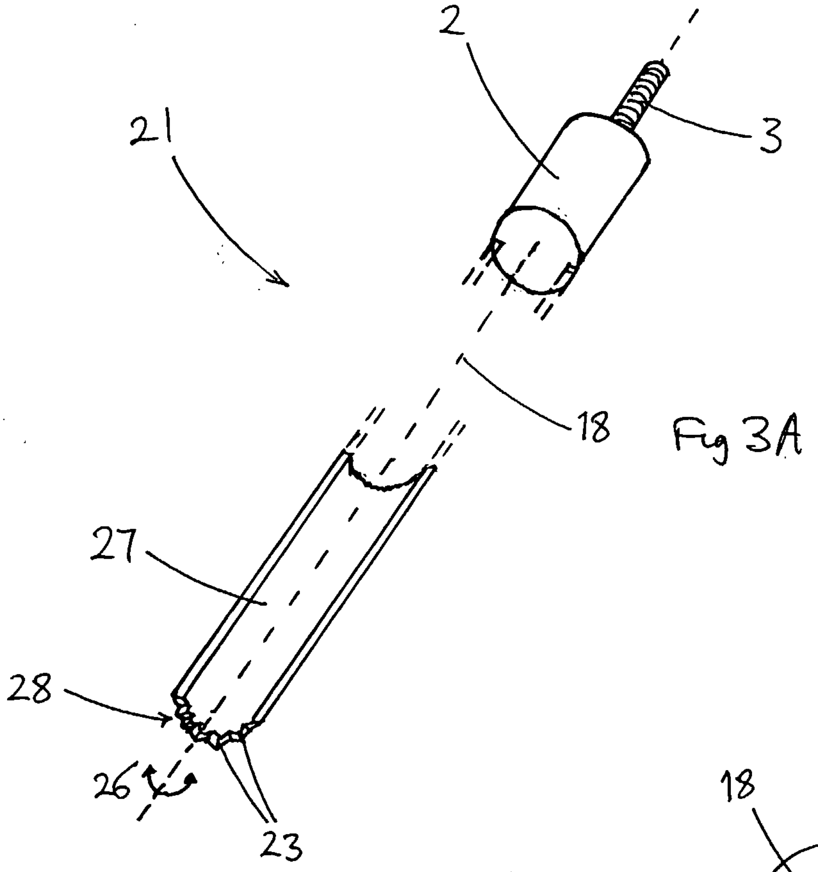

Fig 3A

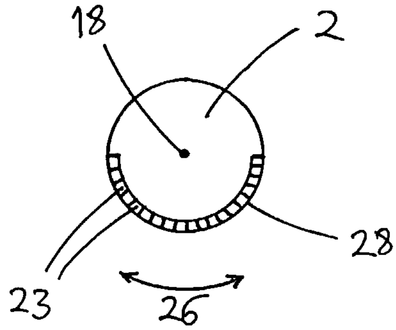

Fig 3B

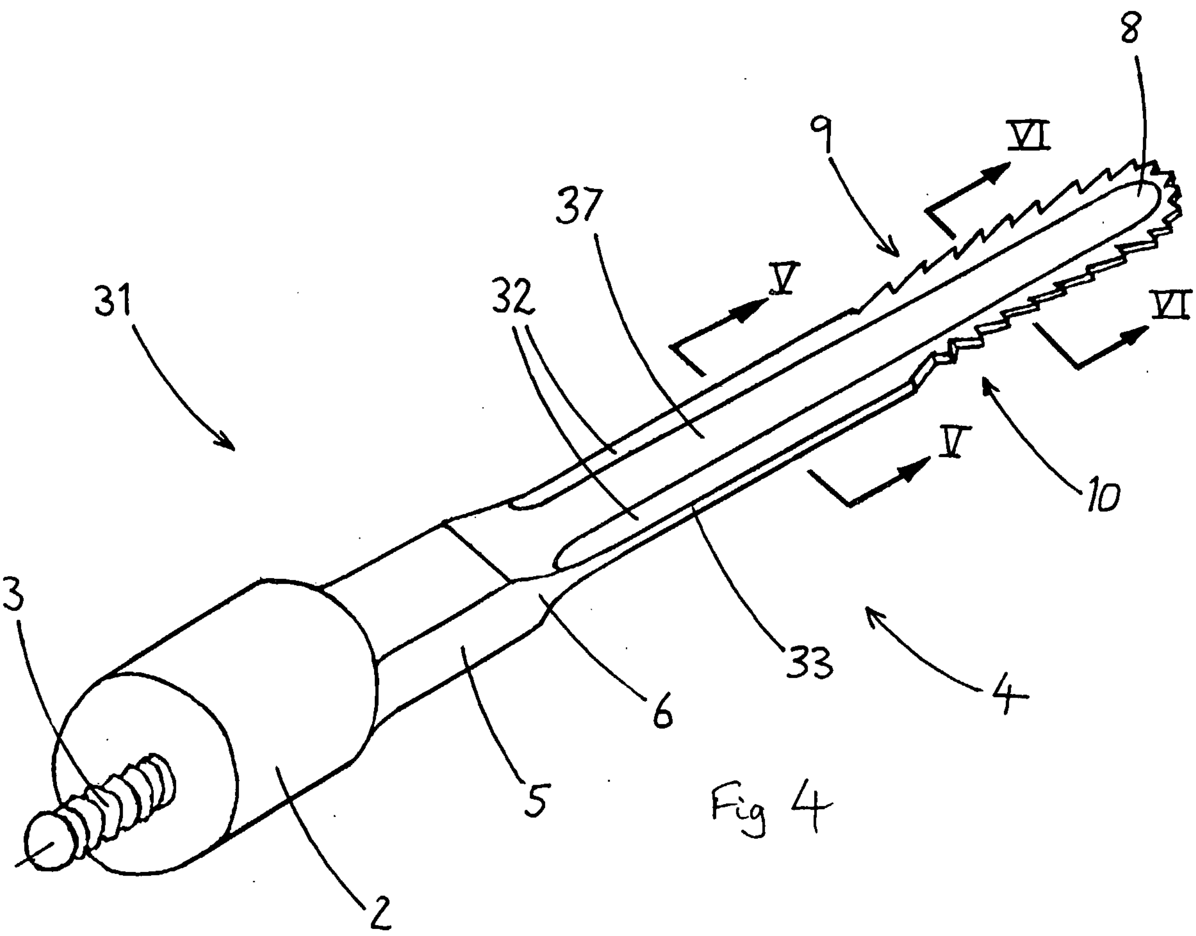

Fig 4

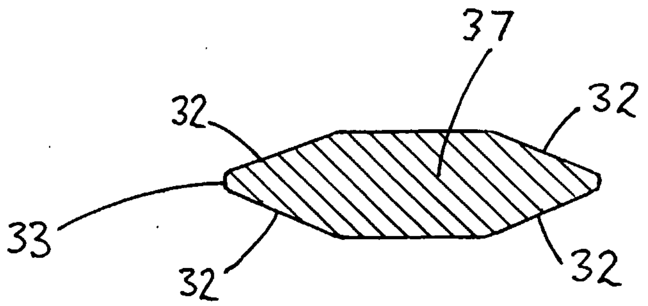

Fig 5

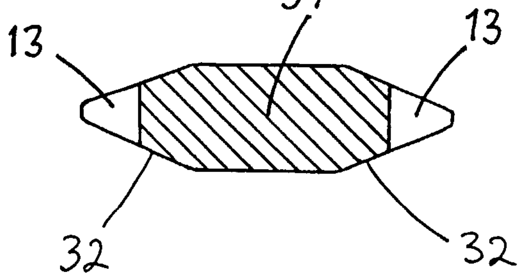

Fig 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 0456470 A **[0008]**

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摘要(译)

用于切割骨头的工具（1,31）包括可连接到纵向模式超声波振动发生器的细长刀片（7,37）。刀片（7,37）具有两个侧向切割边缘（9,10），其通过圆形远侧末端（8）连接。一系列三角形齿（13）沿每个切削刃（9,10）和远侧尖端（8）延伸。刀片（37）可朝向每个切削刃（9,10）和远侧尖端（8）逐渐变细。工具（21）的变体包括细长的部分圆柱形刀片（27），其可连接到扭转模式超声波振动的发生器。刀片（27）在其远侧尖端（28）处具有切割边缘，该切割边缘设置有多个三角形齿（23）。所有形式的工具（1,21,31）特别适合于切割植入物周围的松质骨，以在关节成形术的修正过程中被移除。