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(54) Improved osteotome

Verbessertes Osteotom

Osteotome amelioré

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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] Another device according to the prior art is disclosed in WO 2006/0143318 A2. This document is prior art under Art. 54(3) EPC and discloses a torsional pineapple dissection tip with a plurality of teeth on a partially conical portion which is suited for dissection of bone and calcified neoplasm. US 2002/0099400 relates to a phacoemulsification apparatus for removing the natural crystalline lens of the eye having means for generating ultrasonic vibrations configured to produce torsional mode ultrasonic vibrations and connectable to a shaft of a rotary cutting bit. The cutting bit has a distal tip comprising a least one cutting edge provided with a plurality of serrations each having a first cutting facet substantially transverse to the direction of said ultrasonic vibrations.

[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. The invention is defined by the subject-matter of appended claim 1. Preferred embodiments are defined in the dependent claims. Embodiments of 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 which is not part of 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 embodying the present invention;
- **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 which is not part of 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.

[0010] 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.

[0011] 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.

[0012] 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.

[0013] 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.

[0014] 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.

[0015] 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.

[0016] 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.

[0017] The tool 1 is connected to an ultrasound generator operating in the frequency range 20-75kHz.

[0018] 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.

[0019] 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.

[0020] 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.

[0021] 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.

[0022] 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.

[0023] 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.

[0024] 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.

[0025] 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.

[0026] 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.

[0027] 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.

[0028] 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).

[0029] 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.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] A similar tapered profile may also be created around the cutting distal tip 28 of the second tool 21.

Claims

1. A tool (21) adapted to cut bone comprising:

   means for generating ultrasonic vibrations, and an elongate blade (27) operatively connectable thereto, the blade (27) having at least one cutting edge (28) provided with a plurality of serrations (23) each having a first cutting facet substantially transverse to the direction of said ultrasonic vibrations, wherein the means for generating ultrasonic vibrations is configured to produce torsional mode ultrasonic vibrations, and wherein the elongate blade (27) has a distal tip comprising the at least one cutting edge (28); wherein the serrations (23) extend distally from the tip of the elongate blade (27) and the blade has a curved cross-section which is an arc of a circle.

2. A tool (21) as claimed in claim 1, wherein the serrations (23) are generally triangular.

3. A tool (21) as claimed in claim 1 or 2, wherein the blade (27) is generally hemicylindrical.

4. A tool (21) as claimed in any preceding claim, wherein said tool (21) is adapted to be torsionally vibratable about a longitudinal axis extending through the centre of said circle.

5. A tool (21) as claimed in any preceding claim, wherein a portion of the elongate blade (27) adjacent its tip tapers longitudinally towards said tip.

6. A tool (21) as claimed in claim 5, wherein the tapered portion comprises an angled surface located on a concave face of the curved elongate blade (27).

7. A tool (21) as claimed in any preceding claim, wherein the ultrasonic generator is adapted to generate ultrasonic vibrations at a frequency within the range of 20-75 kHz.

Patentansprüche

1. Werkzeug (21), das zum Schneiden von Knochen ausgebildet ist, aufweisend:

   eine Einrichtung zur Erzeugung von Ultraschallschwingungen, und

ein damit betriebsmäßig verbindbares längliches Klingenelement (27), wobei das Klingenelement (27) mindestens eine Schneidkante (28) aufweist, die mit einer Mehrzahl von Kerbzähnen (23) versehen ist, die jeweils eine erste Schneidfacette im Wesentlichen quer zu der Richtung der Ultraschallschwingungen aufweisen, wobei die Einrichtung zur Erzeugung von Ultraschallschwingungendazu ausgebildet ist, Ultraschallschwingungen im Torsionsmodus zu erzeugen, und wobei das längliche Klingenelement (27) eine distale Spitze besitzt, die die mindestens eine Schneidkante (28) aufweist;
wobei sich die Kerbzähne (23) von der Spitze des länglichen Klingenelements (27) distal weg erstrecken und das Klingenelement einen gekrümmten Querschnitt aufweist, bei dem es sich um einen Kreisbogen handelt.

2. Werkzeug (21) nach Anspruch 1,
wobei die Kerbzähne (23) allgemein dreieckig sind.

3. Werkzeug (21) nach Anspruch 1 oder 2,
wobei das Klingenelement (27) allgemein halbzylindrisch ausgebildet ist.

4. Werkzeug (21) nach einem der vorhergehenden Ansprüche,
wobei das Werkzeug (21) derart ausgebildet ist, dass es um eine durch die Mitte des Kreises verlaufende Längsachse torsionsmäßig schwingfähig ist.

5. Werkzeug (21) nach einem der vorhergehenden Ansprüche,
wobei ein Bereich des länglichen Klingenelements (27), der der Spitze desselben benachbart ist, sich in Längsrichtung zu der Spitze hin verjüngt.

6. Werkzeug (21) nach Anspruch 5,
wobei der sich verjüngende Bereich eine winkelige Oberfläche aufweist, die sich auf einer konkaven Fläche des gekrümmten länglichen Klingenelements (27) befindet.

7. Werkzeug (21) nach einem der vorhergehenden Ansprüche,
wobei der Ultraschallgenerator dazu ausgebildet ist, Ultraschallschwingungen mit einer Frequenz im Bereich von 20 bis 75 kHz zu erzeugen.

Revendications

1. Un outil (21) adapté pour couper de l'os comprenant :

des moyens pour générer des vibrations ultrasoniques, et

une lame allongée (27) apte à être reliée fonctionnellement à ceux-ci, la lame (27) ayant au moins un bord de coupe (28) présentant une pluralité de dentelures (23) ayant chacune une première facette de coupe sensiblement transversale à la direction desdites vibrations ultrasonores, les moyens pour générer des vibrations ultrasoniques étant configurés pour produire des vibrations ultrasoniques en mode de torsion, et la lame allongée (27) ayant une pointe distale qui comprend ledit au moins un bord de coupe (28) ;
les dentelures (23) s'étendant distalement depuis la pointe de la lame allongée (27) et la lame présente une section transversale courbée qui est un arc de cercle.

2. Un outil (21) selon la revendication 1, dans lequel les dentelures (23) sont, d'une façon générale, triangulaires.

3. Un outil (21) selon la revendication 1 ou la revendication 2, dans lequel la lame (27) est, d'une façon générale, hémicylindrique.

4. Un outil (21) selon l'une quelconque des revendications précédentes, dans lequel ledit outil (21) est apte à être vibré en torsion autour d'un axe longitudinal s'étendant à travers le centre dudit cercle.

5. Un outil (21) selon l'une quelconque des revendications précédentes, dans lequel une partie de la lame allongée (27) adjacente à son extrémité se rétrécit longitudinalement vers ladite pointe.

6. Un outil (21) selon la revendication 5, dans lequel la partie conique comprend une surface angulaire située sur une face concave de la lame allongée incurvée (27).

7. Un outil (21) selon l'une quelconque des revendications précédentes, dans lequel le générateur d'ultrasons est adapté pour générer des vibrations ultrasonores à une fréquence située dans la gamme allant de 20 à 75 kHz.

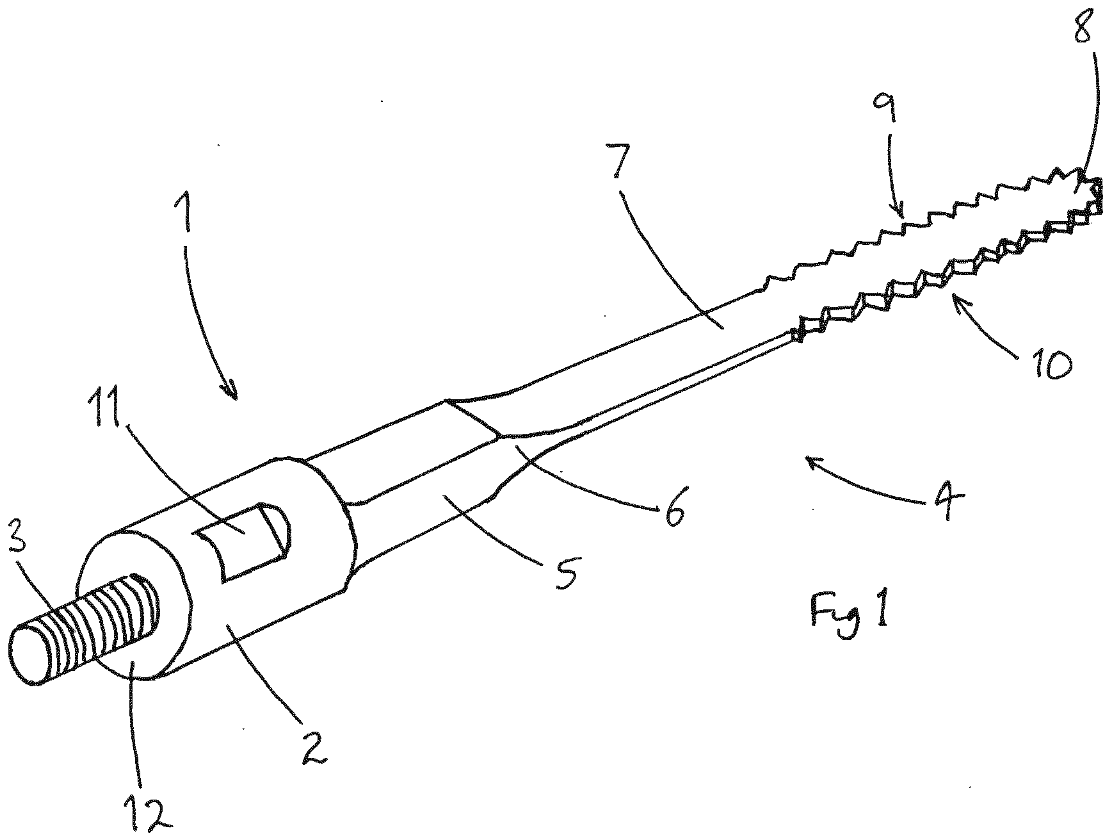
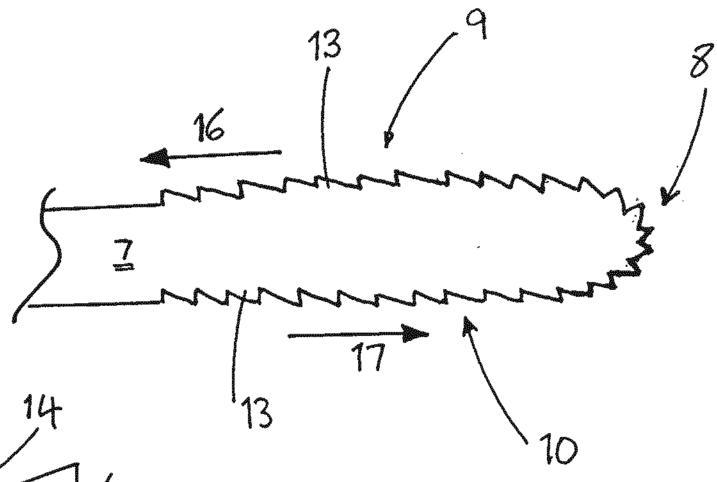


Fig 1

Fig 2A



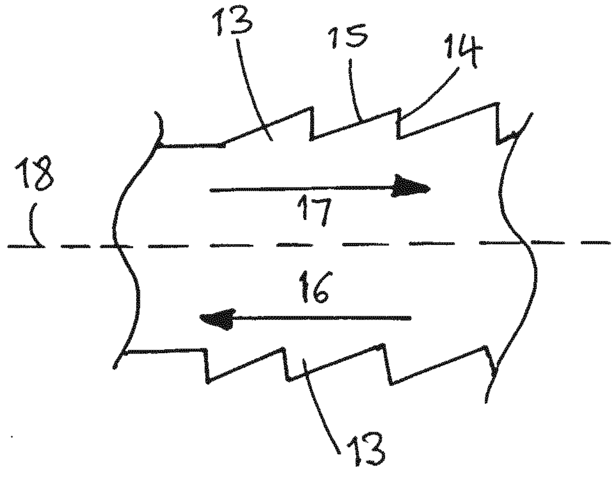


Fig 2B

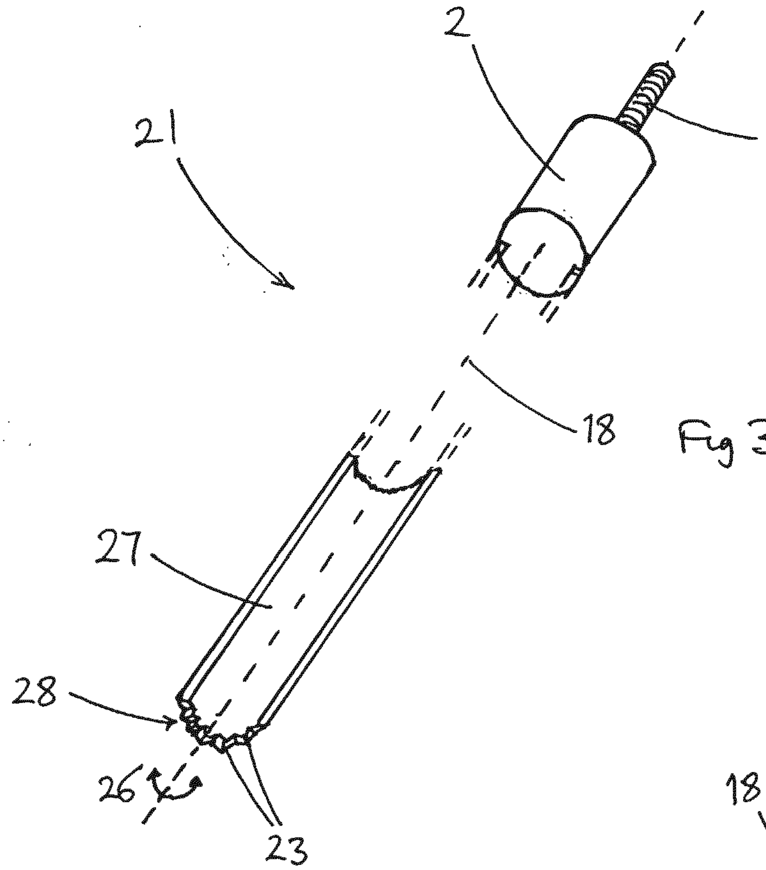


Fig 3A

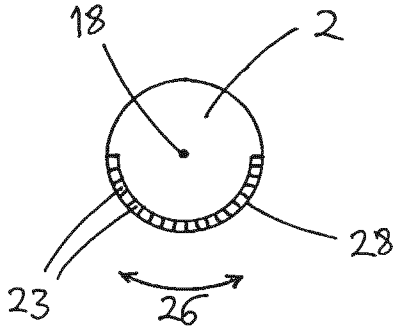


Fig 3B

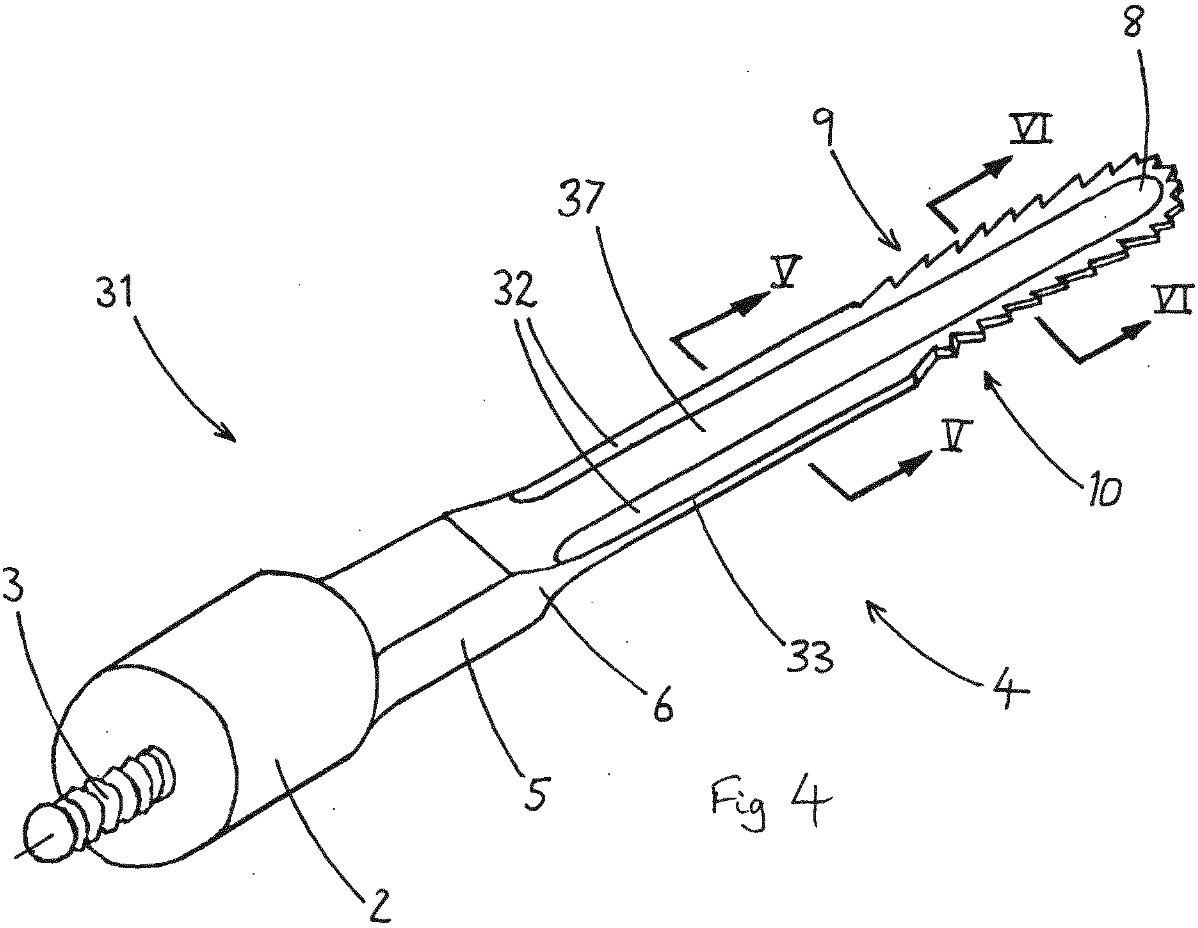


Fig 4

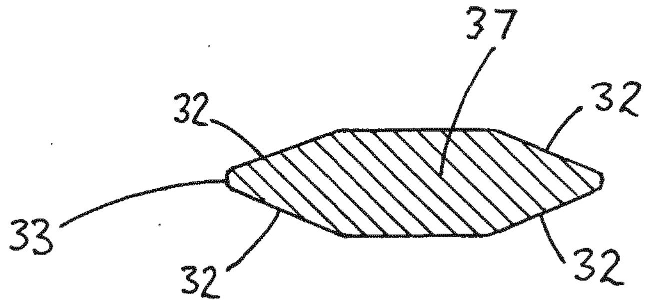


Fig 5

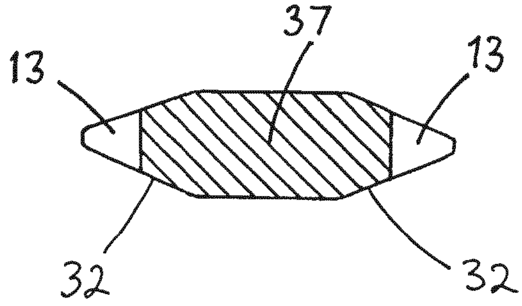


Fig 6

REFERENCES CITED IN THE DESCRIPTION

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- US 20020099400 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。