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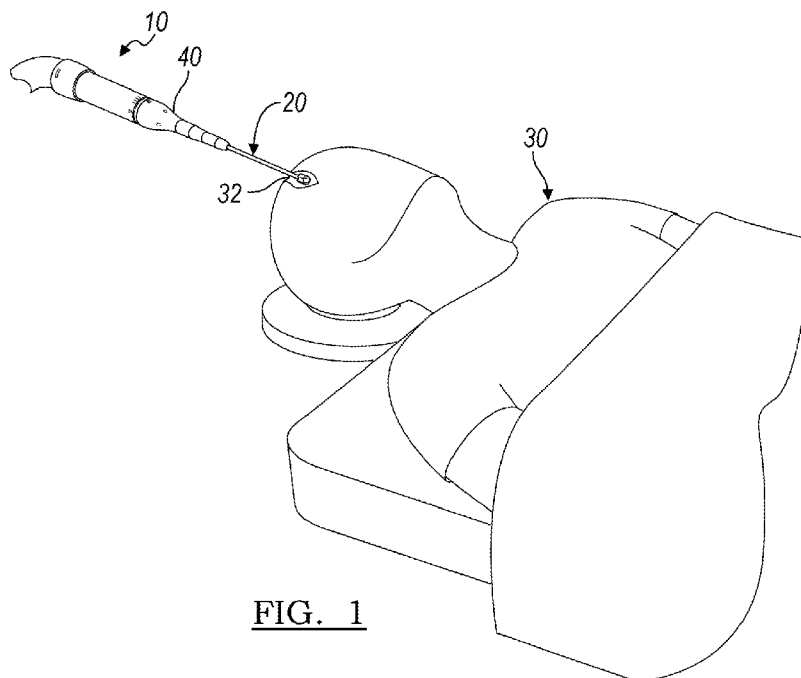
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[Continued on next page]

(54) Title: SURGICAL BURS



**FIG. 1**

(57) Abstract: A surgical bur is disclosed having cutting and trailing edges and associated flutes and lands. Each flute includes a cutting edge. Each of the trailing edges relates in a selected dimension to a preceding cutting edge.



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## SURGICAL BURS

### FIELD

- 5   **[0001]**   The disclosure relates to a surgical systems for bone cutting or shaping, and more particularly to surgical burs.

### BACKGROUND

- 10   **[0002]**   This section provides background information related to the present disclosure which is not necessarily prior art.

- 15   **[0003]**   Surgical burs need sharp and durable cutting edges in order to efficiently dissect, cut, and/or shape bone during a surgical procedure. Human anatomy tends to locate sensitive soft tissue structures, such as nerves and blood vessels, near bones for protection. These structures can include the dura mater. Dura mater, or dura, refers to the outermost layer of protective soft tissue surrounding the brain and spinal column of a patient. During cranial and spinal procedures, the distal end of a bur can come in contact with dura mater. The term “distal” means away from a medical practitioner holding a surgical tool with a rotating bur. The term “proximal” means towards the medical practitioner and away from the patient.

- 20   **[0004]**   It is desirable for the surgical burs to provide stability while drilling in an axial direction and to be able to efficiently cut while being moved in a radial direction. The axial direction may be, for example, a direction parallel to, along, and/or in line with a longitudinal axis of the surgical bur. The radial direction may be, for example, a direction away from and not parallel to the longitudinal axis of the surgical bur. The radial direction may be a direction away from and/or perpendicular to the longitudinal axis.

### SUMMARY

- 30   **[0005]**   This section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope or all of its features.

**[0006]** A surgical bur is disclosed, the bur may include flutes and lands. Each of the flutes includes a cutting edge, rake surfaces, and a clearance surface. Each of the lands is disposed between a pair of the flutes. Each of the flutes may have multiple rake surfaces with respective rake angles. Each of the lands is disposed between a pair of the flutes.

**[0007]** A surgical bur may further include a trailing edge that follows the cutting edge. In operation, the surgical bur may rotate so that a cutting edge is configured to cut bone as the surgical bur rotates in a selected direction. The trailing edge may follow the cutting edge as the surgical bur rotates. The trailing edge may also engage bone, but not cut the bone.

**[0008]** Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this summary are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

## DRAWINGS

**[0009]** The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

**[0010]** FIG. 1 is a perspective environmental view of a surgical dissection cutter assembly incorporating a surgical bur and in use on a patient in accordance with an embodiment of the present disclosure.

**[0011]** FIG. 2 is a perspective view of the surgical dissection cutter assembly of FIG. 1.

**[0012]** FIG. 3 is a detail front perspective view of a surgical bur.

**[0013]** FIG. 4 is a front detail view of the surgical bur of FIG. 3.

**[0014]** FIG. 5 is a side view of the surgical bur of FIG. 3.

**[0015]** FIG. 6 is a detail front perspective view of a surgical bur.

**[0016]** FIG. 7 is a front detail view of the surgical bur of FIG. 6.

**[0017]** FIG. 8 is a side view of the surgical bur of FIG. 6.

**[0018]** FIG. 9A is a detail environmental view of the surgical bur of FIG. 3 in use in a first position.

**[0019]** FIG. 9B is a detail environmental view of the surgical bur of FIG. 3 in use in a second position.

**[0020]** Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

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#### DETAILED DESCRIPTION

**[0021]** The following description includes disclosure of rotatable surgical burs (also referred to below as the surgical burs). Cutting edges and trailing edges, as disclosed below. The surgical burs may include one or more of a plurality of  
10 external geometries, such as a ball, a cylindrical, an oval, or other generally known shape, such as the Midas Rex® surgical burs sold by Medtronic, Inc. having a place of business in Minneapolis, MN. Surgical burs, including those disclosed herein, may be driven by high speed drills, such as the Midas Rex® Legend EHS Stylus High-Speed Surgical Drill which may be appropriate for a  
15 wide range of surgeries, including spine, neurology, and ear-nose-throat (ENT) procedures. The drills may drive the burs at appropriate and selectable speeds, such as about 200 to 75,000 rotations per minute (rpm), including about 7,000 to 70,000 rpms.

**[0022]** Example embodiments will now be described more fully with reference to  
20 the accompanying drawings. The following description is merely exemplary in nature and is not intended to limit the present disclosure, application, or uses. For example, although a human patient is illustrated as a subject, it is understood that a subject may be any appropriate subject. Further, the subject may include inanimate and non-living subjects. Non-living subjects may include solid working  
25 materials such as a objects formed of wood, ceramics, metal, etc. Certain tissues, such as bone tissue, may be rigid and may be shaped with a cutting tool. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features.

**[0023]** FIG. 1 shows a surgical dissection cutter assembly 10 incorporating a  
30 dissection tool 20 in use on a patient 30 at a surgical access site 32. The patient 30 is illustrated as undergoing a neurological operation. Access to a brain or other neurological structures of the patient 30 often requires delicate dissection of

bone (e.g. a skull) and other tissues. FIG. 1 is provided for example purposes only; the surgical burs disclosed herein may be used in different tools and/or cutter assemblies and may be used for other procedures and/or operations. The dissection cutter assembly 10 includes a dissection tool driver 40, which is being  
5 utilized to dissect a portion of bone and adjacent tissue of the patient 30 in the surgical access site 32. The tool driver may include the Midas Rex® Legend EHS Stylus High-Speed Surgical Drill, as noted above, or other appropriate driver.

**[0024]** FIG. 2 is a perspective view of the surgical dissection cutter assembly 10. The dissection tool driver 40 includes a motor housing 42 connected to a  
10 connector 44, the connector may include a hose or cable assembly. The connector 44 supplies external power and control for a motor included within the motor housing 42. The dissection tool driver 40 further includes an attachment housing 46 that connects to the dissection tool 20. A dissection tool distal end includes a surgical bur 64. A dissection tool proximal end may include a driver  
15 connection 54. The driver connection 54 may engage a connection within the attachment housing 46 to receive rotary power from the motor within the motor housing 42.

**[0025]** Although the following described dissection tools, for example surgical burs, are disclosed and illustrated in the drawings as having a particular number  
20 of flutes, rake surfaces per flute, rake angles per flute, clearance surfaces per flute, lands, axial relief surfaces, clearance surfaces, etc., the surgical burs may have other quantities of each of these items.

**[0026]** FIG. 3 shows a side and perspective view of the dissection tool 20. The dissection tool 20 may be used as part of the dissection assembly 10 of FIG. 1.  
25 The dissection tool 20 includes a shaft 62 and the surgical bur 64. The surgical bur 64 has a design that may generally be referred to as a “match head”, “neuro”, or “matchstick” design and includes a body 66. The body 66 has two convex lands 68 and two flutes 70. Each of the flutes 70 is located between the lands 68 and has a corresponding chip space 72. The lands 68 are convex-shaped and/or  
30 rounded and may be in respective 180° locations about a longitudinal axis 78 of the dissection tool 20, the shaft 62, and/or the surgical bur 64. The surgical bur 64 is rotated about the longitudinal axis 78. The flutes 70 may also be in

respective 180° locations about the longitudinal axis 78. Each of the flutes 70 has one or more rake surfaces on or at a cutting edge 76. A clearance surface 73, which may be a flat or concave surface, may also correspond to the cutting edge 76. The clearance surfaces 73 are formed relative to the flutes 70, and may be on both proximal and distal portions of the flutes 70, near respective bur proximal end 64a and bur distal end 64b.

**[0027]** With additional reference to FIGS. 4 and 5, the surgical bur 64 further includes the cutting edge 76. The cutting edge 76 is spaced a distance 82 from a center or central axis 78 of the bur 64. Generally, the cutting edge 76 axially extends from and is spaced the distance 82 from the center axis 78. Further, the cutting edge 76 is generally set on an edge of the flute 70. The cutting edge 76 is a leading edge while cutting the bur 64 rotates in the direction of arrow 80 around the central point or axis 78. The cutting edge 76 offset the distance 82 generally places the cutting edge 76 at a maximum distance from the center point 78 of the bur 64. That is the cutting edge 76 is generally at a most exterior point or distance from the center 78 as the cutting edge 76 is cutting into a material, as discussed further herein. A rig surface 84 extends from the cutting edge towards a distal tip 86 at the bur distal end 64b, through which the central axis 78 may extend. The distal tip 86 may be a terminal distal tip of the dissection tool 20.

**[0028]** A trailing edge 90 of the bur 64 can be formed at an edge of the curved land 68 and generally adjacent to the flute 70 of the bur 64. The trailing edge 90 is generally an edge of the curved land 68 that follows the cutting edge 76 as the bur 64 rotates in the direction of arrow 80. The trailing edge 90 may be at a distance 94 from the center axis 78. The distance 82 of the cutting edge 76 from the central axis 78 and the distance 94 of the trailing edge 90 from the central axis 78 may be substantially the same or identical. With continuing reference to Fig. 4, the leading edge 76 and the trailing edge 90 may generally lie on a circle 96 having a radius that is substantially equivalent to or defined by the distances 82 and 94 from the center 78. Thus, the cutting edge 76 may not extend beyond the circle 96 or the trailing edge 90. Both the cutting edge 76 and the trailing edge 90 may extend only to the circle 96. Moreover, the cutting edge

and the trailing edge may be include more than one of each, as discussed herein. A third distance 95 of a surface forming the convex land 68 may be less than either of the first distance 82 or the second distance 94. Further, the clearance area 73 of the flutes, as discussed herein, may have a fourth distance 73a from the center 78 that is less than the first, second or third distance.

**[0029]** As further illustrated in Fig. 4, two flutes may be included with the surgical bur 64. A second flute 70a may include a second leading or cutting edge 76a and a second trailing edge 90a. Thus, the bur 64 may include two flutes 70, 70a with equivalent two cutting edges 76, 76a and two trailing edges 90, 90a. The second cutting edge 76a and second trailing edge 90a may also be formed on the circle 96 centered on the central axis 78 of the bur 64.

**[0030]** The bur 64 may include any selected geometry for forming a dissection of a selected structure. For example, the flute may define an arc 97 that is about 5 degrees ( $^{\circ}$ ) to about 35  $^{\circ}$ . The curved land 68 may also define an arc 99, which may also be the arcuate distance from the trailing edge 90, 90a to a cutting edge 76, 76a that is about 175  $^{\circ}$  to about 145  $^{\circ}$ . The arcs 97, 99, however, may be formed with the bur 64 to be any selected arcuate angle. The distances 82, 94 of the cutting edges 76, 76a and the trailing edge 90, 90a, however, may all generally be equivalent.

**[0031]** Turning reference to FIGS. 6-8, a surgical bur 164 is illustrated. The surgical bur 164 can be used as the dissection tool 20 in the assembly 10 in the manner similar to the surgical bur 64, as discussed above. The surgical bur 164 can also include various features and portions similar to the surgical bur 64, as discussed above. Accordingly, this portion will not be described in substantial detail and have similar reference numerals as those noted above increased by 100.

**[0032]** The surgical bur 164 may include a central axis 178 that extends through a shaft 162 of the surgical bur 164. The surgical bur 164 includes a body 166. The surgical bur 164 can include a flute 170 with a cutting edge 176. Further, a trailing edge 190 can be formed on the body 166 and follow the cutting edge 176 as the surgical bur 164 rotates in a direction of arrow 180. Further, a



chip collection area 172 can be defined in the flute 170. A convex land 168 is formed between the cutting edge 176 and the trailing edge 190.

**[0033]** The surgical bur 164 may differ from the surgical bur 64 in that the surgical bur 164 includes three cutting edges 176, 176a and 176b. Accordingly, the surgical bur 164 can also include three flutes 170, 170a and 170b. Further, the surgical bur can include three trailing edges 190, 190a and 190b.

**[0034]** Similar to the surgical bur 64, the surgical bur 164 can define or have a circle 196 that defines an outer perimeter or edge of the surgical bur 164. Accordingly, the cutting edge 176 may be formed at a distance 182 from the central axis 178. The trailing edge 190 can be formed at a distance 194 from the central axis 178. The distance 182 may be substantially equal or equivalent to the distance 194. Therefore, the cutting edge 176 and the trailing edge 190 can both be positioned on the circle 196. Additionally, the surgical bur may include a distal tip 186 that is generally on the axis 178 and other features that are similar to the surgical bur 164. Also, the convex land 168 may have a surface that is a third distance 195 from the center axis 178 that is less than either of the first distance 182 or the second distance 194.

**[0035]** The surgical bur 164, therefore, includes three flutes 170, 170a, 170b while the surgical bur 64 includes two flutes. On the bur 164, the arcuate distance of the flutes 170, 170a, 170b and the arcuate distance from a trailing edge to the next cutting edge 176, 176a, 176b may be selected to be any appropriate distance. The arcuate distances between the various portions may be smaller than on the bur 64 given that there are a greater number of flutes on the bur 164.

**[0036]** It is further understood that a surgical bur, according to the various embodiments, can include any appropriate number of flutes. Regardless, the cutting edge and trailing edge may both be generally on a circle that defines an outer extent of the surgical bur. Therefore, the distance from the central axis to the cutting edge and trailing edge may generally be substantially equivalent or identical, as discussed above. Further, it is understood that the surgical bur may be formed in any appropriate shape such as including a ball shape, a cylindrical shape, or other appropriate shape. The surgical bur, according to various

embodiments, can therefore be used to form a dissection or resection of an appropriate portion of a subject, such as the patient 30 as illustrated in Fig. 1 and discussed further herein.

**[0037]** Turning reference to FIGS. 9A and 9B, the surgical bur 64 is illustrated relative to a bone structure or mass 210. The surgical bur 64 includes the cutting edge 76 and the cutting edge 76a, as discussed above. The surgical bur 64 can move or bore axially generally along the axis 78 of the dissection tool 20. Accordingly, as illustrated in Figs. 9A and 9B, the surgical bur 64 can move along the axis 78 and generally directly out of the plane of the page. An additional movement of the surgical bur 64 can be to cut radially or generally away from the central axis 78, such as in the direction of arrow 212. As the surgical bur is moved in the direction of arrow 212 into the bone mass 210, a channel or trough 214 may be formed. In forming the channel 214, the cutting edge 76 can form one or more bone chips 218 from the bone mass 210. The bone chips 218 can be moved into the flute 70 of the surgical bur 64. In moving into the flute 70 of the surgical bur 64, the bone chip 218 can be moved out of the cutting path of the surgical bur 64, which generally in the direction of arrow 212.

**[0038]** The surgical bur 64, in cutting the bone 210, is rotating in the direction of arrow 80, as discussed above. Further, the bur 64 is moved in the direction of arrow 212 to form the channel 214 in the bone 210. Therefore, the cutting edge 76, moving in the direction of arrow 80, cuts the bone chip 218 and then continues to rotate in the direction of arrow 80 and generally away from a front wall or cutting area 220 of the channel 214. The cutting edge 76 in forming the bone chip 218, therefore, moves the bone chip 218 towards the already formed portion of the channel 214.

**[0039]** As illustrated in Fig. 9B, the cutting edge 76, after forming the bone chip 218, is passing into or through the formed portion of the channel 214 and the trailing edge 90 trailing as the cutting edge 76 is engaging the front or forming wall 220 of the channel 214. As discussed above, the trailing edge 90 can include the distance 94 from the central axis 78 that is substantially equivalent or equal to the distance 82 of the cutting edge 76 from the central axis 78. Therefore, the trailing edge 90 can engage the wall 220 at substantially the same distance from the

central axis 78 as the cutting edge 76 and the forthcoming second cutting edge 76a. This an guide and or stabilize the bur 64, as discussed further herein, during cutting with the cutting edge 76a.

**[0040]** The cutting edge 76a includes a distance 82a which is substantially identical to the distance 82 from the central axis 78. Therefore, the cutting edge 76a, prior to cutting the wall 220, is generally at substantially the same position as the trailing edge 90. Because the radius or distance from the central axis 78 to the wall 220 is substantially identical for the trailing edge 90 and the second cutting edge 76a, there is no jump or jerking of the bur 64 prior to the second cutting edge 76a initiating a cut and formation of the bone chip 218. Therefore, the trailing edge 90 can form or act as a stabilizing edge or surface relative to the wall 220 of the channel 214 prior to the second cutting edge 76a cutting the wall 220. Similarly, the second trailing edge 90a can act as a stabilizing surface or edge relative to the cutting edge 76 prior to the cutting edge 76 cutting the forward wall 220 of the channel 214.

**[0041]** The bur 64 can rotate by the motor generally at a selected rotational rate, such as about 700 to about 75,000 rpm. As an example, the bur 64 may rotate at about 7,000 rpm. Therefore, the engaging of the cutting edges 76 and 76a on the forward wall 220 and the stabilizing by the trailing edges services 90, 90a, can substantially stabilize the bur 64 as the bur 64 forms the channel 214.

**[0042]** Returning reference to FIG. 9A, the bur 64 is stabilized during radial cutting, for example when the cutting edge 76 forms the bone chip 218 to cut or dissect the bone 210. The bur 64 may experience reduced vibrational and forces and chatter during radial cutting. In one example, the bur 64 can experience a reduction of vibration by at least about 40%, including a reduction of about 20-40%, including about 42%. Vibration forces may be measured with an accelerator and reported in g-forces using units such as meters/second<sup>2</sup>.

**[0043]** During operation, the stabilization may occur by the bur 64 rotating within the channel, the cutting edge 76 moves away from the front wall 220 of the channel 214. As the cutting edge 76 moves away from the front wall 220, the trailing edge 90 can engage the wall 220 prior to the next cutting edge 76a. Due to the rotational speed of the bur 64, the elapsed time between the cutting edge

leaving the wall 220 and the trailing edge 90 engaging the wall may be very short, such as on the order of micro-seconds.

**[0044]** The trailing edge 90, however, engages the wall 220 prior to the second cutting edge 76a beginning the cut of the front wall and formation of the bone chip 218. Therefore, as the cutting edge 76a begins to cut the front wall 220 of the channel 214, the bur 64 may be substantially stabilized relative to the front wall 220. This is at least because the trailing edge 90 is the same or substantially the same distance from the center 78 as the cutting edge 76a.

**[0045]** Further, the trailing edge 90 can continue to ride along the wall 220 to stabilize the bur 64 as the bur 64 rotates in the direction of arrow 80 and the cutting edge 76a cuts and forms bone chips along the wall 220. Therefore, the trailing edge may act as a guide that stabilizes the bur 64. The trailing edge 90 stabilizes the bur 64 as following cutting edge, for example the cutting edge 76a, follows the trailing edge 90 as illustrated in FIG. 9B. This assists in stability of the bur 64 during cutting the channel 214.

**[0046]** The contact of the trailing edge 90 with the front wall substantially simultaneously with the cutting edge 76a or immediately prior to may reduce chatter or vibration of the bur 64 while cutting or dissecting. This can reduce user fatigue during use of the assembly 10 including the bur 64. This can also increase precision of the dissection when using the bur 64 due to reduced vibration and chatter. Thus, a user may be able to cut longer without a break to decrease time needed for a procedure and to increase precision of a cut. Accordingly, the bur 64 may also decrease a chance of a mic-cut. It is further understood, as discussed above, that the trailing edge and cutting edge may be any appropriate combination of edges and need not specifically be the ones referred to by reference number above.

**[0047]** In cutting the channel 214, various surgical procedures may occur. For example, a bur hole may be formed in a scalp, as illustrated in FIG. 1. The bur hole may be used to allow access to the brain dura and brain tissue for various procedures, such as placement of a deep-brain stimulation probe, a resection of a tumor, and the like. Further, other procedures may include forming a hole in other cranial tissues, forming a depression or removal of tissue and other

bone matter, including long bones and vertebrae, and other appropriate procedures. Regardless of the specific procedure, however, the bur 64 may cut the channel 214 and the bone 210 without substantial vibration due to the positioning of the trailing edge 90 at substantially the same radial position relative to the central axis 78 as the cutting edge 76a.

**[0048]** Example embodiments are provided so that this disclosure will be thorough, and will fully convey the scope to those who are skilled in the art. Numerous specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well-known processes, well-known device structures, and well-known technologies are not described in detail. Moreover, the design and structure of a surgical bur may be altered from the specific examples provide above, but include a trailing edge that has a distance from a center equal to or substantially equal to a following, such as an immediately following cutting edge. This may allow a substantially smooth and jitter or jump free dissection of tissue, including boney tissue.

**[0049]** The terminology used herein is for the purpose of describing particular example embodiments only and is not intended to be limiting. As used herein, the singular forms "a," "an," and "the" may be intended to include the plural forms as well, unless the context clearly indicates otherwise.

**[0050]** The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

## CLAIMS

What is claimed is:

1. A surgical dissection assembly, comprising:  
an elongated shaft extending from a proximal end towards a distal  
5 end;  
a surgical bur at the distal end of the elongate shaft, the surgical bur  
including:  
a first flute,  
a first cutting edge, and  
10 a first trailing edge,  
wherein the first cutting edge is configured to cut a tissue and  
spaced a first distance from a center axis of the surgical bur,  
wherein the first trailing edge is spaced the first distance from  
the center axis of the surgical bur;  
15 wherein the surgical bur is configured to dissect tissue in a radial  
direction relative to the center axis.
2. The surgical dissection assembly of Claim 1, further comprising:  
a bur distal tip configured to dissect axially along the center axis into  
20 the tissue.
3. The surgical dissection assembly of any of Claims 1 or 2, wherein  
the surgical bur further includes a convex land formed by a wall extending from  
the first trailing edge, wherein the convex land is a second distance from the  
25 center axis and the second distance is less than the first distance.
4. The surgical dissection assembly of Claim 3, wherein the surgical  
bur further includes a second flute having a second cutting edge and a second  
trailing edge;  
30 wherein the convex land extends generally on an arc around the  
center axis between the first cutting edge and the second trailing edge.

5. The surgical dissection assembly of any of Claims 1 to 3, wherein the first flute includes a plurality of flutes, wherein each flute of the plurality of flutes includes a cutting edge and a trailing edge.

5 6. The surgical dissection assembly of any of Claims 1 to 5, wherein the first flute includes a chip clearing area.

7. The surgical dissection assembly of any of Claims 1 to 6, wherein the first cutting edge and the first trailing edge are configured to allow stable radial  
10 cutting.

8. The surgical dissection assembly of any of Claims 1 to 7, further comprising:  
a motor connection at the proximal end of the shaft.

15

9. The surgical dissection assembly of any of Claims 1 to 8, further comprising:  
a motor to drive the surgical bur for dissection of the tissue.

10 10. A surgical dissection assembly, comprising:  
an elongated shaft extending from a proximal end towards a distal end;  
a surgical bur at the distal end of the elongate shaft, the surgical bur including:

25 a first flute having a first cutting edge and a first trailing edge,  
a second flute having a second cutting edge and a second trailing edge,

wherein the first cutting edge and the second cutting edge are configured to cut a tissue and are both spaced a first distance from a center axis  
30 of the surgical bur,

wherein the first trailing edge and the second trailing edge are spaced the first distance from the center axis of the surgical bur;

wherein the surgical bur is configured to dissect tissue in a stable manner while moving in a radial direction relative to the center axis.

11. The surgical dissection assembly of Claim 10, further comprising:  
5 a motor configured to drive the surgical bur; and  
a motor housing to house the motor and configured to be manipulated by a user to dissect the tissue with the surgical bur.

12. The surgical dissection assembly of Claim 11, wherein the motor is  
10 configured to drive the surgical bur in a first rotational direction;  
wherein the first trailing edge engages a surface of the tissue to be cut prior to the second cutting edge cutting the tissue.

13. The surgical dissection assembly of any of Claims 10 to 12, wherein  
15 the proximal end of the shaft includes a motor engaging section to transfer rotation force from the motor to the shaft.

14. The surgical dissection assembly of any of Claims 10 to 13, wherein  
the flute includes a flute surface having a third distance from the center axis less  
20 than the first distance or the second distance;  
wherein the flute forms a chip clearing area.

15. The surgical dissection assembly of any of Claims 10 to 14, wherein  
the surgical bur further includes a first convex land extending generally on a first  
25 arc around the center axis from the first cutting edge to the first trailing edge and a  
second convex land extending generally on a second arc around the center axis  
from the second cutting edge to the second trailing edge.

16. A method of removing material generally in a radial direction from a  
30 center axis of a bur, the method comprising:  
powering a motor to rotationally drive the bur around the center axis  
of the bur;



moving the surgical bur in a radial direction from the center axis; and  
engaging a front wall of a channel with a trailing edge of the bur prior  
to engaging the front wall with a cutting edge of the bur;  
wherein the bur is configured to cut smoothly into the front wall.

5

17. The method of Claim 16, further comprising:  
forming a channel in the material by cutting the front wall and  
removing material from the front wall.

10

18. The method of any of Claims 16 or 17, further comprising:  
forming a bore into the material by moving the bur axially along the  
center axis into the material.

15

19. The method of any of Claims 16 to 18, further comprising:  
forming a hole with the bur.

20. The method of Claim 19, further comprising inserting an object into  
the material through the hole.

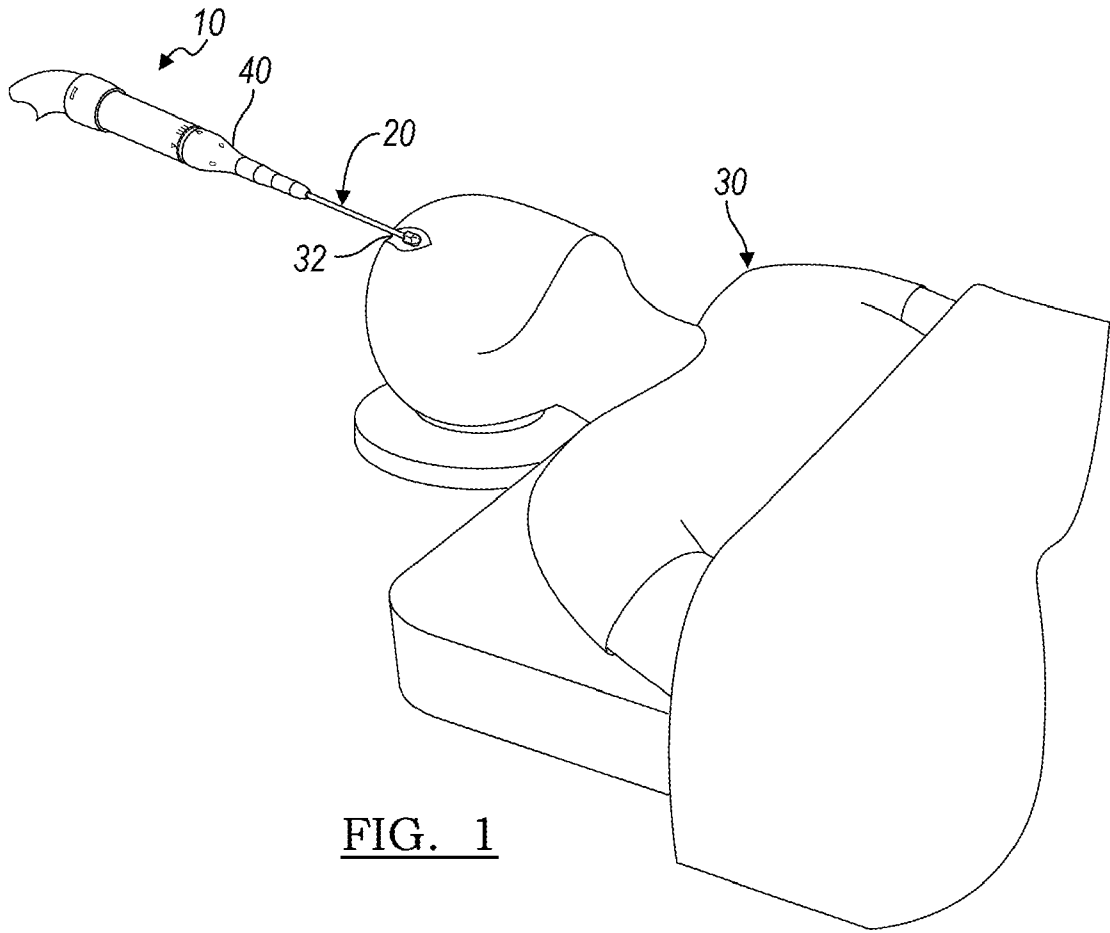


FIG. 1

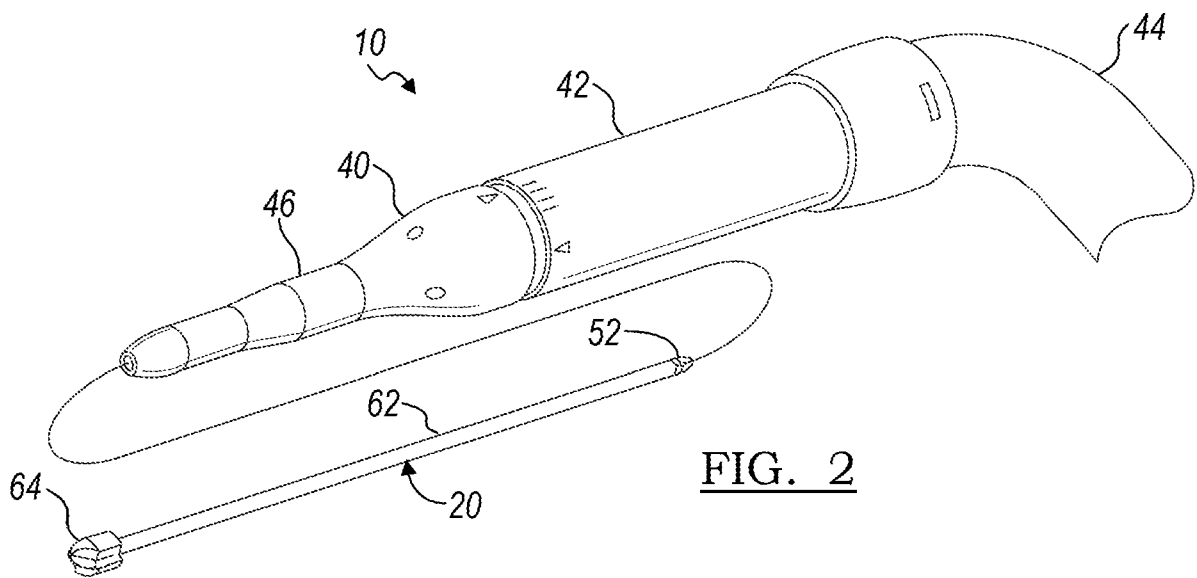


FIG. 2

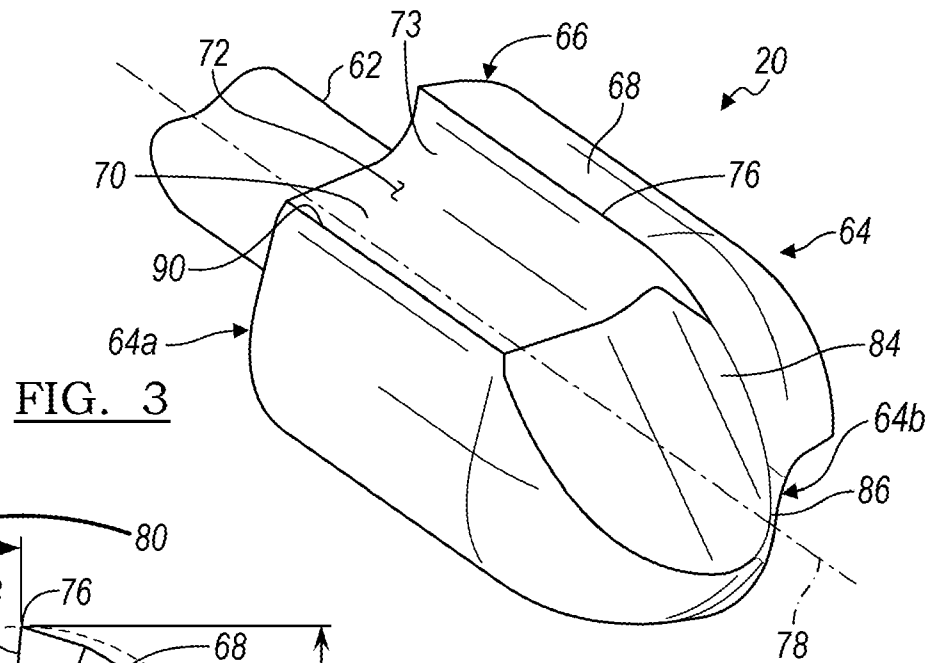


FIG. 3

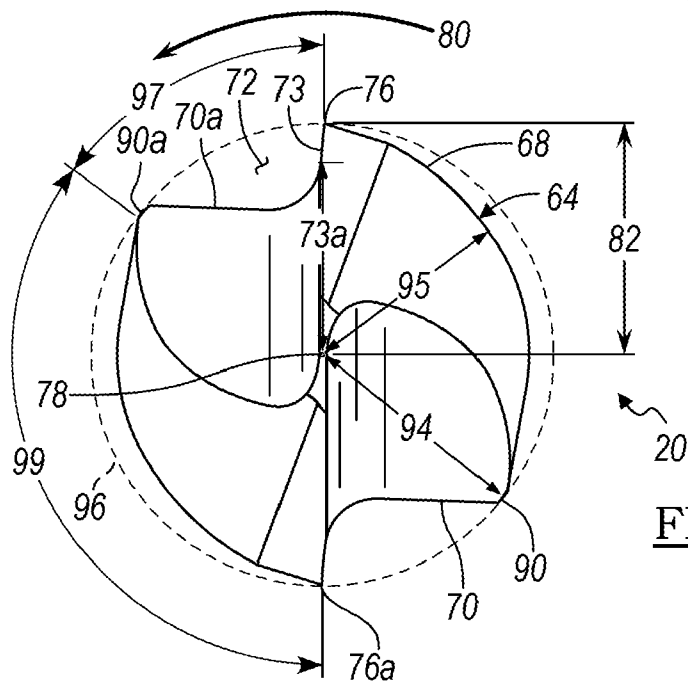


FIG. 4

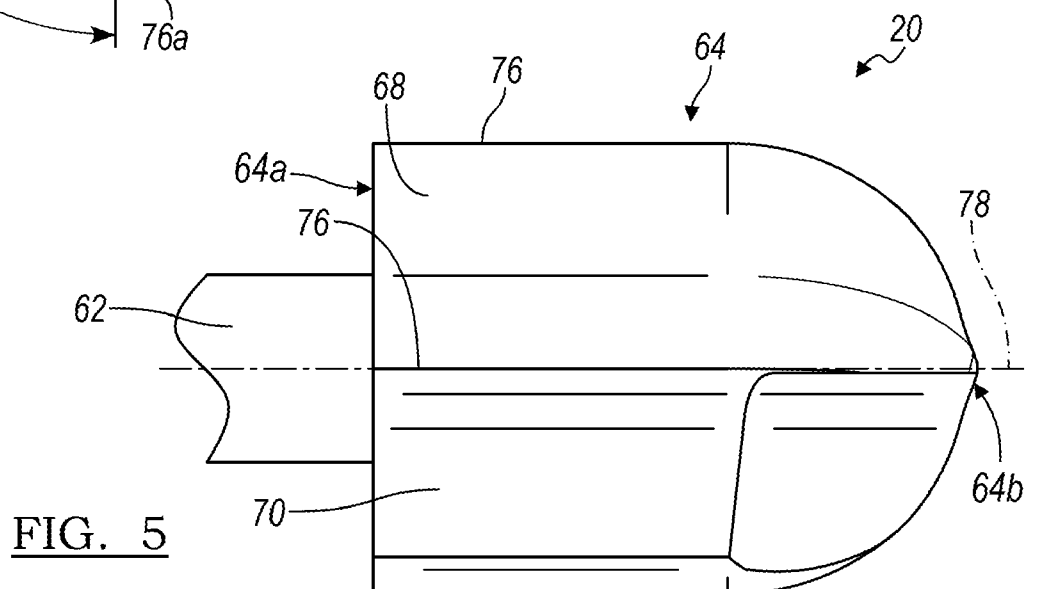


FIG. 5

FIG. 6

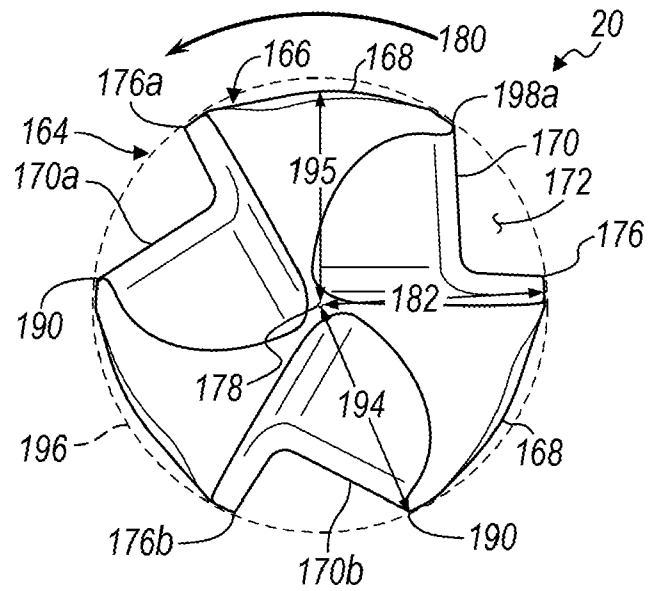


FIG. 7

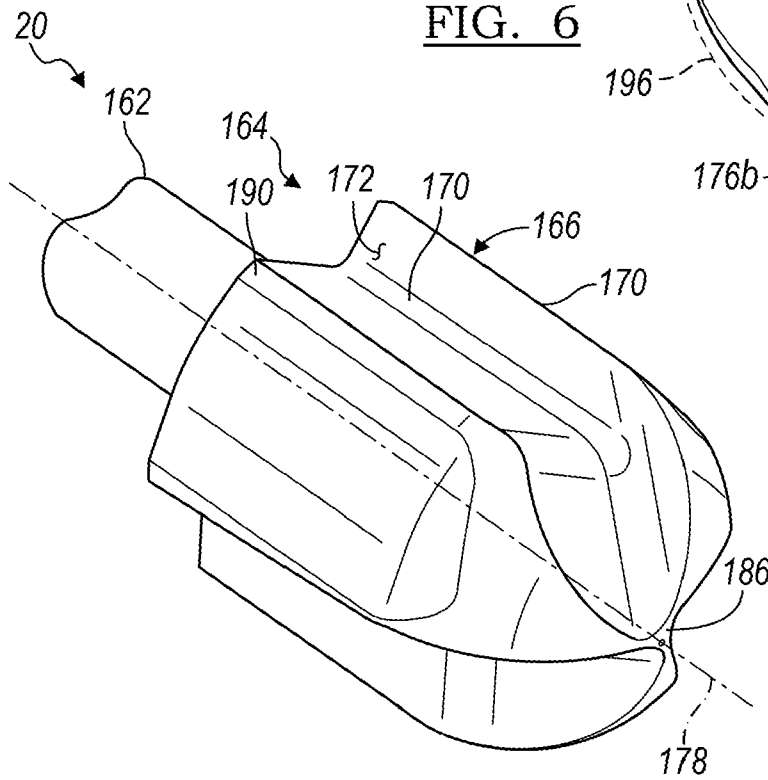
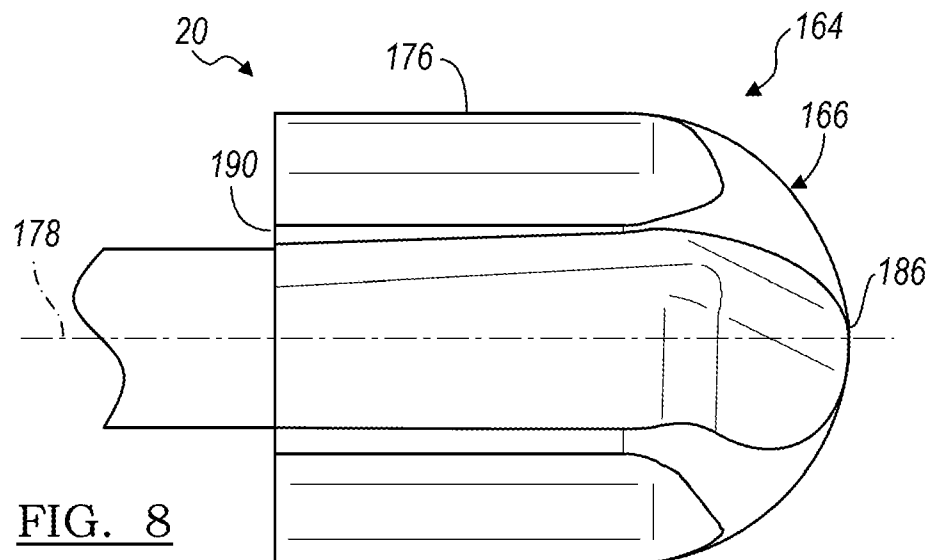


FIG. 8



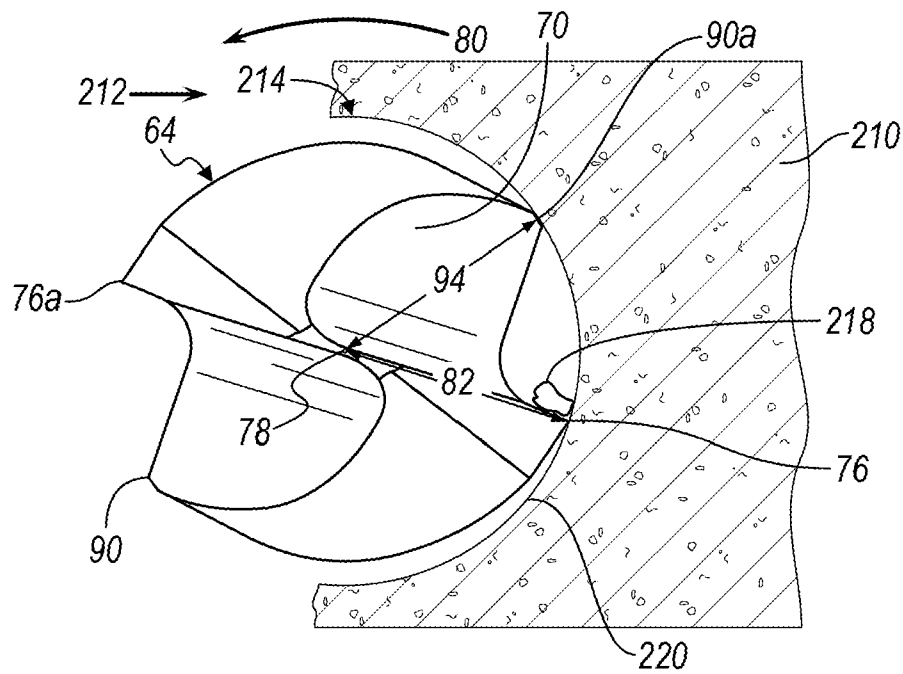


FIG. 9A

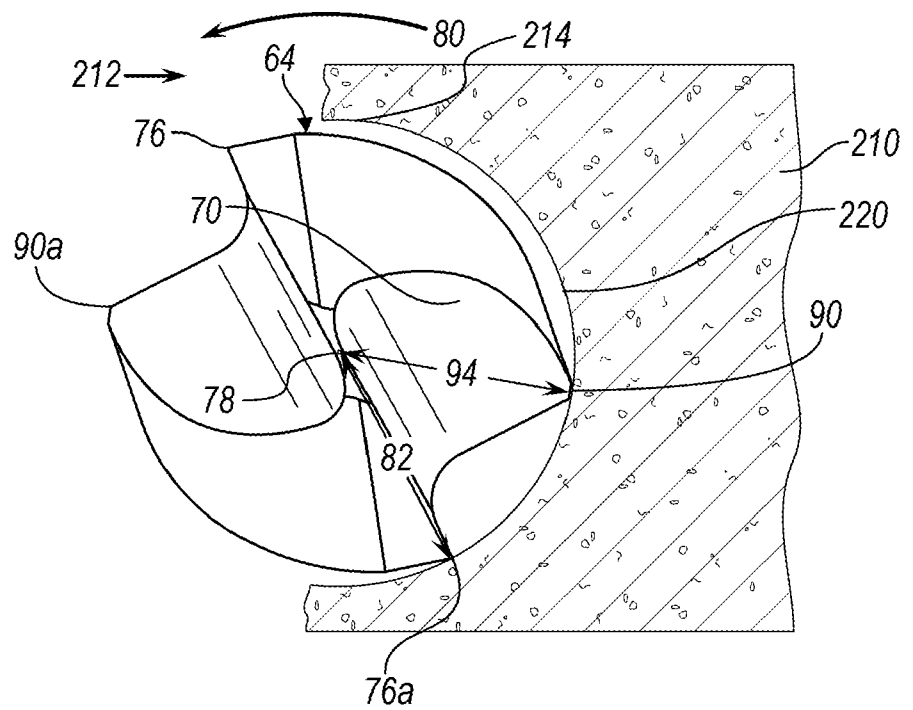


FIG. 9B

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/049464

## A. CLASSIFICATION OF SUBJECT MATTER

INV. A61B17/16

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/023381 A1 (STRYKER IRELAND LTD [IE]; GUBELLINI MATTEO [IE]; MANLEY KEVIN [IE]) 3 March 2011 (2011-03-03) paragraphs [0039], [0053]; figures 10-13 -----	1-15
X	US 2010/209200 A1 (DELACRETAZ FRANCIS [CH]) 19 August 2010 (2010-08-19) figure 14 -----	1
X	US 2005/272004 A1 (DESROSIERS JOHN J [US]) 8 December 2005 (2005-12-08) figures 5A-5E -----	1-15
X	WO 2007/010389 A1 (STRYKER IRELAND LTD [IE]; O'DONOGHUE DENIS [IE]) 25 January 2007 (2007-01-25) figure 4 -----	1



Further documents are listed in the continuation of Box C.



See patent family annex.

## \* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

24 October 2016

Date of mailing of the international search report

03/11/2016

Name and mailing address of the ISA/

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Authorized officer

Fernández Arillo, J

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2016/049464

### Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: 16-20  
because they relate to subject matter not required to be searched by this Authority, namely:  
Pursuant to Rule 39.1(iv) PCT, the subject-matter of claims 16-20 has not been searched, since it is directed to a method for treatment of the human body by surgery (they all contain the step of "removing material", wherein it is clear from the description that the material is bone material).
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

### Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

#### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2016/049464

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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