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(54) Title: CIRCULAR SAW BLADE WITH ELLIPTICAL GULLETS

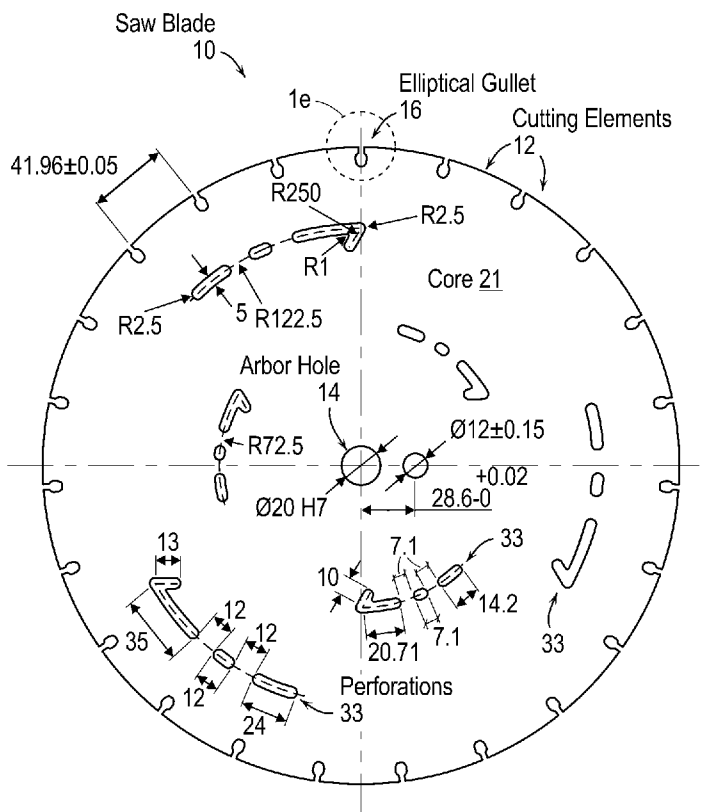


FIG. 1a

(57) Abstract: A saw blade includes a circular core having a plurality of cutting elements along its periphery, and a central arbor hole. One or more gullets extend radially inward from the perimeter of the core. Each gullet includes a shape that includes at least one elongated curve that enlarges radii in gullet areas prone to cracking, relative to other gullet areas.

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## CIRCULAR SAW BLADE WITH ELLIPTICAL GULLETS

### RELATED APPLICATIONS

[0001] This application claims the benefit under 35 USC 119(e) of U.S. Provisional Application No. 61/011,806, filed on January 22, 2008, and is a Continuation-in-Part of U.S. Patent Application No. 11/110,525, filed on April 20, 2005, both of which are incorporated herein by reference in their entirety.

### FIELD OF THE INVENTION

[0002] The invention relates to saw blades, and more particularly, to circular saw blades having gullets designed to reduce fatigue and increase the life of the blade.

### BACKGROUND OF THE INVENTION

[0003] Conventional circular saw blades typically include a circular steel core having a series of cutters or teeth spaced along its perimeter. Gullets, in the form of cutouts extending inwardly from the periphery of the blade, are often interspaced between the cutters to aid cutting, by relieving stresses in the blade and removing swarf. A variety of gullet configurations may be used. The actual gullet configuration employed for a particular blade is based on the cutting application(s) for which the blade is expected to be used.

[0004] Saw blades having relatively narrow gullets have been found useful in sawing of construction material with portable power saws, and in other masonry cutting applications on stationary machines, where smooth cutting action is desired. It has been found that the smoothness of cutting action is enhanced when the cutters are placed relatively close to one another, such as provided by the use of relatively narrow gullets. However, cracks tend to propagate from the tightly radiused ends of these gullets, particularly if the blade is exposed to high radial pressure. This problem is exacerbated on blades in which a fatigue barrier has been surpassed. Alternatively, saw blades having relatively wide gullets may be used. These gullets typically have a relatively large radius at their inner ends, which have been found to provide the blade with relatively high fatigue strength. These gullets may thus be beneficial in relatively high-stress cutting environments, such as floor sawing of asphalt or concrete, in which other blade types tend to fail due to stress cracks propagating from the gullets.

[0005] Keyhole-shaped gullets attempt to combine benefits of both narrow and wide gullets. These gullets enable the cutters of a blade to be positioned relatively close to one another (e.g., so as to provide a smooth cutting action) while also providing each gullet with a relatively large radius at its radially inner end (e.g., so as to help reduce crack formation). While keyhole gullets may exhibit improved characteristics over the narrow and wide gullets in some applications, they are not without drawbacks. For example, results achieved with keyhole gullets have been less than optimal in applications involving difficult to cut materials such as steel or a relatively heterogeneous mix of workpiece materials, such as steel reinforced concrete. Under these conditions, cracks have been found to propagate from the ends or sides of the gullets, which may compromise user safety and saw performance.

[0006] There is a need, therefore, for improved gullets suitable for circular saw blades.

## SUMMARY OF THE INVENTION

[0007] One embodiment of the present invention provides a circular saw blade. The saw blade includes a circular core having a first planar side and a second planar side, a central arbor hole, and an outer perimeter. A plurality of cutting elements is at the outer perimeter of the core. In addition, there are one or more gullets extending radially inward from the perimeter of the core. Each gullet includes a shape that includes at least one elongated curve that enlarges radii in gullet areas prone to cracking, relative to other gullet areas. In one such embodiment, each gullet includes three or more elliptical shapes corresponding to three different gullet areas. In one specific such configuration, the shape of the gullet includes two curved sides, each connected to a radially inward curved bottom. The bottom is shaped like the elongated side of a first elliptical shape, and each of the two sides is shaped like the elongated side of a second elliptical shape. In one such case, the gullet includes an opening that defines the two sides and the bottom. In another such case, the gullet includes a slit that defines the two sides and the bottom. In another such case, the first and the second elliptical shapes are symmetrical about their respective long and short axes. Alternatively, at least one of the first and the second elliptical shapes can be asymmetrical about at least one of its long and short axes. In another such case, the first elliptical shape has short and long axes that are both shorter than respective short

and long axes of the second elliptical shape. The core may include, for example, two or more layers operatively coupled via at least one of a bond material and a mechanical fastener (as opposed to a single layer or unitary blade). In one such case, the core is a sandwich-type core that includes a middle layer of sound-damping material bonded between the first and second planar sides (e.g., cork, resin, copper, or soft iron). The core can be made, for example, of steel and/or non-metallic material, or other suitable material. The cutting elements may include, for example, bonded abrasive segments, a single layer of abrasives, or teeth, or a combination thereof. In one particular configuration, there is at least one gullet between neighboring cutting elements.

[0008] The features and advantages described herein are not all-inclusive and, in particular, many additional features and advantages will be apparent to one of ordinary skill in the art in view of the drawings, specification, and claims. Moreover, it should be noted that the language used in the specification has been principally selected for readability and instructional purposes, and not to limit the scope of the inventive subject matter.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0009] In the accompanying drawings, reference characters refer to the same parts throughout the different views. The drawings are not necessarily to scale; emphasis has instead been placed upon illustrating the principles of the invention. Of the drawings:

[0010] Figures 1a and 1b illustrate a circular saw blade configured with elliptical gullets, in accordance with an embodiment of the present invention.

[0011] Figures 1c, 1d, and 1e illustrate details associated with the elliptical gullets shown in Figure 1a, in accordance with one such embodiment.

[0012] Figures 2a and 2b illustrate a circular saw blade configured with elliptical gullets, in accordance with another embodiment of the present invention.

[0013] Figures 2c and 2d illustrate details associated with the elliptical gullets shown in Figure 2a, in accordance with one such embodiment.

[0014] Figures 3a through 3e each illustrate conventional gullets having circular shaped portions that are prone to cracking.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] An improved gullet for circular saw blades is disclosed. The gullet design employs one or more elliptical shapes to maximize the radius at one or more “weak” regions of conventional gullet designs employing circular shapes, such as each side and bottom of the circular portion at the radially innermost point of typical gullet designs. Any type of circular saw blade can employ the elliptical gullets, including blades having cutting teeth, blades having abrasive segments, and blades having a core made up of one or more layers.

### General Overview

[0016] Conventional saw blades typically include a steel core (e.g., single and double layer cores, as well as sandwich-type cores that include a middle or ‘sandwiched’ layer of a different material such as epoxy, glue, cork, resin, copper, or soft iron). As previously discussed, such existing blades have gullets in the form of cutouts extending inwardly from the periphery of the blade. These gullets are often interspaced between the cutters, to aid cutting and relieve stresses during cutting operation, as well as during the manufacturing process. On conventional blades, the gullets typically include circular shapes in areas that are prone to cracking.

[0017] In contrast, embodiments of the present invention employ gullets having elliptical qualities. In particular, each elliptical gullet includes at least one elliptical shape having its long axis along weak areas associated with circular gullets. These weak areas include, for example, the sides and bottom of the radially inward circular portion of keyhole gullets having a neck portion that opens into a circle portion (such as shown in Figures 3a, 3d, and 3e). Note that the neck portion may be on an angle (as best illustrated in Figure 3d) or have an arrow-shape (as best illustrated in Figure 3e). Other example weak gullet areas include the radially most inward semi-circle portion of narrow and wide gullets (such as shown in Figures 3b and 3c). Maximizing the radius at one or more of these weak locations renders the gullet more resistant to fatigue and cracking. The short axes of the elliptical shapes are provided along gullet areas where cracks are less likely to start spontaneously.

[0018] As will be apparent in light of this disclosure, the elliptical gullets are not required to embody a precise or ‘true’ ellipse, having perfect symmetry about its long and short axes. Rather, the elliptical gullets described herein are designed so as to

enlarge the radii in the known weak gullet areas (e.g., traditionally the bottom and two sides as previously discussed), relative to the non-weak gullet areas. Thus, the term “elliptical” as used herein to describe a gullet’s shape is intended to cover all shape variations that meet this goal, including those shapes having precise elliptical qualities as well as those shapes having an elongated curvature that effectively enlarges the radii in one or more known weak gullet areas (despite any lack of true/precise elliptical qualities of that elongated curvature).

[0019] In addition, the cutout design of the elliptical gullet may vary as well, so long as a long axis of the gullet design is maintained at the known weak areas. For instance, one embodiment provides a generally open-style drop gullet that has a cutout including a pair of first elliptical shapes, each having its long axis in the radial direction of the blade so as to elongate the gullet sides, and/or a second elliptical shape having its long axis in the axial direction of the blade so as to elongate the gullet bottom (as will be discussed with reference to Figures 1a-e). An alternative embodiment provides a generally slit-style gullet having a slit that essentially traces the outline of the open-style drop gullet previously described (as will be discussed with reference to Figures 2a-d). As is known, the term “axial” generally refers to a direction that is substantially parallel to the saw blade’s center of rotation. The term “radial” generally refers to a direction transverse to the axial direction.

[0020] As previously noted, the elliptical gullet is not limited to any particular type of saw blade. Rather, the elliptical gullets may be implemented with blades having teeth (such as for cutting wood or plastic) or abrasive segments (such as for cutting masonry or other very hard materials). Likewise, the elliptical gullets may be implemented with blades having single layer cores, double layer cores, and sandwich-type cores (e.g., for reducing noise in various cutting applications).

#### Saw Blade and Gullet Examples

[0021] Figures 1a through 1e illustrate a circular saw blade configured with elliptical gullets, in accordance with an embodiment of the present invention. As can be seen, the circular saw blade 10 has peripheral cutting elements 12 separated by a series of elliptical gullets 16.

[0022] In the embodiment shown, and as best illustrated in Figure 1a, blade 10 includes a core 21, having an arbor hole 14 through which the blade 10 may be mounted and fastened to the spindle of a circular saw or other suitable machine as conventionally done (e.g., with a threaded fastener). In some embodiments, the blade 10 may further include a bushing such as described in U.S. Patent Application Publication No. 2006/0185492, and/or an assembly for accommodating multiple bore sizes such as described in U.S. Patent Application Publication No. 2006/0266176. Each of these patent applications is herein incorporated by reference in its entirety.

[0023] Saw blades configured in accordance with embodiments of the present invention can be used in any number of applications. For instance, saw blade 10 can be installed on a gasoline powered handheld saw (e.g., STIHL TS760, manufactured by Andreas Stihl AG), and used to dry cut a steel plate. Likewise, saw blade 10 can be installed onto a floor saw (e.g., Clipper CSB1 P13, manufactured by Saint-Gobain SA), and used to wet cut concrete. Likewise, saw blade 10 can be installed onto an automatic, 14 HP (10.3kW) cut-off sawing machine (e.g., HUARD 30V53, manufactured by HUARD), and used to cut a steel or plastic tube. Numerous suitable machines and applications will be apparent in light of this disclosure.

[0024] As shown, the core 21 is substantially circular in shape. In one example embodiment, the core includes two discrete outer layers that are mechanically fastened directly to one another (e.g., via welds, rivets, and/or nut-and-bolt arrangement). Alternatively, the core 21 may be a sandwich-type core, where two discrete outer layers sandwich an inner layer of noise-damping material such as cork, glue, epoxy or other suitable damping material (e.g., resin, copper, or soft iron). Alternatively, the core 21 may be integrally formed through a suitable metrology or molding process (e.g., metal casting, injection molding, hot-pressing, cold-pressing, etc), so long as the elliptical gullets 16 can be provided (e.g., in situ via pressure molding, machined, or otherwise formed). The outer layers of core 21, whether they are discrete or integral in nature, may be fabricated from substantially any material having sufficient strength for the cutting application or applications at hand. Examples of suitable core materials include steel, aluminum, titanium, bronze, their composites and alloys, and combinations thereof (e.g., ANSI 4130 steel and aluminum alloys, 2024, 6065 and 7178).

Alternatively, for some applications, reinforced plastics or non-metallic composites may be used to construct the core 21.

[0025] The core 21 may have other features, in addition to cutting elements 12 and elliptical gullets 16. For example, and as best illustrated in Figure 1a, the core 21 includes one or more perforations 33 extending through the central core, along a circumference disposed concentrically with, and between, the arbor hole 14 and the periphery of blade 10. The perforations are arranged to form annular windows through the core 21 that corresponds to a predetermined cutting depth during rotational operation of the blade 10. In example embodiment, the radially innermost set of perforations 33 form a first annular window corresponding to a first cutting depth, and the radially outermost set of perforations 33 form a second annular window corresponding to a second cutting depth. Additional details of circular saw blades having one or more cutting depth gauges are provided, for example, in U.S. Patent No. 7,210,474, which is herein incorporated by reference in its entirety. Other functional features, such as for balancing the blade, indicating source of the blade, reducing operating noise of the blade, and indicating proper mounting of the blade, can also be employed.

[0026] As best shown in Figures 1c, 1d, and 1e, each gullet 16 of this example embodiment includes a neck portion 18 defined by parallel side walls extending radially inward from the periphery of the saw blade 10. At the radially inward end of the neck portion 18, the side walls diverge (at about 45°, as best shown in Figure 1d) from each other to form an arcuate base 20. As shown, the bottom of base 20 is shaped like the elongated side of elliptical shape 27. Likewise, the left side of base 20 is shaped like the elongated side of elliptical shape 25, and the right side of base 20 is shaped like the elongated side of elliptical shape 26. As will be appreciated in light of this disclosure, elongating the radii of the gullet at these particular locations (bottom and sides of gullet) improves crack-resistance of blade 10. Example dimensions are shown for each of the elliptical shapes embodied (shown in dashed lines) in the design of gullet 16, including the radius for both long and short axes of each. Note, however, and as previously explained, that the gullets 16 can also be configured with elongated shapes that do not possess perfect elliptical shapes. For instance, the shapes may have more than one radius length with respect to the long axes (and/or short axes) such as a

pear-shape or wave-shape, or any concave elongated shape. In short, the elliptical gullets 16 can have any design that effectively enlarges the radii in the known weak gullet areas, relative to radii in the non-weak gullet areas.

[0027] In some embodiments, the cutting elements 12 may take the form of abrasive-laden segments spaced along the periphery or the core 21. The segments may include, for example, superabrasive grains suspended in a metal bond that is brazed or otherwise secured to the periphery or the core 21. For instance, a superabrasive tool may be manufactured by mixing superabrasive particles such as diamond and cubic boron nitride (cBN) with a suitable metal bond such as iron, copper, and tin. The mixture is then compressed in a mold to form the desired shape (e.g., segment having the desired width, length, and curvature). The 'green' form is then sintered at a suitable temperature to form a bonded segment with a plurality of superabrasive particles disposed therein. The segment is attached (e.g., by brazing, arc welding, or laser bonding) to the perimeter of core 21.

[0028] Additional details of circular saw blades configured in accordance with embodiments of the present invention and having suitable abrasive segment designs for cutting elements 12 are provided, for example, in U.S. Patent No. 5,518,443 (abrasive segments with alternating volume percentages of abrasive grain), U.S. Patent No. 6,033,295 (portion of the abrasive segment is hardened), and U.S. Patent No. 5,868,125 (crenelated abrasive segments), each of which is herein incorporated by reference in its entirety. In addition, the abrasive segments can be lengthened, in proportion to the blade diameter, to reduce the number of segments, improve fracture/bend resistance, and reduce manufacturing costs. In one such embodiment, the ratio of abrasive segment length to blade diameter is a minimum of 0.2. As previously mentioned, abrasive segments can be used for relatively difficult cutting operations (e.g., for cutting concrete, asphalt, stone, and other hard materials).

[0029] Alternatively, saw blade 10 may be provided with cutting elements 12 in the form of teeth, such as typical of a wide range of circular saw blades intended for cutting relatively soft materials such as wood, plastic, and the like. As is known, the teeth may be of any size and shape. In addition, the teeth may be provided with conventional hardened tips, such as fabricated from tungsten carbide, and/or may be provided with the abrasive grain bonded thereto. In one such example embodiment,

saw blade 10 is provided with a plurality of teeth having a single layer of abrasive grains chemically bonded to at least a portion of each tooth, as described in U.S. Patent Nos. 6,817,936 and 6,935,940, each of which is herein incorporated by reference in its entirety.

[0030] Alternatively, saw blade 10 may be provided with cutting elements 12 in the form of a single layer of abrasive grain that is brazed, electroplated, or otherwise attached to the periphery of the core 21 (as opposed to attaching bonded segments or providing teeth at the perimeter). Numerous cutting element 12 configurations and materials can be used in embodiments of the present invention, as will be apparent in light of this disclosure. The present invention is not intended to be limited to any particular cutting element configuration or scheme.

[0031] Example dimensions (in millimeters, mm) are also shown in Figures 1a through 1e. These dimensions are merely provided as one specific example embodiment that can be fabricated. However, it will be readily apparent in light of this disclosure that numerous dimensions, as well as elliptical gullet configurations can be used to implement a saw blade in accordance with an embodiment of the present invention. The present invention is not intended to be limited to any particular set or range of blade dimensions or configurations. Rather, embodiments of the present invention are intended to cover any saw blade that can be implemented for its intended purpose and configured with elliptical gullets as described herein.

[0032] Figures 2a through 2e illustrate a circular saw blade configured with elliptical gullets, in accordance with another embodiment of the present invention. As can be seen, the circular saw blade 10 has a core 21 with peripheral cutting elements 12 separated by a series of elliptical gullets 216. The previous discussion with reference to Figures 1a through 1e, including discussion relevant to cutting elements 12 and core 21, is equally applicable here, as is the general discussion relevant to elliptical gullets 16 (including example dimensions) and saw blade 10. The main difference of the embodiment shown in Figures 2a through 2d is the design of elliptical gullets 216. Other differences, such as the lack of a cutting depth gauge formed of perforations 33 and dimensional qualities, will be apparent.

[0033] As best shown in Figures 2c and 2d, each gullet 216 of this example embodiment includes a slit 218 that extends radially inward from the periphery of the

saw blade 10, and essentially beginning at the center of what would be the neck portion 18 of the gullet 16 design. The slit 218 diverges to the right (at about 45°, as best shown in Figure 2c) and essentially traces the outline of what would be the arcuate base 20 of the gullet 16 design. At the end of the trace, slit 218 turns inward and terminates at a circular endpoint 220. The width (kerf) of the slit can be, for example, in the range of 50 microns to 5 millimeters (the embodiment shown is about 1 millimeter). As shown, the bottom of the trace formed by slit 218 is shaped like the elongated side of elliptical shape 227. Likewise, the left side of the trace formed by slit 218 is shaped like the elongated side of elliptical shape 225, and the right side of the trace formed by slit 218 is shaped like the elongated side of elliptical shape 226. Just as with gullet 16, this gullet 216 employs elongated radii at known weak locations (bottom and sides of gullet) to improve crack-resistance of blade 10. Example dimensions are shown for each of the elliptical shapes embodied (shown in dashed lines) in the design of gullet 216, including the radius for both long and short axes of each. Note, however, and as previously explained, that the gullets 216 can also be configured with elongated shapes that do not possess perfect elliptical shapes. For instance, the shapes may have more than one radius length with respect to the long axes (and/or short axes) such as a pear-shape or wave-shape, or any concave elongated shape. In short, the elliptical gullets 216 can have any design that effectively enlarges the radii in the known weak gullet areas, relative to radii in the non-weak gullet areas.

[0034] The foregoing description of the embodiments of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of this disclosure. It is intended that the scope of the invention be limited not by this detailed description, but rather by the claims appended hereto.

## CLAIMS

What is claimed is:

1. A circular saw blade, comprising:
  - a circular core having a first planar side and a second planar side, a central arbor hole, and an outer perimeter;
  - a plurality of cutting elements at the outer perimeter of the core; and
  - one or more gullets extending radially inward from the perimeter of the core, each gullet having a shape that includes at least one elongated curve that enlarges radii in gullet areas prone to cracking, relative to other gullet areas.
2. The circular saw blade of claim 1 wherein the shape of the gullet includes two curved sides, each connected to a radially inward curved bottom, and the bottom is shaped like the elongated side of a first elliptical shape, and each of the two sides is shaped like the elongated side of a second elliptical shape.
3. The circular saw blade of claim 2 wherein the gullet includes an opening that defines the two sides and the bottom.
4. The circular saw blade of claim 2 wherein the gullet includes a slit that defines the two sides and the bottom.
5. The circular saw blade of claim 2 wherein the first and the second elliptical shapes are symmetrical about their respective long and short axes.
6. The circular saw blade of claim 2 wherein at least one of the first and the second elliptical shapes is asymmetrical about at least one of its long and short axes.
7. The circular saw blade of claim 2 wherein the first elliptical shape has short and long axes that are both shorter than respective short and long axes of the second elliptical shape.

8. The circular saw blade of claim 1 wherein the core includes two or more layers operatively coupled via at least one of a bond material and a mechanical fastener.
9. The circular saw blade of claim 8 wherein the core is a sandwich-type core that includes a middle layer of sound-damping material bonded between the first and second planar sides.
10. The circular saw blade of claim 1 wherein the core is made of non-metallic material or steel.
11. The circular saw blade of claim 1 wherein the cutting elements include at least one of bonded abrasive segments, a single layer of abrasives, and teeth.
12. The circular saw blade of claim 1 wherein there is at least one gullet between neighboring cutting elements.
13. The circular saw blade of claim 1 wherein each gullet includes three or more elliptical shapes corresponding to three different gullet areas.
14. A circular saw blade, comprising:
  - a circular core having a first planar side and a second planar side, a central arbor hole;
  - a plurality of cutting elements at the outer perimeter of the core; and
  - one or more gullets extending radially inward from the perimeter of the core, each gullet having a shape that includes at least one elongated curve that enlarges radii in gullet areas prone to cracking, relative to other gullet areas, wherein the shape of each gullet includes two curved sides, each connected to a radially inward curved bottom, and the bottom is shaped like the elongated side of a first elliptical shape, and each of the two sides is shaped like the elongated side of a second elliptical shape;wherein the first elliptical shape has short and long axes that are both shorter than respective short and long axes of the second elliptical shape.

15. The circular saw blade of claim 14 wherein the gullet includes an opening that defines the two sides and the bottom, or a slit that defines the two sides and the bottom.

16. The circular saw blade of claim 14 wherein the first and the second elliptical shapes are symmetrical about their respective long and short axes.

17. The circular saw blade of claim 14 wherein at least one of the first and the second elliptical shapes is asymmetrical about at least one of its long and short axes.

18. A circular saw blade, comprising:

a circular core having a first planar side and a second planar side, a central arbor hole;

a plurality of cutting elements at the outer perimeter of the core; and

one or more gullets extending radially inward from the perimeter of the core,

each gullet having a shape that includes three or more elliptical shapes corresponding to three different gullet areas, thereby enlarging radii of those gullet areas, relative to other gullet areas.

19. The circular saw blade of claim 18 wherein the shape of the gullet includes two curved sides, each connected to a radially inward curved bottom, and the bottom is shaped like the elongated side of a first elliptical shape, and each of the two sides is shaped like the elongated side of a second elliptical shape.

20. The circular saw blade of claim 19 wherein the gullet includes an opening that defines the two sides and the bottom, or a slit that defines the two sides and the bottom.

21. The circular saw blade of claim 18 wherein the elliptical shapes are symmetrical about their respective long and short axes.

22. The circular saw blade of claim 18 wherein at least one of the elliptical shapes is asymmetrical about at least one of its long and short axes.



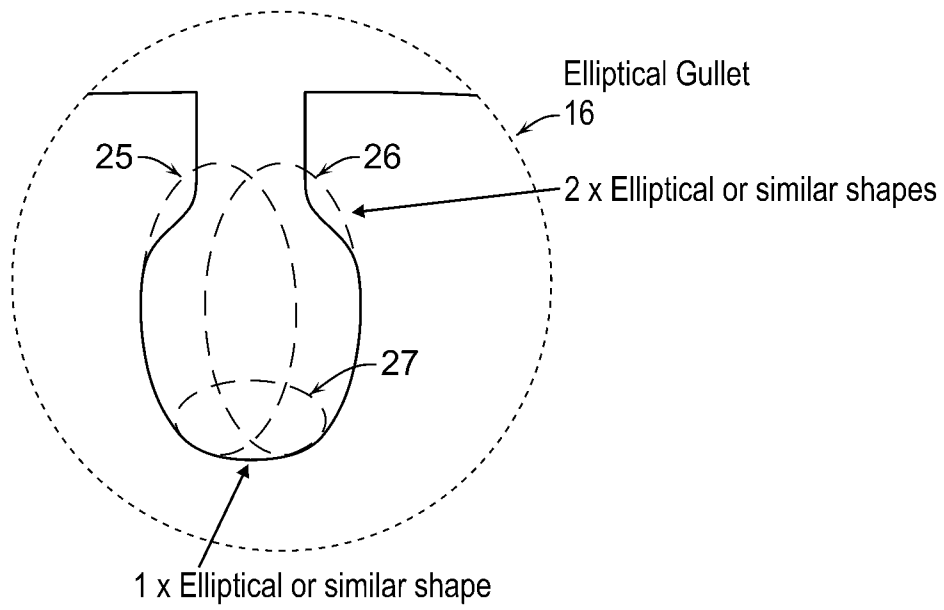


FIG. 1e

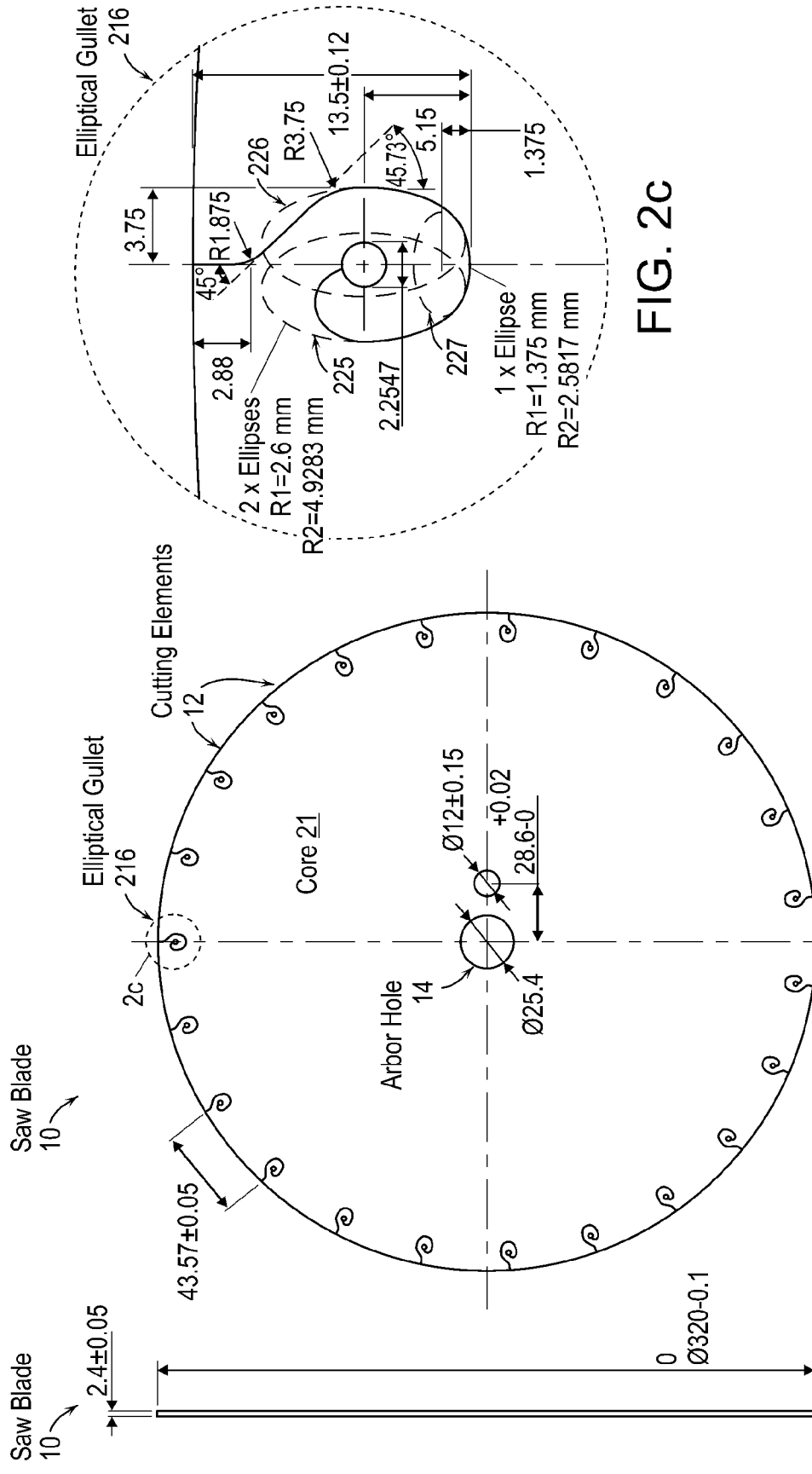


FIG. 2a

FIG. 2c

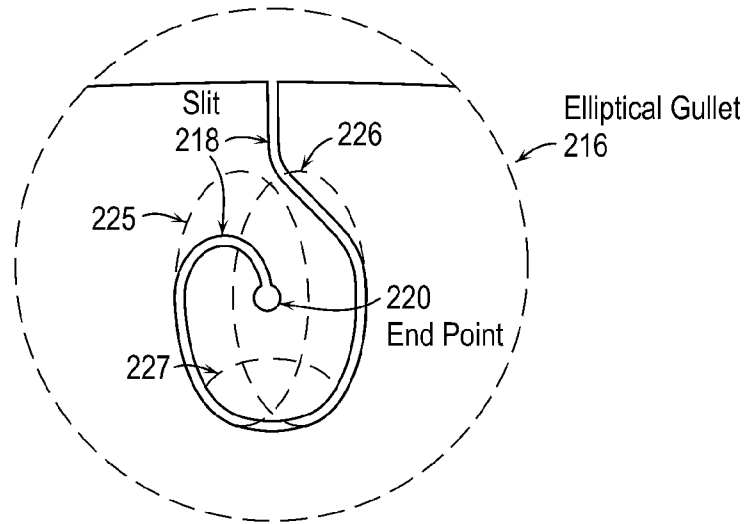
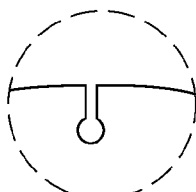
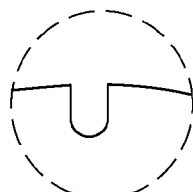


FIG. 2d



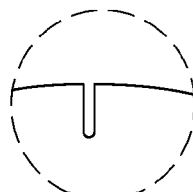
Key Hole

FIG. 3a



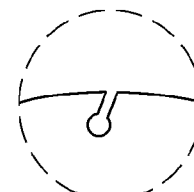
Wide Gullet

FIG. 3b



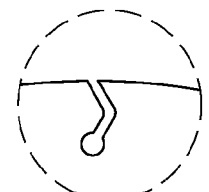
Narrow Gullet

FIG. 3c



Key Hole  
with Angle

FIG. 3d



Arrow Slot

FIG. 3e

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/US2009/031548****A. CLASSIFICATION OF SUBJECT MATTER*****B23D 61/02(2006.01)i, B27B 33/08(2006.01)i, B23D 61/00(2006.01)i, B27B 33/00(2006.01)i***

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)

IPC: B23D

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

Korean utility models and applications for utility models since 1975  
Japanese utility models and applications for utility models since 1975

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

eKIPASS (KIPO internal) &amp; keywords: saw, gullet, and elliptical

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4867025 A (GUNNAR WINER et al.) 19 September 1989 See abstract and Fig. 1.	1, 8-12
A		2-7, 13-22
A	US 4705017 A (LEWIS ROGER L. et al.) 10 November 1987 See abstract and Fig. 3.	1-22
A	US 6681674 B2 (HAKANSSON, WILLIAM et al.) 27 January 2004 See abstract and Fig. 1B.	1-22

 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 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

22 APRIL 2009 (22.04.2009)

Date of mailing of the international search report

**30 APRIL 2009 (30.04.2009)**

Name and mailing address of the ISA/KR

Korean Intellectual Property Office  
Government Complex-Daejeon, 139 Seonsa-ro, Seo-  
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**INTERNATIONAL SEARCH REPORT**

International application No.

**PCT/US2009/031548****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.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
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:

Independent claims 1, 14, and 18 are directed to a circular saw blade. The only common technical feature among claims 1, 14 and 18 is the circular saw blade having a circular core, cutting elements and gullets. This feature lacks novelty and an inventive step with respect to the document US 4867025. Thus, there is no technical relationship left over the prior art among the claimed inventions, leaving the claims without a single general inventive concept.

Hence, there is a lack of unity "a posteriori" (PCT Rules 13.1 and 13.2).

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 fee, this Authority did not invite payment of any additional fee.
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/US2009/031548**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
U S4867025 A	19.09.1989	CH647191A5 DE2953654C1 FR2433385A1 GB2039828A IT1104926B JP55500536T SE439128B SE8002276A W08000320A1	15.01.1985 05.07.1990 14.03.1980 20.08.1980 28.10.1985 21.08.1980 03.06.1985 25.03.1980 06.03.1980
US 4705017 A	10.11.1987	None	
US 6681674 B2	27.01.2004	US 2002-0124708 A1	12.09.2002