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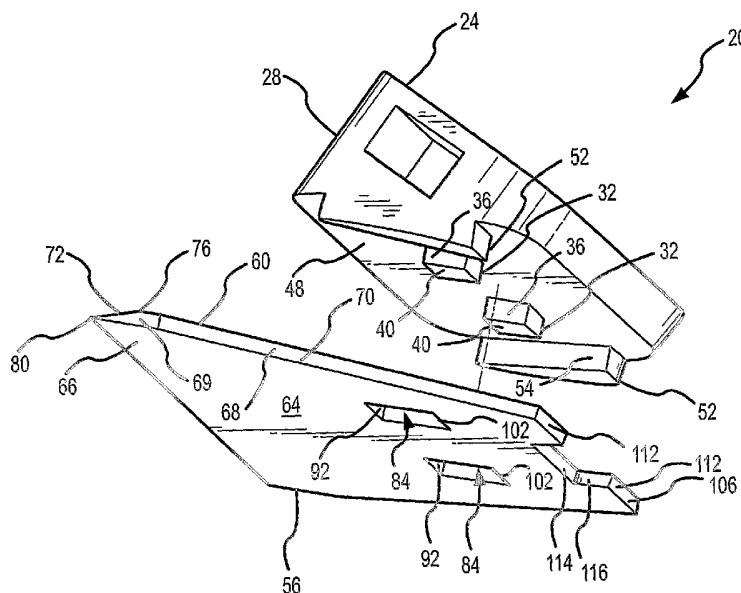
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[Continued on next page]

(54) Title: MICROFABRICATED BLADES



(57) Abstract: A cutting tool (20) for a microkeratome (4) is disclosed. This cutting tool (20) includes a blade handle (24) and a separate cutting blade (56). Surface micromachining may be used to fabricate the blade (56) from a wafer (130). The wafer (130) may be anisotropically etched to define a planar first cutting edge surface (72) that extends from the top surface (60) of the blade (56) to its bottom surface (64) to define a cutting edge (80).



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MICROFABRICATED BLADES

FIELD OF THE INVENTION

The present invention generally relates to the field of cutting blades that may be
5 fabricated by surface micromachining.

BACKGROUND OF THE INVENTION

Many types of blades exist for many types of applications. Blades are used for
cutting biological materials of various types and for various applications. One application
10 that is becoming quite prevalent is the cutting of human eye tissue in relation to a LASIK
eye procedure. Here the blade is used in an automated instrument that is commonly
referred to as a microkeratome or the like. The blade is used to cut a thin protective layer
of corneal tissue from the patient's eye. Typically the cut is made such that this tissue
remains attached to the patient's eye, and thus it is commonly referred to as a "flap."
15 Positioning the flap away from the underlying area (e.g., by a pivotal-like motion about
the remaining interconnection with the patient's eye) exposes the desired portion of the
patient's cornea. A laser is then used to remove tissue from the patient's cornea or to
otherwise "shape" the cornea to address associated refractive errors. Thereafter the flap is
placed back in its original position. Within a few minutes the flap reattaches to the
20 patient's eye, without the use of sutures.

Conventional microkeratome blades are stainless steel. There are a number of
issues with these types of blades. One is that the blade edge is typically examined under a
microscope before being used in a LASIK procedure in an attempt to identify deficiencies
in the cutting edge. Various discontinuities (e.g., burrs) may exist along the blade edge
25 based upon the way in which the blade edge is formed (e.g., mechanical grinding,
polishing) and the material from which the blade is formed, as well as because of the
vulnerability of the cutting edge after being formed. Certain deficiencies associated with
the blade edge may adversely affect the performance of the blade in cutting the eye flap
for a LASIK procedure. Another is that the blade edge of conventional stainless steel
30 microkeratome blades will typically degrade after cutting a single eye flap. Nonetheless,
a common practice is to use the same microkeratome blade to cut a flap on both of the
patient's eyes in a single office visit where the LASIK procedure is performed on each
eye.

Most microkeratome blades are mounted on a blade handle, that is in turn mounted on a cutting head assembly of the microkeratome. How the microkeratome blade is aligned to the blade handle can have a significant impact on the blade's cutting performance when installed on the microkeratome. Certain conventional stainless steel microkeratome blades have a mark on a surface thereof where the blade handle must be optically aligned therewith. Other conventional stainless steel microkeratome blades have holes that extend through the body of the blade. The corresponding blade handle has pins that are disposed within these holes. How these alignment marks or holes are formed on the cutting blade may have an impact on the accuracy with which the cutting edge of the blade is disposed relative to a reference surface of the blade handle. This in turn will affect the accuracy of the positioning of the blade's cutting edge when installed in the microkeratome.

Other types of microkeratome blades have been proposed. One is diamond in which a crystal is typically cleaved to define a cutting edge. Another is silicon. Both isotropic and anisotropic etches have been suggested as options for fabricating a cutting edge for a microkeratome blade or the like from a silicon wafer. Notwithstanding the recognition of these various types of options in the art, stainless steel microkeratome blades still dominate the market. In fact, the inventors associated with the subject patent application do not have knowledge of any silicon microkeratome blade that is commercially available.

Factors other than the material from which the cutting blade is formed and the manner of fabricating the same may have an impact on the results that are achieved when cutting an eye flap. Microkeratome cutting head assemblies commonly move within one or more dimensions or directions while cutting an eye flap. One known microkeratome moves the cutting blade in two distinct dimensions or directions – one where the cutting blade oscillates in a direction that is parallel with its cutting edge, and another where the cutting blade moves along an axial or arcuate path in a direction that is at least generally "across" the patient's eye to create the eye flap. Generally, as the amount of surface area of the cutting blade that remains in contact with the eye flap being formed increases during continued movement of the cutting blade relative to the patient's eye and the eye flap, so to does the potential for damage to the eye flap or other eye tissue. Oscillation of the cutting blade in the above-noted manner can also expose the eye flap to shear forces. Shear forces may deform the eye flap, may adversely impact the physical attributes of the eye flap, may adversely impact the cut surface of the eye or eye flap, or any combination

thereof. Therefore, it would be desirable to incorporate a cutting blade in a microkeratome cutting head assembly in a manner that limits the surface area of the cutting blade that the eye flap can contact while the cutting blade continues to move relative to the patient's eye and the eye flap.

5

BRIEF SUMMARY OF THE INVENTION

There are 10 groups of inventions. Each of these groups are separately addressed herein.

GROUP 1

10 A first aspect of the present invention is generally directed to a cutting tool that includes a blade mounted to a blade handle. The blade includes a first cutting edge surface, a second cutting edge surface, a cutting edge that is defined by the intersection of the first and second cutting edge surfaces, and a first registration surface. This first registration surface is spaced from the cutting edge and is parallel with the first cutting
15 edge surface. The blade handle includes a first registrant. Both the first registration surface of the blade and the first registrant of the blade handle contribute to accurately disposing the cutting edge in a desired alignment.

Various refinements exist of the features noted in relation to the first aspect of the present invention. Further features may also be incorporated in the first aspect of the
20 present invention as well. These refinements and additional features may exist individually or in any combination. The cutting tool of the first aspect may be used for any appropriate application, including biological applications. In one embodiment, this cutting tool is used by a microkeratome for cutting flaps of human eye tissue for LASIK procedures. The cutting edge of the blade may be accurately aligned to a reference
25 surface of the blade handle using the first registration surface of the blade and the first registrant of the blade handle. This in turn allows the cutting edge to be accurately positioned on a microkeratome.

Semiconductor processing techniques may be used to fabricate the cutting blade of the first aspect from a wafer. This wafer may have top and bottom major surfaces that
30 are defined by a set of 3 Miller indices, where at least one Miller index of the set of 3 Miller indices has an absolute value greater than 3 (and thereby including both the positive and negative intercepts). This increases the likelihood of being able to fabricate the cutting edge at a particular blade angle (the angle between the first and second cutting edge surfaces). A variety of blade angles may be utilized in relation to the first aspect. It

should be appreciated that at least certain blade angles may be realized in accordance with the first aspect without the requirement that at least one individual Miller index in the set of 3 Miller indices that define the top and bottom surface of the blade have an absolute value greater than 3.

5 In one embodiment of the first aspect, a wafer is subjected to an anisotropic etch to simultaneously define the first cutting edge surface and the first registration surface. As such, the first cutting edge surface and the first registration surface should "respond" the same to the etch process (e.g., to an under etch; to an over etch). Both the first cutting edge surface and the first registration surface may correspond with a particular
10 crystal plane that defines a desired blade angle relative to the second cutting edge surface, and that in effect acts as an etch stop for the anisotropic etch. In one embodiment, both the first cutting edge surface and the first registration surface of the blade are parallel with the same crystal plane within the {111} family of crystal planes (including both the positive and negative intercepts).

15 The cutting edge associated with the blade of the first aspect may be defined in a variety of manners. In one embodiment, the blade includes top and bottom surfaces that are planar and disposed parallel to each other. The first cutting edge surface may be disposed at an angle relative to and intersect with the top surface, while the second cutting edge surface may be defined by the bottom surface of the blade. This may be
20 characterized as a single-beveled configuration for the cutting blade and is the preferred configuration in the case of the first aspect. Another option is to use a double-beveled configuration for the blade. Here the blade again may include top and bottom surfaces that are planar and disposed parallel to each other. In the double-beveled case, however, the second cutting edge surface is disposed an angle relative to and intersects with the
25 bottom surface.

 Multiple registration surfaces may be formed on the blade of the cutting tool of the first aspect. In one embodiment, at least two registration surfaces are disposed within a common reference plane (e.g., coplanar). This common reference plane may be parallel with the cutting edge. Each registration surface utilized by the blade may be defined by a
30 registration cavity that is formed in an upper surface of the blade. Any such registration cavity may extend through the entire thickness of the blade. In this case, the first cutting edge surface would extend between the cutting edge and a first edge at the top or upper surface of the blade, while the first registration surface would extend between a second edge at the top or upper surface of the blade and a third edge at the bottom or lower

surface of the blade. The first edge associated with the first cutting edge surface and the second edge associated with the first registration cavity may be disposed within a first reference plane that is parallel with a second reference plane that contains the cutting edge associated with the first cutting edge surface and the third edge associated with the first registration cavity.

A first registration cavity that defines the first registration surface of the blade of the first aspect may be characterized as being concave or accessible through a top or upper surface of the blade. This first registration cavity would be spaced from the cutting edge and include first and second ends, with the first end being disposed or located between the cutting edge and the second end. The second end of the first registration cavity may include the first registration surface, and will more typically be defined entirely by the first registration surface. This first registration cavity may extend partially within the cutting blade (i.e., extend from a top surface of the blade toward, but not to, a bottom surface of the blade), or may extend all the way through the body of the blade as noted above. The first end of the first registration cavity may be disposed in any appropriate orientation relative to a planar top surface of the blade, while the first registration surface may be disposed at an angle other than perpendicular relative to this planar top surface.

The first registrant of the blade handle in the case of the first aspect may extend at least within the above-noted first registration cavity. Multiple options exist for registering the first registrant of the blade handle with the blade. When registering with the blade, the first registrant of the blade handle may be spaced from the first end of the first registration cavity (e.g., by a distance of at least about 1 millimeter in one embodiment). Registration may be provided along and limited to a line contact between the first registrant of the blade handle and the blade. Consider the case where the first registration surface extends from a first edge at the intersection of the first registration surface at a top surface of the blade, to a second edge. In one embodiment, the first registrant interfaces with the first registration surface closer to the second edge than to the first edge. The second edge may be located at the intersection of the first registration surface with a bottom or lower surface of the blade. In another embodiment, the first registrant interfaces with the first registration surface at its second edge. In yet another embodiment, the first registrant interfaces with the first registration surface at an intermediate location between its first and second edges.

A second aspect of the present invention is generally directed to a cutting tool that includes a blade mounted to a blade handle. The blade includes a first cutting edge surface, a second cutting edge surface, a cutting edge that is defined by the intersection of the first and second cutting edge surfaces, and a first registration cavity. This first registration cavity is spaced from the cutting edge and includes first and second ends. The first end is disposed or located between the cutting edge and the second end. The blade handle includes a first registrant that at least extends within the first registration cavity. Both the first registration cavity of the blade and the first registrant of the blade handle contribute to accurately disposing the cutting edge in a desired alignment.

Various refinements exist of the features noted in relation to the second aspect of the present invention. Further features may also be incorporated in the second aspect of the present invention as well. These refinements and additional features may exist individually or in any combination. The cutting tool of the second aspect may be used for any appropriate application, including biological applications. In one embodiment, this cutting tool is used by a microkeratome for cutting flaps of human eye tissue for LASIK procedures. The cutting edge of the blade may be accurately aligned to a reference surface of the blade handle using the first registration cavity of the blade and the first registrant of the blade handle. This in turn allows the cutting edge to be accurately positioned on a microkeratome.

The first registration cavity of the second aspect may be characterized as being concave in that it is accessible through a top or upper surface of the blade. This first registration cavity may extend partially within the cutting blade (i.e., extend from a top surface of the blade toward, but not to, a bottom surface of the blade), or may extend all the way through the body of the blade. The first end of the first registration cavity may be disposed in any appropriate orientation relative to a planar top surface of the blade, while the second end may be disposed at an angle other than perpendicular relative to this planar top surface. In one embodiment, no portion of the first registrant contacts the first end of the first registration cavity when the blade and blade handle are registered utilizing the first registration cavity and the first registrant.

Multiple concave registration cavities may be formed on the blade of the cutting tool of the second aspect. In one embodiment, the blade includes a concave second registration cavity that is spaced from the cutting edge and that includes third and fourth ends. The third end is disposed or located between the cutting edge and the fourth end. The blade handle includes a second registrant that at least extends within the second

registration cavity. Both the second registration cavity of the blade and the second registrant of the blade handle further contribute to accurately disposing the cutting edge in a desired alignment.

5 The above-noted second registrant of the blade handle associated with the second aspect may be positioned such that the first and second registrants are disposed along a line that is parallel with the cutting edge of the blade. Another way to characterize the position of the second registrant relative to the first registrant is that they are equidistantly disposed from the cutting edge of the blade. In any case, the second end of the first registration cavity and the fourth end of the second registration cavity may be planar
10 surfaces that are parallel with the first cutting edge surface. The first and second registration surfaces may be coplanar or located within a common reference plane. These first and second registration surfaces may be utilized by the first and second registrants to properly register the blade (more specifically its cutting edge) relative to the blade handle (more specifically a registration surface or structure associated therewith).

15 In one embodiment of the second aspect, the second end of the first registration cavity includes a first registration surface that is parallel with the first cutting edge surface. The first registrant of the blade handle in the case of the second aspect may extend at least within the above-noted first registration cavity. Multiple options exist for registering the first registrant of the blade handle with the blade. When registering with
20 the blade, the first registrant of the blade handle may be spaced from the first end of the first registration cavity (e.g., by a distance of at least about 1 millimeter in one embodiment). Registration may be provided along and limited to a line contact between the first registrant of the blade handle and the blade. Consider the case where the first registration surface extends from a first edge at the intersection of the first registration
25 surface at a top surface of the blade, to a second edge. In one embodiment, the first registrant interfaces with the first registration surface closer to the second edge than to the first edge. The second edge may be located at the intersection of the first registration surface with a bottom or lower surface of the blade. In another embodiment, the first registrant interfaces with the first registration surface at its second edge. In yet another
30 embodiment, the first registrant interfaces with the first registration surface at an intermediate location between its first and second edges.

Semiconductor processing techniques may be used to fabricate the cutting blade of the second aspect from a wafer. This wafer may have top and bottom major surfaces that are defined by a set of Miller indices, where at least one Miller index of the set of 3

Miller indices has an absolute value greater than 3 (including both the positive and negative intercepts). This increases the likelihood of being able to fabricate the cutting edge at a particular blade angle (the angle between the first and second cutting edge surfaces). A variety of blade angles may be utilized in relation to the second aspect. It
5 should be appreciated that at least certain blade angles may be realized in accordance with the second aspect without the requirement that at least one individual Miller index in the set of 3 Miller indices that define the top and bottom surface of the blade have an absolute value greater than 3.

In one embodiment of the second aspect, a wafer is subjected to an anisotropic
10 etch to simultaneously define the first cutting edge surface and the first registration cavity. Both the first cutting edge surface and the second end of the first registration cavity may correspond with a particular crystal plane that defines a desired blade angle relative to the second cutting edge surface, and that in effect acts as an etch stop for the anisotropic etch. In one embodiment, both the first cutting edge surface and the second
15 end of the first registration cavity of the blade are parallel with the same crystal plane within the {111} family of crystal planes (including both the positive and negative intercepts).

The cutting edge associated with the blade of the second aspect may be defined in a variety of manners. In one embodiment, the blade includes top and bottom surfaces that
20 are planar and disposed parallel to each other. The first cutting edge surface may be disposed at an angle relative to and intersect with the top surface, while the second cutting edge surface may be defined by the bottom surface of the blade. This may be characterized as a single-beveled configuration for the cutting blade and is the preferred configuration. Another option is to use a double-beveled configuration for the blade.
25 Here the blade again may include top and bottom surfaces that are planar and disposed parallel to each other. In the double-beveled case, however, the second cutting edge surface is disposed an angle relative to and intersects with the bottom surface.

A third aspect of the present invention is generally directed to a cutting tool that includes a blade. The blade includes a first cutting edge surface, a second cutting edge
30 surface, a cutting edge that is defined by the intersection of the first and second cutting edge surfaces, and a first registration surface. This first registration surface is spaced from the cutting edge and is parallel with the first cutting edge surface.

Various refinements exist of the features noted in relation to the third aspect of the present invention. Further features may also be incorporated in the third aspect of the

present invention as well. These refinements and additional features may exist individually or in any combination. The cutting tool of the third aspect may be used for any appropriate application, including biological applications. In one embodiment, this cutting tool is used by a microkeratome for cutting flaps of human eye tissue for LASIK
5 procedures. The cutting edge of the blade may be accurately aligned relative to the microkeratome utilizing at least the first registration surface.

Semiconductor processing techniques may be used to fabricate the cutting blade of the third aspect from a wafer. This wafer may have top and bottom major surfaces that are defined by a set of 3 Miller indices, where at least one Miller index of the set of 3
10 Miller indices has an absolute value greater than 3 (including both the positive and negative intercepts). This increases the likelihood of being able to fabricate the cutting edge at a particular blade angle (the angle between the first and second cutting edge surfaces). A variety of blade angles may be utilized in relation to the third aspect. It should be appreciated that at least certain blade angles may be realized in accordance with
15 the third aspect without the requirement that at least one individual Miller index in the set of 3 Miller indices that define the top and bottom surface of the wafer have an absolute value greater than 3.

In one embodiment of the third aspect, a wafer is subjected to an anisotropic etch to simultaneously define the first cutting edge surface and the first registration surface.
20 Both the first cutting edge surface and the first registration surface may correspond with a particular crystal plane that defines a desired blade angle relative to the second cutting edge surface, and that in effect acts as an etch stop for the anisotropic etch. In one embodiment, both the first cutting edge surface and the first registration surface of the blade are parallel with the same crystal plane within the {111} family of crystal planes
25 (including both the positive and negative intercepts).

The cutting edge associated with the blade of the third aspect may be defined in a variety of manners. In one embodiment, the blade includes top and bottom surfaces that are planar and disposed parallel to each other. The first cutting edge surface may be disposed at an angle relative to and intersect with the top surface, while the second cutting
30 edge surface may be defined by the bottom surface of the blade. This may be characterized as a single-beveled configuration for the cutting blade and is the preferred configuration. Another option is to use a double-beveled configuration for the blade. Here the blade again may include top and bottom surfaces that are planar and disposed

parallel to each other. In the double-beveled case, however, the second cutting edge surface is disposed an angle relative to and intersects with the bottom surface.

Multiple registration surfaces may be formed on the blade of the cutting tool of the third aspect. In one embodiment, at least two registration surfaces are disposed within a common reference plane. This common reference plane may be parallel with the cutting edge. Each registration surface utilized by the blade may be defined by a registration cavity that is formed in an upper surface of the blade. Any such registration cavity may extend through the entire thickness of the blade. In this case, the first cutting edge surface would extend between the cutting edge and a first edge at the top or upper surface of the blade, while the first registration surface would extend between a second edge at the top or upper surface of the blade and a third edge at the bottom or lower surface of the blade. The first edge associated with the first cutting edge surface and the second edge associated with the first registration cavity may be disposed within a first reference plane that is parallel with a second reference plane that contains the cutting edge associated with the first cutting edge surface and the third edge associated with the first registration cavity.

A first registration cavity that defines the first registration surface of the blade of the third aspect may be characterized as being concave or accessible through a top or upper surface of the blade. This first registration cavity would be spaced from the cutting edge and include first and second ends, with the first end being disposed or located between the cutting edge and the second end. The second end of the first registration cavity may be defined by the first registration surface. This first registration cavity may extend partially within the cutting blade (i.e., extend from a top surface of the blade toward, but not to, a bottom surface of the blade), or may extend all the way through the body of the blade as noted above. The first end of the first registration cavity may be disposed in any appropriate orientation relative to a planar top surface of the blade, while the first registration surface may be disposed at an angle other than perpendicular relative to this planar top surface.

GROUP 2

A first aspect of the present invention is generally directed to fabricating a blade from a substrate. A masking layer is formed on a first surface of the substrate, and a blade mask is transferred onto this masking layer. The substrate is etched at least through first and second openings that extend through the blade mask so as to expose the first surface of the substrate to an appropriate etchant. A first cutting edge surface and a first

registration feature are defined by etching the substrate through the first and second openings, respectively, in the blade mask.

Various refinements exist of the features noted relation to the first aspect of the present invention. Further features may also be incorporated in the first aspect of the present invention as well. These refinements and additional features may exist individually or in any combination. Multiple blades of the type described in relation to the first aspect may be simultaneously fabricated from the same substrate. Additional openings and/or modifications of the openings described in relation to the first aspect may be defined in the masking layer to define various other features in relation to each such blade. For instance, multiple cutting edge surfaces could be defined for one or more blades being fabricated from the same substrate, multiple registration features could be defined for one or more blades being fabricated from the same substrate, or both.

The blade mask may be aligned to a first crystallographic plane associated with the substrate before being transferred onto the masking layer in the case of the first aspect. This alignment may be accomplished in any appropriate manner, including by etching a plurality of alignment slots or grooves on the first surface of the substrate. Any appropriate way may be used to transfer the blade mask onto the masking layer, including without limitation photomasking, masking, photolithography, and microlithography, followed by plasma etching, reactive ion etching, or ion beam milling the masking layer in accordance with the blade mask.

The etching of the substrate in accordance with the first aspect may be characterized as an anisotropic etch, a chemical etch, or both. In any case, the first cutting edge surface and the first registration feature may be simultaneously or concurrently formed by the etching of the substrate. Termination of the etching of the substrate at a pair of spaced locations on the substrate may coincide with having reached the same crystallographic plane at each of these locations to define the first cutting edge surface and the first registration feature. Both the first cutting edge surface and the first registration feature may be planar surfaces that are disposed in parallel relation, for instance corresponding with a common crystallographic plane.

The first cutting edge surface may extend from the first surface of the substrate to a second surface of the substrate that is opposite its first surface in the case of the first aspect. The intersection of the first cutting edge surface with the second surface of the substrate may define a first cutting edge. The etching of the substrate that defines the first cutting edge surface may include etching through the entire vertical extent or thickness of

the substrate from only one side of the substrate to define the first cutting edge. Definition of the first registration feature similarly may be through etching the substrate from only one side thereof, including from the same side used to define the first cutting edge surface.

5 A first registration cavity may be etched into the substrate in accordance with the first aspect. This first registration cavity may be defined in part by a first registration surface that serves as the first registration feature, and the first cutting edge surface and the first registration surface may be parallel to each other. In one embodiment, the first cutting edge surface extends between a first edge and a first cutting edge, while the noted
10 first registration surface extends between a second edge and a third edge. Both the first and second edges are located at the first surface of the substrate (i.e., by an intersection of the first cutting edge surface with the first surface of the substrate, and by an intersection of the first registration surface with the first surface of the substrate, respectively). A common reference plane contains the first cutting edge associated with the first cutting
15 edge surface and the third edge associated with the first registration surface, and this common reference plane is parallel with the first surface of the substrate in one embodiment. In one embodiment, both the first cutting edge surface and the first registration surface also intersect with a second surface of the substrate that is disposed opposite the above-noted first surface. Therefore, the first cutting edge associated with
20 the first cutting edge surface and the third edge associated with the first registration surface will be disposed at the intersection of the second surface of the substrate with the first cutting edge surface and the first registration surface, respectively, in this case.

More than one registration feature may be defined by etching the substrate in accordance with the first aspect (e.g., a second reference feature). Each registration
25 feature of the first blade that is defined by an etch may have the characteristics of the first registration feature discussed herein. For instance, the etch associated with a first aspect may simultaneously or concurrently form the first cutting edge surface, the first registration feature, and a second registration feature. The etching of the substrate may proceed to the same crystallographic plane at first, second, and third spaced locations of
30 the substrate to define the first cutting edge surface, the first registration feature, and a second registration feature, respectively. Termination of the etching of the substrate at multiple, spaced locations on the substrate may coincide with having reached the same crystallographic plane at each of these locations to define the first cutting edge surface, the first registration feature, and a second registration feature. Both the first cutting edge

surface, the first registration feature, and a second registration feature may be planar surfaces, with the first cutting edge surface being parallel with the planar surfaces associated with each of the first and second registration features (e.g., corresponding with a common crystallographic plane). In one embodiment, the planar surfaces associated
5 with the first and second registration features may be disposed within a common reference plane, and further may define a portion of a corresponding registration cavity.

Other blade structure may be defined by the etch in the case of the first aspect. For instance, the etch may proceed through the entire thickness or vertical extent of the substrate to define at least a portion of the perimeter of the first blade. Moreover, any
10 registration cavity utilized by the first aspect may be defined by the etch. In one embodiment, the etch proceeds through the entire thickness or vertical extent of the substrate to define each such registration cavity.

A second aspect of the present invention is generally directed to fabricating a blade from a substrate. The substrate may be etched at one location to define a first
15 cutting edge surface for a first blade. The substrate may also be etched at another, separate location to define a first registration cavity for the first blade.

Various refinements exist of the features noted relation to the second aspect of the present invention. Further features may also be incorporated in the second aspect of the present invention as well. These refinements and additional features may exist
20 individually or in any combination. Multiple blades of the type described in relation to the second aspect may be simultaneously fabricated from the same substrate. Additional structure may be defined for one or more of the blades in accordance with the second aspect as well. For instance, multiple cutting edge surfaces could be defined for one or more blades being fabricated from the same substrate, multiple registration cavities could
25 be defined for one or more blades being fabricated from the same substrate, or both.

The etching of the substrate in accordance with the second aspect may be characterized as an anisotropic etch, a chemical etch, or both. In any case, the first cutting edge surface and the first registration cavity may be simultaneously or concurrently formed by the etching of the substrate. Termination of the etching of the
30 substrate at a pair of spaced locations on the substrate may coincide with having reached the same crystallographic plane at each of these locations to define the first cutting edge surface and to define a portion of the first registration cavity. Both the first cutting edge surface and a first registration surface that defines part of the first registration cavity may

be planar surfaces that are disposed in parallel relation, for instance corresponding with a common crystallographic plane.

5 The first cutting edge surface may extend from a first surface of the substrate to a second surface of the substrate that is opposite its first surface in the case of the second aspect. The intersection of the first cutting edge surface with the second surface of the substrate may define a first cutting edge. The etching of the substrate that defines the first cutting edge surface may include etching through the entire vertical extent or thickness of the substrate from only one side of the substrate to define the first cutting edge. Definition of the first registration cavity similarly may be through etching the substrate
10 from only one side thereof, including from the same side used to define the first cutting edge surface.

Part of the first registration cavity may be defined by a first registration surface in the case of the second aspect as noted above, and the first cutting edge surface and the first registration surface may be parallel to each other. In one embodiment, the first
15 cutting edge surface extends between a first edge and a first cutting edge, while the noted first registration surface extends between a second edge and a third edge. Both the first and second edges are located at a first surface of the substrate (i.e., by an intersection of the first cutting edge surface with the first surface of the substrate, and by an intersection of the first registration surface with the first surface of the substrate, respectively). A
20 common reference plane contains the first cutting edge associated with the first cutting edge surface and the third edge associated with the first registration surface, and this common reference plane is parallel with the first surface of the substrate in one embodiment. In one embodiment, both the first cutting edge surface and the first registration surface also intersect with a second surface of the substrate that is disposed
25 opposite the above-noted first surface. Therefore, the first cutting edge associated with the first cutting edge surface and the third edge associated with the first registration surface will be disposed at the intersection of the second surface of the substrate with the first cutting edge surface and the first registration surface, respectively, in this case.

More than one registration cavity may be defined by etching the substrate in
30 accordance with the second aspect (e.g., a second reference cavity). Each registration cavity of the first blade that is defined by an etch may have the characteristics of the first registration cavity discussed herein. For instance, the etch associated with the second aspect may simultaneously or concurrently form the first cutting edge surface, the first registration cavity, and a second registration cavity. The etching of the substrate may

proceed to the same crystallographic plane at first, second, and third spaced locations of the substrate to define the first cutting edge surface, the first registration cavity, and a second registration cavity, respectively. Termination of the etching of the substrate at multiple, spaced locations on the substrate may coincide with having reached the same
5 crystallographic plane at each of these locations to define the first cutting edge surface, the first registration cavity, and a second registration cavity. Both the first cutting edge surface, the first registration cavity, and a second registration cavity may be or defined in part by planar surfaces, with the first cutting edge surface being parallel with planar registration surfaces associated with each of the first and second registration cavity (e.g.,
10 corresponding with a common crystallographic plane). In one embodiment, the planar registration surfaces associated with the first and second registration cavities may be disposed within a common reference plane, and further may define a portion of a corresponding registration cavity.

Other blade structure may be defined by an etch in the case of the second aspect.
15 For instance, an etch may proceed through the entire thickness or vertical extent of the substrate to define at least a portion of the perimeter of the first blade. Moreover, any registration cavity utilized by the second aspect may be defined by an etch. In one embodiment, the corresponding etch proceeds through the entire thickness or vertical extent of the substrate to define each such registration cavity.

20 A masking layer may be formed on a first surface of the substrate in the case of the second aspect, and a blade mask may be transferred onto this masking layer. The substrate is etched at least through first and second openings that extend through the blade mask so as to expose the first surface of the substrate to an appropriate etchant. The first cutting edge surface and the first registration cavity may be defined by etching the
25 substrate through the first and second openings, respectively, in the blade mask. The blade mask may be aligned to a first crystallographic plane associated with the substrate before being transferred onto the masking layer. This alignment may be accomplished in any appropriate manner, including by etching a plurality of alignment slots or grooves on the first surface of the substrate. Any appropriate way may be used to transfer the blade
30 mask onto the masking layer, including without limitation photomasking, masking, photolithography, and microlithography, followed by plasma etching, reactive ion etching, or ion beam milling the masking layer in accordance with the blade mask.

A third aspect of the present invention generally relates to the fabrication of a blade from a substrate. At least one opening down through the entire vertical extent or

thickness of substrate is created. A continuous opening of this type may be in accordance with a pattern that defines at least a portion of a perimeter of a first blade. That is, the entire perimeter of the first blade need not initially be defined in accordance with the third aspect. In any case, a first registration feature is also defined from the substrate. In one
5 embodiment, the first registration feature is formed from the substrate during the time that the opening(s) are being defined. Another embodiment has the first registration feature being defined from the substrate by the same technique that defines the opening(s).

Various refinements exist of the features noted in relation to the third aspect of the present invention. Further features may also be incorporated in the third aspect of the
10 present invention as well. These refinements and additional features may exist individually or in any combination. The various features discussed above in relation to the first and second aspects may be utilized by this third aspect, individually or in any combination.

GROUP 3

15 First and second aspects of the present invention each generally relate to a blade handle mounting fixture. Both the configuration of the blade mounting fixture and the manner of mounting a blade handle onto a blade using such a fixture are encompassed by these aspects of the present invention. That is, the structure of such a fixture that accommodates/facilitates the various features, to now be described in relation to the first
20 and/or second aspects, is also encompassed by the present invention.

A wafer is positioned on a first fixture in a first aspect of the present invention. This wafer includes at least one blade (hereafter a "first blade"). A first cutting edge of the first blade is maintained in spaced relation to the first fixture for at least a portion of the time that the wafer is positioned on the first fixture. That is, the first cutting edge of
25 the first blade does not contact the first fixture at least for a portion of the time that the wafer is positioned on the first fixture. A first blade handle is mounted on the first blade at a time when the wafer is positioned on the first fixture.

Various refinements exist of the features noted in relation to the first aspect of the present invention. Further features may also be incorporated in the first aspect of the
30 present invention as well. These refinements and additional features may exist individually or in any combination. The wafer may be disposed within a recess that is formed on an upper surface of the first fixture. A perimeter of this recess may at least substantially approximate a perimeter of the wafer. Less than an entirety of a lower surface of the wafer is physically engaged by the first fixture in one embodiment.

Biassing forces may be exerted on the wafer while positioned on the first fixture in accordance with the first aspect. In one embodiment, the wafer is attracted or biased toward the first fixture. One way in which this may be done is by applying a suction force to at least a portion of a surface of the wafer that projects toward or faces the first fixture (e.g., utilizing a vacuum). Preferably, the wafer is forcibly retained against the first fixture while mounting the first blade handle on the first blade.

The wafer utilized in relation to the first aspect may include a first score for at least facilitating the separation of the first blade from the wafer at the appropriate time. The first fixture may support the wafer at a location that is directly under the first score. Another way of characterizing how the first fixture supports the wafer in relation to this first score is that the first fixture may support the wafer such that mounting the first blade handle on the first blade does not result in any net moment or torque about this first score. After the first blade handle has been mounted on the first blade, the wafer may be removed from the first fixture and the first blade may be separated from the wafer at least generally along this first score. Separation of the first blade from the wafer may be enhanced by aligning the first score with a predetermined crystal plane of the wafer.

The first blade associated with the first aspect may be disposed on a free end of what may be characterized as a first blade support tab or first cantilever. One end of this first cantilever is fixed or anchored (e.g., stationary relative to an adjoining portion of the wafer), while its opposite end (the noted free end on which the first blade is disposed) is movable at least generally about the fixed end of the first cantilever at the appropriate time (e.g., when separating the first blade from the wafer in the above-noted manner). At least a portion of this first cantilever may be supported by the first fixture while the first blade handle is being mounted on the first blade. This then reduces the potential for a movement of the first blade toward the fixture while mounting the first blade handle on the first blade. There is preferably no deflection of the free end of the first cantilever toward the first fixture while mounting the first blade handle on the first blade in the case of the first aspect.

A first cutting edge cavity may be formed on an upper surface of the first fixture and sized/configured so as to be aligned (e.g., vertically) with the first cutting edge of the first blade when the wafer is positioned on the first fixture in the first aspect. Disposing the first cutting edge over the first cutting edge cavity thereby provides the required spacing between the first cutting edge and the first fixture. The spacing between the first cutting edge and the first fixture may be maintained throughout the entire time that the

wafer is positioned on the first fixture. Therefore, the first cutting edge may be maintained in spaced relation with the first fixture as the first blade handle is being mounted on the first blade.

Preferably the first blade handle is maintained in fixed relation to the first blade after being mounted thereon in accordance with the first aspect. Any appropriate way of anchoring the first blade handle to the first blade may be utilized. However, in one embodiment an adhesive is applied to at least one of the first blade handle and the first blade prior to mounting the first blade handle on the first blade. Light curable adhesives are preferred such that the position of the first blade handle may be adjusted after establishing an initial contact between the first blade handle and the first blade via the intermediary adhesive. Once the first blade handle is in the desired/required position relative to the first blade, a light source may be activated to cure or set the adhesive to thereafter maintain the first blade handle in fixed relation to the first blade. Stated another way, the preferred adhesive is one having a set or cure time that will allow the first blade handle to be moved into the desired/required position after being initially seated on the first blade.

The surface of the first fixture may be configured such that no portion of the first blade handle contacts the first fixture while mounting the first blade handle on the first blade in the case of the first aspect, and more preferably throughout the entire time that the wafer is positioned on the first fixture. In one embodiment, a first registrant extends from a lower surface of the first blade handle and a first registration cavity is accessible through an upper surface of the first blade. Mounting the first blade handle on the first blade may then entail directing the first registrant of the first blade handle at least within this first registration cavity of the first blade. An open space may separate the lower extreme of the first registrant and the first fixture after the first blade handle is mounted on the first blade. This may be provided by aligning the first registrant with a first registrant cavity that is formed on a surface of the first fixture that projects toward or faces the wafer such that this end of the first registrant is disposed in spaced relation with the first fixture at all times, and thereby including after the first blade handle is mounted on the first blade.

One embodiment of the first aspect is directed toward having first and second registrants extend from a lower surface of the first blade handle in combination with first and second registration cavities that are accessible through an upper surface of the first blade. Mounting the first blade handle on the first blade may then entail disposing the

first registrant of the first blade handle at least within this first registration cavity of the first blade, and disposing the second registrant of the first blade handle at least within this second registration cavity of the first blade. An open space may separate the lower extreme of both the first and second registrants and the first fixture after the first blade handle is mounted on the first blade. First and second registrant cavities may be formed on an upper surface of the first fixture in alignment with the first and second registrants, respectively, to provide the desired spacing. In one embodiment, the first fixture supports the wafer at least at a location that is between the first and second registration cavities of the first blade.

Mounting the first blade handle on the first blade in accordance with the first aspect may entail disposing the first blade handle on an upper surface of the first blade (e.g., so that the first blade then entirely supports the first blade handle), thereafter moving the first blade handle relative to the first blade, and terminating this movement when a first registration feature (e.g., a first registrant) of the first blade handle contacts a first registration feature (e.g., a first registration surface) of the first blade (e.g., a mechanical registration), or so as to register the first blade handle to the first blade. In one embodiment, the first blade handle is moved in a first direction to in effect seat a lower surface of the first blade handle on an upper surface of the first blade, and the first blade handle is thereafter moved in a second direction that is perpendicular to this first direction to achieve the desired registration. Movement of the first blade handle relative to the first blade until the desired registration has occurred may also be characterized as moving the first blade handle at least generally away from the first cutting edge of the first blade or toward a rear end of the first blade. Another characterization of the movement of the first blade handle relative to the first blade to achieve the desired registration is that the first blade handle moves relative to the first blade along a path that is parallel with the upper surface of the first blade on which the first blade handle is in effect seated. In any case, the first blade holder is preferably fixed or anchored to the first blade after the desired registration is achieved.

Multiple first blades may be formed on the wafer prior to being positioned on the first fixture in the case of the first aspect. A first blade handle may be mounted on each first blade in the above-described manner. First blade handles may be sequentially mounted on the various first blades, multiple first blade handles may be simultaneously mounted on multiple first blades, or first blade handles may be simultaneously mounted on all first blades formed on the wafer. Regardless of how many first blades are formed

on the wafer and the sequence of installing any first blade handle(s) thereon, the wafer may be removed from the first fixture with a first blade handle being mounted on at least one first blade and with the first blade(s) remaining part of the first wafer. That is, after a first blade handle has been mounted on at least one first blade, the wafer may be removed
5 from the first fixture and without having separated any such first blade (with a first blade handle mounted thereon) from the wafer. Thereafter, the various individual first blades with a first blade handle mounted thereon may be separated from the remainder of the wafer.

A wafer is positioned on a first fixture in a second aspect of the present invention.
10 This wafer includes at least one blade (hereafter a "first blade"). A first blade handle is mounted on the first blade at a time when the wafer is positioned on the first fixture. Some time after the first blade handle has been mounted on the first blade, the wafer is removed from the first fixture.

Various refinements exist of the features noted in relation to the second aspect of
15 the present invention. Further features may also be incorporated in the second aspect of the present invention as well. These refinements and additional features may exist individually or in any combination. The wafer may be disposed within a recess that is formed on an upper surface of the first fixture. A perimeter of this recess may at least substantially approximate a perimeter of the wafer. Less than an entirety of a lower
20 surface of the wafer is physically engaged by the first fixture in one embodiment.

Biasing forces may be exerted on the wafer while positioned on the first fixture in accordance with the second aspect. In one embodiment, the wafer is attracted or biased toward the first fixture. One way in which this may be done is by applying a suction force to at least a portion of a surface of the wafer that projects toward or faces the first
25 fixture (e.g., utilizing a vacuum). Preferably, the wafer is forcibly retained against the first fixture while mounting the first blade handle on the first blade.

The wafer utilized in relation to the second aspect may include a first score for at least facilitating the separation of the first blade from the wafer at the appropriate time. The first fixture may support the wafer at a location that is directly under the first score.
30 Another way of characterizing how the first fixture supports the wafer in relation to this first score is that the first fixture may support the wafer such that mounting the first blade handle on the first blade does not result in any net moment or torque about this first score. After the first blade handle has been mounted on the first blade, the wafer may be removed from the first fixture and the first blade may be separated from the wafer at least

generally along this first score. Separation of the first blade from the wafer may be enhanced by aligning the first score with a predetermined crystal plane of the wafer.

5 The first blade associated with the second aspect may be disposed on a free end of what may be characterized as a first blade support tab or first cantilever. One end of this first cantilever is fixed or anchored (e.g., stationary relative to an adjoining portion of the wafer), while its opposite end (the noted free end on which the first blade is disposed) is movable at least generally about the fixed end of the first cantilever at the appropriate time (e.g., when separating the first blade from the wafer in the above-noted manner). At least a portion of this first cantilever may be supported by the first fixture while the first blade handle is being mounted on the first blade. This then reduces the potential for a movement of the first blade toward the fixture while mounting the first blade handle on the first blade. There is preferably no deflection of the free end of the first cantilever toward the first fixture while mounting the first blade handle on the first blade in the case of the second aspect.

15 A first cutting edge of the first blade is preferably maintained in spaced relation to the first fixture for at least a portion of the time that the wafer is positioned on the first fixture in the case of the second aspect. That is, the first cutting edge of the first blade does not contact the first fixture at least for a portion of the time that the wafer is positioned on the first fixture. In this regard, a first cutting edge cavity may be formed on an upper surface of the first fixture and sized/configured so as to be aligned (e.g., vertically) with the first cutting edge of the first blade when the wafer is positioned on the first fixture. Disposing the first cutting edge over the first cutting edge cavity thereby provides the desired spacing between the first cutting edge and the first fixture. The spacing between the first cutting edge and the first fixture may be maintained throughout the entire time that the wafer is positioned on the first fixture. Therefore, the first cutting edge may be maintained in spaced relation with the first fixture as the first blade handle is being mounted on the first blade.

20 Preferably the first blade handle is maintained in fixed relation to the first blade after being mounted thereon in accordance with the second aspect. Any appropriate way of anchoring the first blade handle to the first blade may be utilized. However, in one embodiment an adhesive is applied to at least one of the first blade handle and the first blade prior to mounting the first blade handle on the first blade. Light curable adhesives are preferred such that the position of the first blade handle may be adjusted after establishing an initial contact between the first blade handle and the first blade via the

intermediary adhesive. Once the first blade handle is in the desired/required position relative to the first blade, a light source may be activated to cure or set the adhesive to thereafter maintain the first blade handle in fixed relation to the first blade. Stated another way, the preferred adhesive is one having a set or cure time that will allow the first blade handle to be moved into the desired/required position after being initially seated on the first blade.

The surface of the first fixture may be configured such that no portion of the first blade handle contacts the first fixture while mounting the first blade handle on the first blade in the case of the second aspect, and more preferably throughout the entire time that the wafer is positioned on the first fixture. In one embodiment, a first registrant extends from a lower surface of the first blade handle and a first registration cavity is accessible through an upper surface of the first blade. Mounting the first blade handle on the first blade may then entail directing the first registrant of the first blade handle at least within this first registration cavity of the first blade. An open space may separate the lower extreme of the first registrant and the first fixture after the first blade handle is mounted on the first blade. This may be provided by aligning the first registrant with a first registrant cavity that is formed on a surface of the first fixture that projects toward or faces the wafer such that this end of the first registrant is disposed in spaced relation with the first fixture at all times, and thereby including after the first blade handle is mounted on the first blade.

One embodiment of the second aspect is directed toward having first and second registrants extend from a lower surface of the first blade handle in combination with first and second registration cavities that are accessible through an upper surface of the first blade. Mounting the first blade handle on the first blade may then entail disposing the first registrant of the first blade handle at least within this first registration cavity of the first blade, and disposing the second registrant of the first blade handle at least within this second registration cavity of the first blade. An open space may separate the lower extreme of both the first and second registrants and the first fixture after the first blade handle is mounted on the first blade. First and second registrant cavities may be formed on an upper surface of the first fixture in alignment with the first and second registrants, respectively, to provide the desired spacing. In one embodiment, the first fixture supports the wafer at least at a location that is between the first and second registration cavities of the first blade.

Mounting the first blade handle on the first blade in accordance with the second aspect may entail disposing the first blade handle on an upper surface of the first blade (e.g., so that the first blade then entirely supports the first blade handle), thereafter moving the first blade handle relative to the first blade, and terminating this movement
5 when a first registration feature (e.g., a first registrant) of the first blade handle contacts a first registration feature (e.g., a first registration surface) of the first blade (e.g., a mechanical registration), or so as to register the first blade handle to the first blade. In one embodiment, the first blade handle is moved in a first direction to in effect seat a lower surface of the first blade handle on an upper surface of the first blade, and the first
10 blade handle is thereafter moved in a second direction that is perpendicular to this first direction to achieve the desired registration. Movement of the first blade handle relative to the first blade until the desired registration has occurred may also be characterized as moving the first blade handle at least generally away from the first cutting edge of the first blade or toward a rear end of the first blade. Another characterization of the
15 movement of the first blade handle relative to the first blade to achieve the desired registration is that the first blade handle moves relative to the first blade along a path that is parallel with an upper surface of the first blade on which the first blade handle is in effect seated. In any case, the first blade holder is preferably fixed or anchored to the first blade after the desired registration is achieved.

20 Multiple first blades may be formed on the wafer prior to being positioned on the first fixture in the case of the second aspect. A first blade handle may be mounted on each first blade in the above-described manner. First blade handles may be sequentially mounted on the various first blades, multiple first blade handles may be simultaneously mounted on multiple first blades, or first blade handles may be simultaneously mounted
25 on all first blades formed on the wafer. Regardless of how many first blades are formed on the wafer and the sequence of installing any first blade handle(s) thereon, the wafer is removed from the first fixture with a first blade handle being mounted on at least one first blade and with the first blade(s) remaining part of the first wafer. That is, after a first blade handle has been mounted on at least one first blade, the wafer is removed from the
30 first fixture and without having separated any such first blade with a first blade handle mounted thereon from the wafer. Thereafter, the various individual first blades with a first blade handle mounted thereon may be separated from the remainder of the wafer.

A third aspect of the present invention is directed to mounting a first blade handle on a first blade. The first blade handle is disposed on an upper surface of the first blade

(e.g., so that the first blade then entirely supports the first blade handle). Thereafter, the first blade handle is moved relative to the first blade. This movement is terminated when the first blade handle is appropriately registered to the first blade. The first blade holder is then fixed or anchored to the first blade after registration is achieved.

5 Various refinements exist of the features noted in relation to the third aspect of the present invention. Further features may also be incorporated in the third aspect of the present invention as well. These refinements and additional features may exist individually or in any combination. Registration may occur when a first registration feature (e.g., a first registrant) of the first blade handle contacts a first registration feature
10 (e.g., a first registration surface) of the first blade (e.g., a mechanical registration). Multiple registrants on the first blade holder and multiple registration cavities with a corresponding registration surface on the first blade may be utilized. The various features discussed above in the first and/or second aspects regarding any such registrant/registration cavity may be utilized by this third aspect as well.

15 In one embodiment of the third aspect, the first blade handle is moved in a first direction to in effect seat a lower surface of the first blade handle on the upper surface of the first blade, and the first blade handle is thereafter moved in a second direction that is perpendicular to this first direction to achieve the desired registration. Movement of the first blade handle relative to the first blade until the desired registration has occurred in
20 the case of the third aspect may also be characterized as moving the first blade handle at least generally away from a first cutting edge of the first blade or toward a rear end of the first blade. Another characterization of the movement of the first blade handle relative to the first blade to achieve the desired registration is that the first blade handle moves relative to the first blade along a path that is parallel with the upper surface of the first
25 blade on which the first blade handle is in effect seated.

The first blade associated with the third aspect may be part of a wafer. This wafer may be positioned on a first fixture. The first blade handle may be mounted on the first blade in accordance with the third aspect while the wafer is positioned on this first fixture. The wafer may be disposed within a recess that is formed on an upper surface of the first
30 fixture. A perimeter of this recess may at least substantially approximate a perimeter of the wafer. In any case, biasing forces may be exerted on the wafer while positioned on the first fixture. In one embodiment, the wafer is attracted or biased toward the first fixture. One way in which this may be done is by applying a suction force to at least a portion of a surface of the wafer that projects toward or faces the first fixture (e.g.,

utilizing a vacuum). Preferably, the wafer is forcibly retained against the first fixture while mounting the first blade handle on the first blade.

Multiple first blades may be formed on the above-noted wafer prior to being positioned on the first fixture in the above-noted variation of the third aspect. A first blade handle may be mounted on each first blade in the above-described manner. First
5 blade handles may be sequentially mounted on the various first blades, multiple first blade handles may be simultaneously mounted on multiple first blades, or first blade handles may be simultaneously mounted on all first blades formed on the wafer. Regardless of how many first blades are formed on the wafer and the sequence of
10 installing any first blade handle(s) thereon, the wafer may be removed from the first fixture with a first blade handle being mounted on at least one first blade and with the first blade(s) remaining part of the first wafer. That is, after a first blade handle has been mounted on at least one first blade, the wafer may be removed from the first fixture and without having separated any such first blade with a first blade handle mounted thereon
15 from the wafer. Thereafter, the various individual first blades with a first blade handle mounted thereon may be separated from the remainder of the wafer.

GROUP 4

The various aspects of the present invention generally relate to what may be characterized as a blade separation fixture. Both the configuration of the blade separation
20 fixture and the manner of separating a blade from a wafer using such a fixture are encompassed by the various aspects of the present invention. That is, the structure of such a fixture that accommodates/facilitates the various features, to now be described in relation to the various specific aspects, is also encompassed by the present invention.

A wafer is positioned on a first fixture in a first aspect of the present invention.
25 This wafer includes at least one blade (hereafter a "first blade"). A first cutting edge of the first blade is maintained in spaced relation to the first fixture for at least a portion of the time that the wafer is positioned on the first fixture. That is, the first cutting edge of the first blade does not contact the first fixture at least for a portion of the time that the wafer is positioned on the first fixture. The first blade is separated from a remainder of
30 the wafer with the wafer being positioned on the first fixture.

Various refinements exist of the features noted in relation to the first aspect of the present invention. Further features may also be incorporated in the first aspect of the present invention as well. These refinements and additional features may exist individually or in any combination. The wafer may be disposed within a recess that is

formed on an upper surface of the first fixture. A perimeter of this recess may at least substantially approximate a perimeter of the wafer. Biasing forces may be exerted on the wafer while positioned on the first fixture as well. In one embodiment, the wafer is attracted or biased toward the first fixture. One way in which this may be done is by
5 applying a suction force to at least a portion of a surface of the wafer that projects toward or faces the first fixture (e.g., utilizing a vacuum). Preferably, the wafer is forcibly retained against the first fixture while the first blade is separated from the remainder of the wafer.

Less than an entirety of a lower surface of the wafer is physically engaged by the
10 first fixture prior to initiating the separation of the first blade in one embodiment of the first aspect. For instance, the entire first blade may be disposed in spaced relation to the first fixture, at least prior to initiating its separation from the remainder of the wafer. Another way to characterize how the first fixture supports the wafer is that it may do so with the first blade being suspended above the first fixture so as to not be in contact
15 therewith. In this regard, the first blade may be disposed on a free end of what may be characterized as a first blade support tab or first cantilever. One end of this first cantilever may extend from what may be characterized as a wafer frame. This "wafer frame" may be viewed as the remainder of the wafer in relation to each first blade and corresponding first cantilever formed from the wafer, and preferably does not itself
20 include any cantilevered structure. In any case, an opposite end of the above-noted first cantilever (the noted free end on which the first blade is disposed) is movable at least generally about the fixed end of the first cantilever (e.g., that which merges with the wafer frame). At least a portion of this first cantilever may be supported by the first fixture, while the first blade remains in spaced relation to the first fixture to await
25 separation.

A first cutting edge cavity may be formed on an upper surface of the first fixture and sized/configured so as to be aligned (e.g., vertically) with the first cutting edge of the first blade when the wafer is positioned on the first fixture in the first aspect. Disposing the first cutting edge over the first cutting edge cavity thereby provides the required
30 spacing between the first cutting edge and the first fixture. The spacing between the first cutting edge and the first fixture may be maintained throughout the entire time that the wafer is positioned on the first fixture. Therefore, the first cutting edge may be maintained in spaced relation with the first fixture prior to, during, and after the first blade is separated from the remainder of the wafer.

Separation of the first blade from a remainder of the wafer in accordance with the first aspect may include fracturing the wafer. This separation may be at least substantially along a line that is at least substantially parallel with the first cutting edge of the first blade. A first score in the wafer may be utilized for this separation. The wafer
5 may be fractured at least generally along this first score to at least facilitate the separation of the first blade from the remainder of the wafer. In one embodiment, the first fixture is configured to support the wafer proximate this first score and yet maintain the first blade in spaced relation to the first fixture.

Deflection of the first blade at least generally toward the first fixture may be
10 utilized to achieve separation of the first blade from the remainder of the wafer in the case of the first aspect. Any such deflection need not be of the entire first blade, but may be limited to only a portion of the first blade. Moreover, not all portions of the first blade need to deflect the same amount in the general direction of the first fixture.

A first blade handle may be mounted on the first blade prior to positioning the
15 wafer on the first fixture in the case of the first aspect. This first blade handle would then be on the first blade when it is separated from the remainder of the wafer. In one embodiment, a force is exerted directly on the first blade handle and at least generally in a direction of the first fixture to separate the first blade from the remainder of the wafer. In another embodiment, a force is exerted directly on the first blade and at least generally in
20 a direction of the first fixture to separate the first blade from the remainder of the wafer.

As noted above, the entire first blade may be disposed in spaced relation to the first fixture when the wafer is positioned on the first fixture in the first aspect. The first blade may be separated from the remainder of the wafer while still being spaced from the first fixture. That is, prior to any portion of the first blade establishing contact with the
25 underlying first fixture in a manner discussed in more detail below, the first blade may separate from the remainder of the wafer as a result of the exertion of a force on the first blade (directly or indirectly through the above-noted first blade handle) that is again at least generally directed toward the first fixture.

Contact may be established between the first blade and the first fixture after the
30 first blade has separated from the remainder of the wafer in the case of the first aspect. However, the first cutting edge of the first blade preferably remains in spaced relation to the first fixture. In one embodiment, the first blade is directed onto what may be characterized as a horizontal beam that traverses the first blade (e.g., disposed parallel with but spaced from its first cutting edge) and that is recessed relative to a surface of the

first fixture that supports the wafer on the first fixture. At this time the first cutting edge of the first blade may be disposed over what may be characterized as a cutting edge cavity formed on the upper surface of the first fixture, while a rear edge may be disposed over what may be characterized as a pivot cavity formed on the upper surface of the first
5 fixture. A rearward portion of the first blade may then be directed into the pivot cavity by a pivoting-like or teeter-totter-like action of the first blade about the recessed horizontal beam. This of course increases the spacing between the first cutting edge of the first blade and the first fixture, while decreasing the spacing between a rear end of the first blade and the first fixture. Therefore, the first cutting edge of the first blade may actually
10 first move toward the first fixture as the first blade is being separated from the remainder of the wafer (preferably without contacting the first fixture as the first cutting edge is again preferably disposed over a first cutting edge cavity formed on the upper surface of the first fixture), and then back away from the first fixture after the first blade starts to pivot about the noted horizontal beam. Once again, preferably the first cutting edge of
15 the first blade never contacts the first fixture the entire time that the wafer is positioned on the first fixture.

The first blade may seat against an inclined surface formed on the upper surface of the first fixture after the first blade has separated from the remainder of the wafer in the case of the first aspect. This inclined surface may define a portion of a boundary of the
20 above-noted pivot cavity. In any case, a rear end of the first blade will be disposed at a lower elevation than its first cutting edge when the first blade is seated against this inclined surface. Biasing forces may be exerted on the first blade to retain the same against this inclined surface. In one embodiment, the first blade is attracted or biased toward the first fixture after being separated from the remainder of the wafer. One way in
25 which this may be done is by applying a suction force to at least a portion of a lower surface of the first blade that interfaces with the inclined surface (e.g., utilizing a vacuum).

Multiple first blades may be formed on the wafer prior to being positioned on the first fixture in the case of the first aspect. A first blade handle may be mounted on each
30 first blade as well before the wafer is positioned on the first fixture. First blades may be sequentially separated from the remainder of the wafer in the above-noted manner, multiple first blades may be simultaneously separated from the remainder of the wafer in the above-noted manner, or all first blades formed on the wafer may be simultaneously separated from the remainder of the wafer in the above-noted manner. Regardless of how

many first blades are formed on the wafer and the sequence of separating first blades from the remainder of the wafer, the wafer may be removed from the first fixture after at least one first blade has been separated from the remainder of the wafer. All first blades are preferably separated from the wafer prior to removing the wafer from the first fixture.

- 5 However, any first blade that has been separated from the remainder of the wafer may be removed from the first fixture prior to or after the wafer is removed from the first fixture.

A wafer is positioned on a first fixture in a second aspect of the present invention. This wafer includes at least one blade (hereafter a "first blade"). This first blade is suspended above the first fixture, at least while it remains part of the wafer. The first
10 blade is separated from a remainder of the wafer with the wafer being positioned on the first fixture.

Various refinements exist of the features noted in relation to the second aspect of the present invention. Further features may also be incorporated in the second aspect of the present invention as well. These refinements and additional features may exist
15 individually or in any combination. The wafer may be disposed within a recess that is formed on an upper surface of the first fixture. A perimeter of this recess may at least substantially approximate a perimeter of the wafer. Biasing forces may be exerted on the wafer while positioned on the first fixture as well. In one embodiment, the wafer is attracted or biased toward the first fixture. One way in which this may be done is by
20 applying a suction force to at least a portion of a surface of the wafer that projects toward or faces the first fixture (e.g., utilizing a vacuum). Preferably, the wafer is forcibly retained against the first fixture while the first blade is separated from the remainder of the wafer.

Less than an entirety of a lower surface of the wafer is physically engaged by the
25 first fixture prior to initiating the separation of the first blade in one embodiment of the second aspect. That is, the first blade is part of the wafer, and the first blade again is suspended above the first fixture in the case of the second aspect. One way in which this may be accomplished is by disposing the first blade on a free end of what may be characterized as a first blade support tab or first cantilever. One end of this first
30 cantilever may extend from what may be characterized as a wafer frame. This "wafer frame" may be viewed as the remainder of the wafer in relation to each first blade and corresponding first cantilever formed from the wafer, and preferably does not itself include any cantilevered structure. In any case, an opposite end of the above-noted first cantilever (the noted free end on which the first blade is disposed) is movable at least

generally about the fixed end of the first cantilever (e.g., that which merges with the wafer frame). At least a portion of this first cantilever may be supported by the first fixture, while the first blade remains in spaced relation to the first fixture to await separation.

5 A first cutting edge cavity may be formed on an upper surface of the first fixture and sized/configured so as to be aligned (e.g., vertically) with a first cutting edge of the first blade when the wafer is positioned on the first fixture in the second aspect. Disposing the first cutting edge over the first cutting edge cavity provides a desired spacing between the first cutting edge and the first fixture. This spacing between the first
10 cutting edge and the first fixture may be maintained throughout the entire time that the wafer is positioned on the first fixture. Therefore, the first cutting edge may be maintained in spaced relation with the first fixture prior to, during, and after the first blade is separated from the remainder of the wafer.

 Separation of the first blade from a remainder of the wafer in accordance with the
15 second aspect may include fracturing the wafer. This separation may be at least substantially along a line that is at least substantially parallel with the first cutting edge of the first blade. A first score in the wafer may be utilized for this separation. The wafer may be fractured at least generally along this first score to at least facilitate the separation of the first blade from the remainder of the wafer. In one embodiment, the first fixture is
20 configured to support the wafer proximate this first score and yet maintain the first blade in spaced relation to the first fixture.

 Deflection of the first blade at least generally toward the first fixture may be utilized to achieve separation of the first blade from the remainder of the wafer in the case of the second aspect. Any such deflection need not be of the entire first blade, but may be
25 limited to only a portion of the first blade. Moreover, not all portions of the first blade need to deflect the same amount in the general direction of the first fixture.

 A first blade handle may be mounted on the first blade prior to positioning the wafer on the first fixture in the case of the second aspect. This first blade handle would then be on the first blade when it is separated from the remainder of the wafer. In one
30 embodiment, a force is exerted directly on the first blade handle and at least generally in a direction of the first fixture to separate the first blade from the remainder of the wafer. In another embodiment, a force is exerted directly on the first blade and at least generally in a direction of the first fixture to separate the first blade from the remainder of the wafer.

As noted above, the entire first blade is disposed in spaced relation to the first fixture when the wafer is positioned on the first fixture in the second aspect when awaiting separation. The first blade may be separated from the remainder of the wafer while still being spaced from the first fixture. That is, prior to any portion of the first blade establishing contact with the underlying first fixture in a manner discussed in more detail below, the first blade may separate from the remainder of the wafer as a result of the exertion of a force on the first blade (directly or indirectly through the above-noted first blade handle) that is again at least generally directed toward the first fixture.

Contact may be established between the first blade and the first fixture after the first blade has separated from the remainder of the wafer in the case of the second aspect. However, the first cutting edge of the first blade preferably remains in spaced relation to the first fixture. In one embodiment, the first blade is directed onto what may be characterized as a horizontal beam that traverses the first blade (e.g., disposed parallel with but spaced from its first cutting edge) and that is recessed relative to a surface of the first fixture that supports the wafer on the first fixture. At this time the first cutting edge of the first blade may be disposed over what may be characterized as a cutting edge cavity formed on the upper surface of the first fixture, while a rear edge may be disposed over what may be characterized as a pivot cavity formed on the upper surface of the first fixture. A rearward portion of the first blade may then be directed into the pivot cavity by a pivoting-like or teeter-totter-like action of the first blade about the recessed horizontal beam. This of course increases the spacing between the first cutting edge of the first blade and the first fixture, while decreasing the spacing between a rear end of the first blade and the first fixture. Therefore, the first cutting edge of the first blade may actually first move toward the first fixture as the first blade is being separated from the remainder of the wafer (preferably without contacting the first fixture as the first cutting edge is again preferably disposed over a first cutting edge cavity formed on the upper surface of the first fixture), and then back away from the first fixture after the first blade starts to pivot about the noted horizontal beam. Once again, preferably the first cutting edge of the first blade never contacts the first fixture the entire time that the wafer is positioned on the first fixture.

The first blade may seat against an inclined surface formed on the upper surface of the first fixture after the first blade has separated from the remainder of the wafer in the case of the second aspect. This inclined surface may define a portion of a boundary of the above-noted pivot cavity. In any case, a rear end of the first blade will be disposed at a

lower elevation than its first cutting edge when the first blade is seated against this inclined surface. Biasing forces may be exerted on the first blade to retain the same against this inclined surface. In one embodiment, the first blade is attracted or biased toward the first fixture after being separated from the remainder of the wafer. One way in which this may be done is by applying a suction force to at least a portion of a lower surface of the first blade that interfaces with the inclined surface (e.g., utilizing a vacuum).

Multiple first blades may be formed on the wafer prior to being positioned on the first fixture in the case of the second aspect. A first blade handle may be mounted on each first blade as well before the wafer is positioned on the first fixture. First blades may be sequentially separated from the remainder of the wafer in the above-noted manner, multiple first blades may be simultaneously separated from the remainder of the wafer in the above-noted manner, or all first blades formed on the wafer may be simultaneously separated from the remainder of the wafer in the above-noted manner. Regardless of how many first blades are formed on the wafer and the sequence of separating first blades from the remainder of the wafer, the wafer may be removed from the first fixture after at least one first blade has been separated from the remainder of the wafer. All first blades are preferably separated from the wafer prior to removing the wafer from the first fixture. However, any first blade that has been separated from the remainder of the wafer may be removed from the first fixture prior to or after the wafer is removed from the first fixture.

A wafer is positioned on a first fixture in a third aspect of the present invention. This wafer includes at least one blade (hereafter a "first blade"). A force is transmitted to the first blade. This force is at least generally directed toward the first fixture. At least a portion of the first blade deflects in response to this force. This deflection in turn causes the first blade to separate from a remainder of the wafer. The various features discussed above in relation to the first and second aspects may be utilized by this third aspect, alone or in any combination.

A wafer is positioned on a first fixture in a fourth aspect of the present invention. This wafer includes at least one blade (hereafter a "first blade"). A force is transmitted to the first blade. This force is at least generally directed toward the first fixture. The first blade separates from a remainder of the wafer in response to this force. The first blade also undergoes a pivoting or pivot-like action. In one embodiment, this pivoting motion is about an axis that is spaced from but parallel to a first cutting edge of the first blade. In

any case, the noted pivoting motion of the first blade is such so as to direct the first cutting edge of the first blade at least generally away from the first fixture. The various features discussed above in relation to the first and second aspects may be utilized by this fourth aspect, alone or in any combination.

5 A wafer is positioned on a first fixture in a fifth aspect of the present invention. This wafer includes at least one blade (hereafter a "first blade"). A force is transmitted to the first blade. This force is at least generally directed toward the first fixture. The first blade separates from a remainder of the wafer in response to this force and is directed onto a beam (i.e., the first blade is at least initially disposed in spaced relation to the
10 beam). The first blade is then directed from this beam onto an inclined surface of the first fixture that disposes a cutting edge of the first blade at a higher elevation than a rear edge of the first blade. The various features discussed above in relation to the first and second aspects may be utilized by this fifth aspect, alone or in any combination.

 A wafer is positioned on a first fixture in a sixth aspect of the present invention.
15 This wafer includes at least one blade (hereafter a "first blade"). A force is transmitted to the first blade. This force is at least generally directed toward the first fixture. A first cutting edge of the first blade is directed toward, but preferably not to, the first fixture in response to this force. After the first blade separates from a remainder of the wafer, the first cutting edge of the first blade is then directed away from the first fixture. Therefore,
20 the first cutting edge of the first blade first moves toward, and then away from the first fixture in relation to the separation of the first blade from the remainder of the wafer. The various features discussed above in relation to the first and second aspects may be utilized by this sixth aspect, alone or in any combination.

GROUP 5

25 The present invention generally relates to a method of assembling a cutting tool. One fixture (hereafter a "first fixture") is used to mount a blade handle on one or more blades that are formed on the wafer. In this regard, a first blade handle is mounted on a first blade while the wafer is positioned on the first fixture. The wafer is removed from the first fixture after a blade handle has been mounted on at least one of the blades of the
30 wafer. Thereafter, the wafer is positioned on a different fixture (hereafter a "second fixture"). At least one blade with a handle mounted thereon is separated from a remainder of the wafer while the wafer is positioned on the second fixture.

 Various refinements exist of the features noted in relation to the present invention. Further features may also be incorporated in the present invention as well. These

refinements and additional features may exist individually or in any combination. The wafer may be disposed within a recess that is formed on an upper surface of both the first and second fixtures. A perimeter of each of these recesses may at least substantially approximate a perimeter of the wafer. Less than an entirety of a lower surface of the wafer is physically engaged by both the first and second fixtures in one embodiment.

Biassing forces may be exerted on the wafer while positioned on both the first and second fixtures. In one embodiment, the wafer is attracted or biased toward the first and second fixtures when positioned thereon. One way in which this may be done is by applying a suction force to at least a portion of a surface of the wafer that projects toward or faces the relevant first or second fixture (e.g., utilizing a vacuum). Preferably, the wafer is forcibly retained against the first fixture while mounting the first blade handle on the first blade. Similarly, preferably the wafer is forcibly retained against the second fixture while separating the first blade from the remainder of the wafer.

A first cutting edge of the first blade may be maintained in spaced relation to the first fixture for at least a portion of the time that the wafer is positioned on the first fixture. That is, the first cutting edge of the first blade does not contact the first fixture at least for a portion of the time that the wafer is positioned on the first fixture. In one embodiment, a first cutting edge cavity may be formed on an upper surface of the first fixture and sized/configured so as to be aligned (e.g., vertically) with the first cutting edge of the first blade when the wafer is positioned on the first fixture. Disposing the first cutting edge over the first cutting edge cavity thereby provides the desired spacing between the first cutting edge and the first fixture. The spacing between the first cutting edge and the first fixture may be maintained throughout the entire time that the wafer is positioned on the first fixture. Therefore, the first cutting edge may be maintained in spaced relation with the first fixture as the first blade handle is being mounted on the first blade.

The wafer utilized in relation to the first aspect may include a first score for at least facilitating the separation of the first blade from the wafer when positioned on the second fixture and as will be discussed in more detail below. The first fixture may support the wafer at a location that is directly under the first score. Another way of characterizing how the first fixture supports the wafer in relation to this first score is that the first fixture may support the wafer such that mounting the first blade handle on the first blade does not result in any net moment or torque about this first score. After the first blade handle has been mounted on the first blade, the wafer may be removed from

the first fixture and the first blade may be separated from the wafer at least generally along this first score using the second fixture. Separation of the first blade from the wafer may be enhanced by aligning the first score with a predetermined crystal plane of the wafer.

5 The first blade may be disposed on a free end of what may be characterized as a first blade support tab or first cantilever. One end of this first cantilever is fixed or anchored (e.g., stationary relative to an adjoining portion of the wafer), while its opposite end (the noted free end on which the first blade is disposed) is movable at least generally about the fixed end of the first cantilever at the appropriate time (e.g., when separating the
10 first blade from the wafer in the above-noted manner). At least a portion of this first cantilever may be supported by the first fixture while the first blade handle is being mounted on the first blade. This then reduces the potential for a movement of the first blade toward the first fixture while mounting the first blade handle on the first blade. There is preferably no deflection of the free end of the first cantilever toward the first
15 fixture while mounting the first blade handle on the first blade.

 Preferably the first blade handle is maintained in fixed relation to the first blade after being mounted thereon. Any appropriate way of anchoring the first blade handle to the first blade may be utilized. However, in one embodiment an adhesive is applied to at least one of the first blade handle and the first blade prior to mounting the first blade
20 handle on the first blade. Light curable adhesives are preferred such that the position of the first blade handle may be adjusted after establishing an initial contact between the first blade handle and the first blade via the intermediary adhesive. Once the first blade handle is in the desired/required position relative to the first blade, a light source may be activated to cure or set the adhesive to thereafter maintain the first blade handle in fixed
25 relation to the first blade. Stated another way, the preferred adhesive is one having a set or cure time that will allow the first blade handle to be moved into the desired/required position after being initially seated on the first blade.

 The surface of the first fixture may be configured such that no portion of the first blade handle contacts the first fixture while mounting the first blade handle on the first
30 blade, and more preferably throughout the entire time that the wafer is positioned on the first fixture. In one embodiment, a first registrant extends from a lower surface of the first blade handle and a first registration cavity is accessible through an upper surface of the first blade. Mounting the first blade handle on the first blade may then entail directing the first registrant of the first blade handle at least within this first registration cavity of

the first blade. An open space may separate the lower extreme of the first registrant and the first fixture after the first blade handle is mounted on the first blade. This may be provided by aligning the first registrant with a first registrant cavity that is formed on a surface of the first fixture that projects toward or faces the wafer such that this end of the
5 first registrant is disposed in spaced relation with the first fixture at all times, and thereby including after the first blade handle is mounted on the first blade.

One embodiment of the present invention is directed toward having first and second registrants extend from a lower surface of the first blade handle in combination with first and second registration cavities that are accessible through an upper surface of
10 the first blade. Mounting the first blade handle on the first blade may then entail disposing the first registrant of the first blade handle at least within this first registration cavity of the first blade, and disposing the second registrant of the first blade handle at least within this second registration cavity of the first blade. An open space may separate the lower extreme of both the first and second registrants and the first fixture after the
15 first blade handle is mounted on the first blade. First and second registrant cavities may be formed on an upper surface of the first fixture in alignment with the first and second registrants, respectively, to provide the desired spacing. In one embodiment, the first fixture supports the wafer at least at a location that is between the first and second registration cavities of the first blade.

20 Mounting the first blade handle on the first blade may entail disposing the first blade handle on an upper surface of the first blade (e.g., so that the first blade then entirely supports the first blade handle), thereafter moving the first blade handle relative to the first blade, and terminating this movement when a first registration feature (e.g., a first registrant) of the first blade handle contacts a first registration feature (e.g., a first
25 registration surface) of the first blade (e.g., a mechanical registration), or so as to register the first blade handle to the first blade. In one embodiment, the first blade handle is moved in a first direction to in effect seat a lower surface of the first blade handle on an upper surface of the first blade, and the first blade handle is thereafter moved in a second direction that is perpendicular to this first direction to achieve the desired registration.
30 Movement of the first blade handle relative to the first blade until the desired registration has occurred may also be characterized as moving the first blade handle at least generally away from a first cutting edge of the first blade or toward a rear end of the first blade. Another characterization of the movement of the first blade handle relative to the first blade to achieve the desired registration is that the first blade handle moves relative to the

first blade along a path that is parallel with the upper surface of the first blade on which the first blade handle is in effect seated. In any case, the first blade handle is preferably fixed or anchored to the first blade after the desired registration is achieved.

Multiple first blades may be formed on the wafer prior to being positioned on the first fixture. A first blade handle may be mounted on each first blade in the above-described manner. First blade handles may be sequentially mounted on the various first blades, multiple first blade handles may be simultaneously mounted on multiple first blades, or first blade handles may be simultaneously mounted on all first blades formed on the wafer. Regardless of how many first blades are formed on the wafer and the sequence of installing any first blade handle(s) thereon, the wafer may be removed from the first fixture with a first blade handle being mounted on at least one first blade and with the first blade(s) remaining part of the first wafer. That is, after a first blade handle has been mounted on at least one first blade, the wafer may be removed from the first fixture and without having separated any such first blade (with a first blade handle mounted thereon) from the wafer. Thereafter, the various individual first blades with a first blade handle mounted thereon may be separated from the remainder of the wafer using the second fixture that will now be discussed.

One way to characterize how the second fixture may support the wafer is that it may do so with the first blade being suspended above the second fixture so as to not be in contact therewith. In this regard, the first blade may be disposed on a free end of what may be characterized as a first blade support tab or first cantilever. One end of this first cantilever may extend from what may be characterized as a wafer frame. This "wafer frame" may be viewed as the remainder of the wafer in relation to each first blade and corresponding first cantilever formed from the wafer, and preferably does not itself include any cantilevered structure. In any case, an opposite end of the above-noted first cantilever (the noted free end on which the first blade is disposed) is movable at least generally about the fixed end of the first cantilever (e.g., that which merges with the wafer frame). At least a portion of this first cantilever may be supported by the second fixture, while the first blade remains in spaced relation to the second fixture to await separation.

A first cutting edge of the first blade may be disposed in spaced relation to the second fixture for at least a portion of the time that the wafer is positioned on the second fixture. That is, the first cutting edge of the first blade does not contact the second fixture at least for a portion of the time that the wafer is positioned on the second fixture.

Preferably, the first cutting edge never contacts either the first or second fixture. In any case, a first cutting edge cavity may be formed on an upper surface of the second fixture and sized/configured so as to be aligned (e.g., vertically) with the first cutting edge of the first blade when the wafer is positioned on the second fixture. Disposing the first cutting
5 edge over the first cutting edge cavity thereby provides the desired spacing between the first cutting edge and the second fixture. The spacing between the first cutting edge and the second fixture may be maintained throughout the entire time that the wafer is positioned on the second fixture. Therefore, the first cutting edge may be maintained in spaced relation with the second fixture prior to, during, and after the first blade is
10 separated from the remainder of the wafer.

Separation of the first blade from a remainder of the wafer may include fracturing the wafer. This separation may be at least substantially along a line that is at least substantially parallel with the first cutting edge of the first blade. A first score in the wafer may be utilized for this separation. The wafer may be fractured at least generally
15 along this first score to at least facilitate the separation of the first blade from the remainder of the wafer. In one embodiment, the second fixture is configured to support the wafer proximate to this first score and yet maintain the first blade in spaced relation to the first fixture.

Deflection of the first blade at least generally toward the second fixture may be
20 utilized to achieve separation of the first blade from the remainder of the wafer. Any such deflection need not be of the entire first blade, but may be limited to only a portion of the first blade. Moreover, not all portions of the first blade need to deflect the same amount in the general direction of the second fixture.

The first blade handle is already mounted on the first blade at the time that it is
25 separated from the remainder of the wafer. In one embodiment, a force is exerted directly on the first blade handle and at least generally in a direction of the second fixture to separate the first blade from the remainder of the wafer. In another embodiment, a force is exerted directly on the first blade and at least generally in a direction of the second fixture to separate the first blade from the remainder of the wafer.

30 As noted above, the entire first blade may be disposed in spaced relation to the second fixture when the wafer is positioned on the second fixture and while the first blade is still part of the wafer. The first blade may be separated from the remainder of the wafer while still being spaced from the second fixture. That is, prior to any portion of the first blade establishing contact with the underlying second fixture in a manner discussed

in more detail below, the first blade may separate from the remainder of the wafer as a result of the exertion of a force on the first blade (directly or indirectly through the above-noted first blade handle) that is again at least generally directed toward the second fixture.

Contact may be established between the first blade and the second fixture after the first blade has separated from the remainder of the wafer. However, the first cutting edge of the first blade still preferably remains in spaced relation to the second fixture. In one embodiment, the first blade is directed onto what may be characterized as a horizontal beam that traverses the first blade (e.g., disposed parallel with but spaced from its first cutting edge) and that is recessed relative to a surface of the second fixture that supports the wafer on the second fixture. At this time the first cutting edge of the first blade may be disposed over what may be characterized as a cutting edge cavity formed on the upper surface of the second fixture, while a rear edge may be disposed over what may be characterized as a pivot cavity formed on the upper surface of the second fixture. A rearward portion of the first blade may then be directed into the pivot cavity by a pivoting-like or teeter-totter-like action of the first blade about the recessed horizontal beam. This of course increases the spacing between the first cutting edge of the first blade and the second fixture, while decreasing the spacing between a rear end of the first blade and the second fixture. Therefore, the first cutting edge of the first blade may actually first move toward the second fixture as the first blade is being separated from the remainder of the wafer (preferably without contacting the second fixture as the first cutting edge is again preferably disposed over a first cutting edge cavity formed on the upper surface of the second fixture), and then back away from the second fixture after the first blade starts to pivot about the noted horizontal beam. Once again, preferably the first cutting edge of the first blade never contacts the second fixture the entire time that the wafer is positioned on the second fixture.

The first blade may seat against an inclined surface formed on the upper surface of the second fixture after the first blade has separated from the remainder of the wafer. This inclined surface may define a portion of a boundary of the above-noted pivot cavity. In any case, a rear end of the first blade will be disposed at a lower elevation than its first cutting edge when the first blade is seated against this inclined surface. Biasing forces may be exerted on the first blade to retain the same against this inclined surface. In one embodiment, the first blade is attracted or biased toward the second fixture after being separated from the remainder of the wafer. One way in which this may be done is by

applying a suction force to at least a portion of a lower surface of the first blade that interfaces with the inclined surface (e.g., utilizing a vacuum).

Multiple first blades may be formed on the wafer prior to being positioned on the second fixture. A first blade handle may be mounted on each first blade as well before
5 the wafer is positioned on the second fixture. First blades may be sequentially separated from the remainder of the wafer in the above-noted manner, multiple first blades may be simultaneously separated from the remainder of the wafer in the above-noted manner, or all first blades formed on the wafer may be simultaneously separated from the remainder
10 of the wafer in the above-noted manner. Regardless of how many first blades are formed on the wafer and the sequence of separating first blades from the remainder of the wafer, the wafer may be removed from the second fixture after at least one first blade has been separated from the remainder of the wafer. All first blades are preferably separated from the wafer prior to removing the wafer from the second fixture. However, any first blade that has been separated from the remainder of the wafer may be removed from the second
15 fixture prior to or after the wafer is removed from the second fixture.

GROUP 6

A first aspect of the present invention is generally directed to a cutting tool that includes a blade body having first and second oppositely disposed major surfaces (e.g., an upper surface and an oppositely disposed lower surface). At least the first major surface
20 of the blade body is defined by a first set of three Miller indices, and at least one of these three Miller indices has an absolute value that is greater than three. The blade body further includes a first cutting edge surface that is disposed at an angle relative to the first major surface. A first cutting edge is defined at least in part by the first cutting edge surface.

25 Various refinements exist of the features noted in relation to the first aspect of the present invention. Further features may also be incorporated in the first aspect of the present invention as well. These refinements and additional features may exist individually or in any combination. Multiple cutting edge surfaces may be formed in association with the cutting tool of the first aspect, any number of which may have the
30 characteristics of or relating to a first cutting edge surface to be described herein in relation to the cutting tool. The first cutting edge may be defined by the intersection of two or more cutting edge surfaces, one of which is the first cutting edge surface. The cutting tool may also utilize multiple cutting edges.

Semiconductor processing techniques may be used to fabricate the blade body from a wafer in relation to the first aspect. This wafer may have at least one, and more preferably both, its top and bottom major surfaces defined by the same first set of three Miller indices, again where at least one of these three Miller indices has an absolute value that is greater than three (and thereby including both the positive and negative intercepts). Having at least the first major surface of the blade body defined by the noted first set of three Miller indices increases the likelihood of being able to fabricate the first cutting edge at a particular blade angle (defined by the intersection of the first cutting edge surface with at least one other surface). A variety of blade angles may then be utilized in relation to the first aspect.

Any suitable material may be utilized by the first aspect in relation to the blade body, for instance a wafer that is appropriate for use in semiconductor processing. Representative suitable materials for the blade body include ceramic, silicon, and quartz. Single crystal materials in general are desirable for the blade body in the case of the first aspect (e.g., single crystal silicon; single crystal quartz). Utilizing a single crystal material for the substrate, where there is at least one etchant that is selective to at least one crystal plane of the particular single crystal material, allows for a desirable formation of the first cutting edge surface that at least assists in the definition of the first cutting edge for the cutting tool of the first aspect, as well as possibly other features of the cutting tool (e.g., at least one registration feature for the cutting tool). That is, those single crystal materials that may be etched to a particular crystal plane, and have the etch in effect stop after reaching this particular crystal plane, may be particularly suited for use in the fabrication of the cutting tool in accordance with the first aspect.

The above-noted type of wafer, or any other appropriate substrate for that matter, may undergo an anisotropic etch to define the first cutting edge surface used by the cutting tool of the first aspect. The first cutting edge surface may correspond with a particular crystal plane that defines a desired blade angle for the first cutting edge, and that in effect acts as an etch stop for the anisotropic etch. The first cutting edge surface may then be properly characterized as an "etched surface." In one embodiment, the first cutting edge surface of the cutting tool is parallel with a crystal plane within the {111} family of crystal planes (including both the positive and negative intercepts). Any relative angular relationship may be utilized between the first cutting edge surface and the first major surface of the blade body, although typically the first cutting edge surface and

the first major surface of the blade body will typically be disposed in other than perpendicular relation.

The first cutting edge associated with the cutting tool of the first aspect may be defined in a variety of manners. In one embodiment, the first and second major surfaces of the blade body are planar and disposed parallel to each other. The first cutting edge surface may be disposed at an angle relative to and intersect with the first major surface (e.g., a top or upper surface), while a second cutting edge surface that intersects with the first cutting edge surface to define the first cutting edge may be defined by the second major surface of the blade body (e.g., a bottom or lower surface). This may be characterized as a single-beveled configuration for the cutting tool and is the preferred configuration in the case of the first aspect. Another option is to use a double-beveled configuration for the cutting tool. Here again the first and second major surfaces of the blade body may be planar and disposed parallel to each other. In the double-beveled case, however, a second cutting edge surface that intersects with the first cutting edge surface to define the first cutting edge is disposed at an angle relative to and intersects with the second major surface of the blade body, versus being a part thereof as in the case of the above-noted single-beveled configuration.

One or more registration surfaces on the blade body may be utilized by the cutting tool in the case of the first aspect. Each such registration surface may be used to position a blade handle of the cutting tool in a certain predetermined relationship with the first cutting edge of the blade body. Multiple registration surfaces may be disposed within a common reference plane (e.g., coplanar). In one embodiment, this common reference plane is parallel with the cutting edge.

A first registration surface that may be utilized by the first aspect is spaced from the first cutting edge and may be parallel with the first cutting edge surface. Each registration surface may have the characteristics of or relating to this first registration surface. The above-noted blade handle may include a first registrant that interfaces with the first registration surface in a manner so as to at least contribute to accurately disposing the first cutting edge in a desired alignment. Although the cutting tool of the first aspect may be used for any appropriate application, including biological applications, in one embodiment the cutting tool of the first aspect is used by a microkeratome for cutting flaps of human eye tissue for LASIK procedures. The first cutting edge of the blade body may be accurately aligned to a reference surface of the blade handle using the first

registration surface of the blade body and the first registrant of the blade handle. This in turn allows the first cutting edge to be accurately positioned on a microkeratome.

As noted above, a wafer or other appropriate substrate may undergo an anisotropic etch to define the first cutting edge surface used by the cutting tool of the first aspect.

5 This same anisotropic etch may also define the above-noted first registration surface. In any case, the first registration surface may correspond with a particular crystal plane, and that in effect acts as an etch stop for the anisotropic etch. The first registration surface may then be properly characterized as an "etched surface." In one embodiment, the first registration surface of the cutting tool is parallel with a crystal plane within the {111}

10 family of crystal planes (including both the positive and negative intercepts). Any relative angular relationship may be utilized between the first registration surface and the first major surface of the blade body, although typically the first cutting edge surface and the first major surface of the blade body will typically be disposed in other than perpendicular relation. These characteristics of the first registration surface may be

15 implemented in combination with those characteristics discussed herein in relation to the first cutting edge surface, individually or in any combination.

The first registration surface that may be utilized by the cutting tool of the first aspect may define a portion of a first registration cavity that is formed in an upper surface of the blade body and that extends at least part of the way through the blade body. This

20 first registration cavity extends through the entire thickness of the blade body in one embodiment. In this case, the first cutting edge surface could extend between the first cutting edge and a first edge at the first major surface of the blade body (e.g., its top or upper surface), while the first registration surface could extend between a second edge at the first major surface of the blade body and a third edge at the second major surface of

25 the blade body (e.g., bottom or lower surface). The first edge associated with the first cutting edge surface and the second edge associated with the first registration cavity may be disposed within a first reference plane that is parallel with a second reference plane that contains the first cutting edge associated with the first cutting edge surface and the third edge associated with the first registration cavity.

30 A first registration cavity that is at least defined in part by the above-noted first registration surface, and that may be used by the cutting tool of the first aspect, may be characterized as being concave or accessible through a top or upper surface of the blade body. This first registration cavity could be spaced from the first cutting edge and include first and second ends (e.g., with the first end being disposed or located between the

cutting edge and the second end). In any case, the second end of the first registration cavity may include the above-noted first registration surface, and will more typically be defined entirely by the first registration surface. This first registration cavity may extend partially within the cutting tool (i.e., extend from a top surface of the blade body toward, but not to, a bottom surface of the blade body), or may extend all the way through the body of the blade body. The first end of the first registration cavity may be disposed in any appropriate orientation relative to a planar top surface of the blade body, while the first registration surface may be disposed at an angle other than perpendicular relative to this planar top surface.

10 The above-noted first registrant of a blade handle, that may again be utilized by the cutting tool of the first aspect, may extend at least within the above-noted first registration cavity. The blade handle may be disposed on the first major surface of the blade body. Multiple options exist for registering the first registrant of such a blade handle with the blade body. When registering with the blade body, the first registrant of the blade handle may be spaced from the noted first end of the first registration cavity (e.g., by a distance of at least about 1 millimeter in one embodiment). Registration may be provided along and limited to a line contact between the first registrant of the blade handle and the blade body. Consider the case where the first registration surface extends from a first edge at the intersection of the first registration surface at the first major surface of the blade body (e.g., its top or upper surface), to a second edge. In one embodiment, the first registrant interfaces with the first registration surface closer to the second edge than to the first edge. The second edge may be located at the intersection of the first registration surface with the second major surface of the blade body (e.g., its bottom or lower surface). In another embodiment, the first registrant interfaces with the first registration surface at its second edge. In yet another embodiment, the first registrant interfaces with the first registration surface at an intermediate location between its first and second edges.

30 Multiple first registration cavities at least generally of the above-noted type may be formed on the blade body of the cutting tool of the first aspect, and the above-noted blade handle may including multiple corresponding registrants. Each registration cavity of the blade and registrant of the blade handle may further contribute to accurately disposing the cutting edge in a desired alignment. Consider the case there the blade body includes first and second registration cavities, and where a blade handle with first and second registrants is provided for the cutting tool. The first and second registrants of the

blade handle may be positioned such that the first and second registrants are disposed along a line that is parallel with the cutting edge of the blade. Another way to characterize the position of the second registrant relative to the first registrant is that they are equidistantly disposed from the cutting edge of the blade. In any case, the first and second registration surfaces may be planar surfaces that are parallel with the first cutting edge surface. The first and second registration surfaces may be coplanar or located within a common reference plane. These first and second registration surfaces may be utilized by the first and second registrants to properly register the blade (more specifically its cutting edge) relative to the blade handle (more specifically a registration surface or structure associated therewith).

GROUP 7

A first aspect of the present invention generally relates to using an etch to define at least part of at least one cutting blade from a substrate, as well as to define at least one score on this substrate for separating its corresponding blade(s) from the substrate. More specifically, at least one cutting edge surface for a first blade is defined by etching the substrate. Multiple cutting edge surfaces may be formed in association with any particular blade, each of which may have the characteristics of or relating to a first cutting edge surface to be described herein in relation to the first blade. It should be appreciated that multiple blades may be formed from the same substrate as well, each of which may have the characteristics of or relating to the first blade to be described herein. At least one score that is associated with the first blade is also defined by etching this same substrate (hereafter a "first score", although multiple scores may be formed in association with the first blade, and each of which may have the characteristics of or relating to the first score to be described herein). This first score may be used to facilitate the separation of the first blade from the substrate at the appropriate time, although this separation is not a requirement of the first aspect.

Various refinements exist of the features noted in relation to the first aspect of the present invention. Further features may also be incorporated in the first aspect of the present invention as well. These refinements and additional features may exist individually or in any combination. Any suitable substrate may be utilized by the first aspect, for instance a wafer that is appropriate for use in semiconductor processing. Representative suitable materials for the substrate include ceramic, silicon, and quartz. Single crystal materials in general are desirable for the substrate in the case of the first aspect (e.g., single crystal silicon; single crystal quartz). Utilizing a single crystal

material for the substrate, where there is at least one etchant that is selective to at least one crystal plane of the particular single crystal material, allows for a desirable formation of the first cutting edge surface that may define a cutting edge for the first blade, as well as possibly other features of the first blade (e.g., at least one registration feature for the first blade). That is, those single crystal materials that may be etched to a particular crystal plane, and have the etch in effect stop after reaching this particular crystal plane, may be particularly suited for use in the fabrication of the first blade in accordance with the first aspect.

The first blade may remain part of or interconnected with the substrate for some time after its first cutting edge surface is defined by an etch in the case of the first aspect. For instance, the substrate with this first blade as a part thereof may be transferred from an etch bath to a first fixture to allow a first blade handle to be attached to the first blade while still attached to the substrate. The substrate may then be transferred from this first fixture to a second fixture where the first blade may be separated from the substrate. Separation again may utilize the first score formed by an etch in accordance with the first aspect. For instance, the substrate may be fractured at least generally along the first score to facilitate the separation of the first blade from the substrate.

The etching of the first cutting edge surface and the first score in accordance with the first aspect may be executed at the same time using a single etchant. In one embodiment, an anisotropic etch is used. It should be appreciated that although the same etch may be used, the time required to completely define each of the various structures may not necessarily be the same. The corresponding etch that defines the first cutting edge surface and the first score each may be in the form of a chemical etch. The same etch that defines the first cutting edge surface for the first blade may also simultaneously define other aspects of or structure associated with the first blade. For instance, this etch may define a first cutting edge for the first blade that uses the first cutting edge surface. In one embodiment, the first score is etched so as to be parallel with this first cutting edge. The etch that defines the first cutting edge surface for the first blade may also define a first perimeter portion of the first blade (i.e., something less than the entire perimeter of the first blade, so that it remains attached to the substrate at least at one location) by etching through the entire vertical extent or thickness of the substrate in accordance with a desired pattern.

At least one blade support tab that maintains a structural interconnection between the first blade and the substrate (hereafter a "first blade support tab", although multiple

blade support tabs may be formed in relation to the first blade, and each of which may have the characteristics of or relating to the first blade support tab to be described herein) may also be defined by an etch in the case of the first aspect. A pair of spaced openings that extend down through the entire vertical extent of thickness of the substrate may be
5 created by an etch to define this first blade support tab. The corresponding etch that defines the first cutting edge surface, the first score, and the first blade support tab may be executed at the same time (although not necessarily of the same duration) using a single etchant (e.g., by immersing the substrate within an appropriate etch bath, with appropriate openings having previously been formed in an etch mask that is on the substrate). This
10 etch may define the entire perimeter of the first blade except where the first blade support tab merges into the first blade. The remainder of the perimeter of the first blade may be defined by the separation of the first blade from the substrate along the first score formed on the first blade support tab.

The first score may be etched in the substrate so as to extend across at least a
15 portion of the above-noted first blade support tab in accordance with the first aspect. In one embodiment, the first score is disposed along the length dimension of the first blade support tab at a location where the first blade support tab is of its minimum width (e.g., so that the shape of the first blade support tab acts as a stress concentrator, to cause the greatest stress to occur at the location of the first score to further facilitate the fracture).
20 The first blade support tab may be shaped to generate the greatest stress at the location of the first score to further facilitate the fracture. In another embodiment, the first score extends across only part of the first blade support tab (e.g., the first score does not extend across the entire width of the first blade support tab in this case). Preferably, the pair of opposite ends of the first score (the distance between which defines a length dimension
25 for the first score) are each spaced from one of the two sides or side edges of the first blade support tab (the distance between the two sides defining the width dimension of the first blade support tab). Another way to characterize this first score is that it has a pair of ends that do not intersect with any opening that extends completely through the substrate. Openings that extend completely through the substrate again may be used to define a
30 portion of a perimeter of the first blade and also may be used to define the first blade support tab.

The first blade may have a pair of notches formed on a first perimeter wall of the first blade (e.g., a wall that defines at least part of the perimeter of the first blade) in the case of the first aspect. This first perimeter wall may be disposed at any appropriate

location along the perimeter of the first blade. The above-noted first blade support tab may merge into the first blade at a location that is between this pair of notches. The first score may be positioned at a location anywhere along a length dimension of the first blade support tab, but the first score is preferably offset from other portions of the first perimeter wall of the first blade having these notches. Any jagged edges or the like that remain after separating the first blade from the substrate using the first score will then be recessed relative to other portions of the first perimeter wall of the first blade. That is, when disposing the first perimeter wall of the first blade on a flat supporting surface, the surface defined by fracturing the first blade support tab along the first score preferably will be spaced from this supporting surface. Separating the first blade from the substrate at least generally along the first score may then serve to interconnect the noted pair of notches to define one larger notch on the first perimeter wall of the first blade. The first score may extend entirely through the substrate, but more preferably only extends through a portion of the thickness of the substrate in accordance with the first aspect. In one embodiment, the first score is etched so as to have a depth that is within a range of about 2% to about 75% of the thickness of the substrate. In another embodiment, the first score is etched so as to have a depth that is within a range of about 2% to about 5% of the thickness of the substrate. In yet another embodiment, the first score is etched so as to have a depth that is within a range of about 10 microns to about 30 microns.

The first score that is etched in accordance with the first aspect may be of any appropriate configuration, but is preferably configured so as to allow the fracture to occur in an at least generally predetermined manner. In one embodiment, the first score is etched to produce first and second planar score surfaces that intersect along a first line. The first planar score surface may be parallel with the first cutting edge surface that is also defined by an etch in accordance with the first aspect. Alignment of the first score with a crystallographic plane of the substrate may enhance the separation of the first blade from the remainder of the substrate, including aligning the intersection of the above-noted first and second planar score surfaces with such a crystallographic plane.

The etching of the first cutting edge surface and the first score in accordance with the first aspect may utilize an appropriate etch mask or the like as generally noted above. In one embodiment, a first masking layer is formed on the substrate. A blade mask may then be transferred onto the first masking layer. Appropriate openings may be defined in the first masking layer in accordance with the blade mask to allow for the etching of the substrate to define both the first cutting edge surface and the first score. In one

embodiment, the blade mask is transferred onto the first masking layer using photomasking, masking, photolithography, or microphotolithography, and openings in the first masking layer are defined in accordance with the blade mask by wet chemical etching, plasma etching, reactive ion etching, or ion beam milling the first masking layer.

5 A second aspect of the present invention generally relates to using an etch process to define at least part of at least one cutting blade from a substrate (hereafter a "first blade" although multiple cutting blades may be formed from the same substrate, and each of which may have the characteristics of or relating to the first blade to be described herein), to define at least one blade support tab that maintains an interconnection between
10 this first blade and a remainder of the substrate (hereafter a "first blade support tab", although multiple blade support tabs may be formed in relation to the first blade, and each of which may have the characteristics of or relating to the first blade support tab to be described herein), and to define at least one score on this substrate for facilitating the separation of the first blade from the substrate(hereafter a "first score", although multiple
15 scores may be formed in relation to the blade support tab, and each of which may have the characteristics of or relating to the first score to be described herein). A first perimeter portion of the first blade is defined by etching through the substrate. The first blade support tab is also defined by etching through the substrate, and functions to structurally interconnect the first blade with a remainder of the substrate. The first score
20 is etched across at least a portion of the first blade support tab. This first score may be used to facilitate the separation of the first blade from the substrate at the appropriate time, although this separation is not a requirement of the second aspect.

Various refinements exist of the features noted in relation to the second aspect of the present invention. Further features may also be incorporated in the second aspect of
25 the present invention as well. These refinements and additional features may exist individually or in any combination. Any suitable substrate may be utilized by the second aspect, for instance a wafer that is appropriate for use in semiconductor processing. Representative suitable materials for the substrate include ceramic, silicon, and quartz. Single crystal materials in general are desirable for the substrate in the case of the second
30 aspect (e.g., single crystal silicon; single crystal quartz). Utilizing a single crystal material for the substrate, where there is at least one etchant that is selective to at least one crystal plane of the particular single crystal material, allows for a desirable formation of at least one planar cutting edge surface that may define a cutting edge for the first blade, as well as possibly other features of the first blade (e.g., at least one registration

feature for the first blade). That is, those single crystal materials that may be etched to a particular crystal plane, and have the etch in effect stop after reaching this particular crystal plane, may be particularly suited for use in the fabrication of the first blade in accordance with the second aspect.

5 The first blade may remain part of or interconnected with the substrate through the first blade support tab for some time after being defined by an etch in the case of the second aspect. For instance, the substrate with the first blade and first blade support tab formed therefrom may be transferred from an etch bath to a first fixture to allow a first blade handle to be attached to the first blade while still attached to the substrate through
10 the first blade support tab. The substrate may then be transferred from this first fixture to a second fixture where the first blade may be separated from the first blade support tab, and thereby the substrate. Separation again may utilize the first score formed by an etch in accordance with the second aspect. For instance, the substrate may be fractured at least generally along the first score to facilitate the separation of the first blade from its
15 corresponding first blade support tab.

 The first perimeter portion associated with the first blade in the case of the second aspect may define the entire perimeter of the first blade, except for that which is defined by separating the first blade from the first blade support tab at least generally along the first score. Consider the case where the first blade support tab merges into the first blade
20 along a portion of a perimeter wall of the first blade (hereafter a "first perimeter wall"). The remainder of the entire perimeter of the first blade may be defined by an etch. Therefore, the first perimeter wall of the first blade in this case will have two textures of sort - one being defined by an etch and the other being defined by the fracturing of the substrate at least generally along the first score.

25 The etching of the first perimeter portion of the first blade, the first blade support tab, and the first score in accordance with the second aspect may be executed at the same time using a single etchant (e.g., an anisotropic etch). For instance, the substrate may be immersed in an appropriate etch bath, with appropriate openings having previously been formed in an etch mask that is on the substrate. It should be appreciated that although the
30 same etch may be used, the time required to completely define each of the various structures may not necessarily be the same. The corresponding etch that defines the first perimeter portion of the first blade surface, the first blade support tab, and the first score each may be in the form of a chemical etch. The same etch that defines the first perimeter portion for the first blade may also simultaneously define other aspects of or structure

associated with the first blade. For instance, this etch may define a first cutting edge surface and a corresponding first cutting edge. In one embodiment, the first score is etched so as to be parallel with this first cutting edge.

5 The first score may be etched in the substrate so as to extend across at least a portion of the first blade support tab in accordance with the second aspect. In one embodiment, the first score is disposed along the length dimension of the first blade support tab at a location where the first blade support tab is of its minimum width (e.g., so that the shape of the first blade support tab acts as a stress concentrator, to cause the greatest stress to occur at the location of the first score to further facilitate the fracture).

10 The first blade support tab may be shaped to generate the greatest stress at the location of the first score to further facilitate the fracture. In another embodiment, the first score extends across only part of the first blade support tab (e.g., the first score does not extend across the entire width of the first blade support tab in this case). Preferably, the pair of opposite ends of the first score (the distance between which defines a length dimension

15 for the first score) are each spaced from one of the two sides or side edges of the first blade support tab (the distance between the two sides defining the width dimension of the first blade support tab). Another way to characterize this first score is that it has a pair of ends that do not intersect with any opening that extends completely through the substrate. Openings that extend completely through the substrate again may be used to define a

20 portion of a perimeter of the first blade and may be used to define the first blade support tab.

The first blade may have a pair of notches formed on a first perimeter wall of the first blade (e.g., a wall that defines at least part of the perimeter of the first blade) in the case of the second aspect. This first perimeter wall may be disposed at any appropriate

25 location along the perimeter of the first blade. The first blade support tab may merge into the first blade at a location that is between this pair of notches. The first score may be positioned at a location anywhere along a length dimension of the first blade support tab, but the first score is preferably offset from other portions of the first perimeter wall of the first blade having these notches. Any jagged edges or the like that remain after separating

30 the first blade from the remainder of the substrate using the first score will then be recessed relative other portions of the first perimeter wall of the first blade. That is, when disposing the first perimeter wall of the first blade on a flat supporting surface, the surface defined by fracturing the first blade support tab along the first score preferably will be spaced from this supporting surface. Separating the first blade from the substrate at least

generally along the first score may then serve to interconnect the noted pair of notches to define one larger notch.

The first score may extend entirely through the substrate, but more preferably only extends through a portion of the thickness of the substrate in accordance with the second aspect. In one embodiment, the first score is etched so as to have a depth that is within a range of about 2% to about 75% of the thickness of the substrate. In another embodiment, the first score is etched so as to have a depth that is within a range of about 2% to about 5% of the thickness of the substrate. In yet another embodiment, the first score is etched so as to have a depth that is within a range of about 10 microns to about 30 microns.

The first score that is etched in accordance with the second aspect may be of any appropriate configuration, but is preferably configured so as to allow the fracture to occur in an at least generally predetermined manner. In one embodiment, the first score is etched to produce first and second planar score surfaces that intersect along a first line. The first planar score surface may be parallel with a first cutting edge surface for the first blade that also may be defined by an etch in accordance with the second aspect. Alignment of the first score with a crystallographic plane of the substrate may enhance the separation of the first blade from the remainder of the substrate, including aligning the intersection of the above-noted first and second planar score surfaces with such a crystallographic plane.

The etching of the first perimeter portion of the first blade, the first blade support tab, and the first score in accordance with the second aspect may utilize an appropriate etch mask or the like as generally noted above. In one embodiment, a first masking layer is formed on the substrate. A blade mask may then be transferred onto the first masking layer. Appropriate openings may be defined in the first masking layer in accordance with the blade mask to allow for the etching of the substrate to define the first perimeter portion of the first blade, the first blade support tab, and the first score. In one embodiment, the blade mask is transferred onto the first masking layer using photomasking, masking, photolithography, or microphotolithography, and openings in the first masking layer are defined in accordance with the blade mask by wet chemical etching, plasma etching, reactive ion etching, or ion beam milling the first masking layer.

A third aspect of the present invention generally relates to the fabrication of at least one blade from a substrate (hereafter a "first blade", although multiple blades may be formed from the same substrate, and each of which may have the characteristics of or

relating to the first blade to be described herein). At least one opening down through the entire vertical extent or thickness of substrate is created. A continuous opening of this type may be in accordance with a pattern that defines a first perimeter portion of the first blade. That is, the entire perimeter of the first blade is not initially defined in accordance with the third aspect. In this regard, at least one score (hereafter a "first score", although multiple scores may be formed in relation to the first blade, and each of which may have the characteristics of or relating to the first score to be described herein) is defined on the substrate. This first score may be used to facilitate the separation of the first blade from the substrate at the appropriate time, although this separation is not a requirement of the third aspect. The first score is defined such that its pair of ends do not intersect with any opening.

Various refinements exist of the features noted in relation to the third aspect of the present invention. Further features may also be incorporated in the third aspect of the present invention as well. These refinements and additional features may exist individually or in any combination. Any opening of the type utilized by the third aspect may be defined in any appropriate manner. The first score associated with the third aspect also may be defined in any appropriate manner. In a preferred embodiment, at least one of these openings is defined by an etch, as is the first score. The various features discussed above in relation to the first and second aspects may be utilized by this third aspect, individually or in any combination.

A fourth aspect of the present invention generally relates to the fabrication of at least one blade from a substrate (hereafter a "first blade", although multiple blades may be formed from the same substrate, and each of which may have the characteristics of or relating to the first blade to be described herein). At least one opening down through the entire vertical extent or thickness of substrate is created. A continuous opening of this type may be in accordance with a pattern that defines a first perimeter portion of the first blade. That is, the entire perimeter of the first blade is not initially defined in accordance with the fourth aspect. At least one score (hereafter a "first score", although multiple scores may be formed in relation to the first blade, and each of which may have the characteristics of or relating to the first score to be described herein) is also defined on the substrate. In one embodiment, the first score is formed during the time that the opening(s) are being defined. Another embodiment has the first score being defined by the same technique that defines the opening(s). Yet another embodiment has this first score recessed from an adjacent perimeter wall. In any case, the first score may be used

to facilitate this separation of the first blade from the substrate at the appropriate time, although this separation is not a requirement of the fourth aspect.

Various refinements exist of the features noted in relation to the fourth aspect of the present invention. Further features may also be incorporated in the fourth aspect of the present invention as well. These refinements and additional features may exist individually or in any combination. Any opening of the type utilized by the fourth aspect may be defined in any appropriate manner. The first score associated with the fourth aspect also may be defined in any appropriate manner. In a preferred embodiment, at least one of these openings is defined by an etch, as is the first score. The various features discussed above in relation to the first and second aspects may be utilized by this fourth aspect, individually or in any combination.

GROUP 8

A first aspect of the present invention is directed to a cutting blade having a body. The cutting blade body includes a first cutting edge and a first perimeter wall having a notch. A first portion of the first perimeter wall defines part of this notch and is of a first texture (hereafter a "first perimeter surface"). A second portion of the first perimeter wall defines another part of this same notch and is of a second texture (hereafter a "second perimeter surface"). The first and second textures are different in the case of the first aspect.

Various refinements exist of the features noted in relation to the first aspect of the present invention. Further features may also be incorporated in the first aspect of the present invention as well. These refinements and additional features may exist individually or in any combination. The first cutting edge may be disposed at any appropriate location on the cutting blade body. Moreover, the first cutting edge may be defined in any appropriate manner. For instance, the first cutting edge may be of a single bevel configuration (e.g., a single cutting edge surface that intersects with the upper or lower surface of the cutting blade body to define the first cutting edge) or a double bevel configuration (e.g., where a pair of cutting edge surfaces intersect to define the first cutting edge - one cutting edge surface being disposed at an angle relative to and intersecting with the upper surface of the cutting blade body, with the other cutting edge surface being disposed at an angle relative to and intersecting with the lower surface of the cutting blade body).

The different textures possessed by the first and second perimeter surfaces of the notch in the case of the first aspect may be based upon the manner in which these surfaces

are defined or produced. An appropriate substrate may be etched to define part of the perimeter of the cutting blade body (as well as to define various other features of the cutting blade), and including the second perimeter surface of the notch having the second texture. Hereafter this type of etch will be referred to as a "perimeter-defining etch." The first perimeter surface having the first texture may be the result of fracturing a structural interconnection that remains between the cutting blade body and the substrate at some point in time after the completion of this perimeter-defining etch. In one embodiment, the perimeter-defining etch defines one portion of the perimeter of the cutting blade body, while a remainder of the perimeter of the cutting blade body is defined by fracturing the noted structural interconnection at some point in time after the perimeter-defining etch has been completed. Any appropriate number of these types of notches may be utilized. Preferably, there is a notch of the type described herein for each structural interconnection that remains between the cutting blade body and substrate after the perimeter-defining etch has been completed.

Additional characterizations may be made in relation to using an etch in the fabrication of the cutting blade associated with the first aspect. All surfaces of the cutting blade body that extend from an upper surface of the cutting blade body at least generally toward a lower surface of the cutting blade body, that extend from this lower surface at least generally toward the upper surface, or that extend all the way between these upper and lower surfaces may be defined by an etch, except for the first perimeter surface of the notch. Another characterization is that aside from upper and lower surfaces of the cutting edge body and the first perimeter surface of the notch, all other surfaces of the cutting blade body may be defined by an etch. Still another etch-related characterization in accordance with the first aspect is that the entire perimeter of the notch is defined by an etch, except for the first perimeter surface of the notch. The first perimeter surface may have any texture other than that which would be defined by an etch, including having a texture associated with fracturing the above-noted structural interconnection that may remain between the cutting blade body and substrate after the perimeter-defining etch has been completed.

Consider the case where an appropriate masking layer is formed on both the upper and lower surfaces of an appropriate substrate. Openings may be defined in one or more of these masking layers so as to correspond with at least certain features of the cutting blade of the first aspect. Access to the substrate by one or more etchants is thereby provided through each opening in the masking layer(s). The etch may proceed entirely

through the substrate to define part of a perimeter of the cutting blade, while the etch may proceed at least partially through the substrate to define one or more cutting edge surfaces for the cutting blade, one or more registration features for the cutting blade, or both. The etch may also proceed at least partially through the substrate to define at least one score.

- 5 Any such score may be used to facilitate the fracturing of the above-noted structural interconnection between the cutting blade body and the substrate in at least somewhat of a predetermined manner. This structural interconnection again remains intact after the perimeter-defining etch has been completed. In one embodiment, this structural interconnection is in the form of a blade support tab that extends within the notch of the
- 10 cutting blade of the first aspect, and a first score extends at least partially across this blade support tab and is located along the blade support tab so as to be disposed within the space defined by the notch. That surface that is defined by fracturing the blade support tab using this score may be the first perimeter surface of the notch of the cutting blade in the case of the first aspect. The remainder of the perimeter of the notch, which includes
- 15 the second perimeter surface, may be defined by the perimeter-defining etch.

The cutting blade body in the case of the first aspect may be formed from any appropriate material. In one embodiment and as noted above, part of the perimeter of the cutting blade body may be etched from a substrate. Most typically this substrate will be in the form of a wafer. Representative materials for the substrate in this respect include

20 single crystal silicon and single crystal quartz. Utilizing a single crystal material for a substrate from which the cutting blade body is etched, where there is at least one etchant that is selective to at least one crystal plane of the particular single crystal material, allows for a desirable formation of a first cutting edge surface and/or at least one registration feature for the cutting blade body. That is, those single crystal materials that may be

25 etched to a particular crystal plane, and have the etch in effect stop after reaching this particular crystal plane, may be particularly suited for use in defining the cutting blade body utilized by the first aspect.

The first perimeter wall of the cutting blade body having the notch in accordance with the first aspect may be located along any portion of the perimeter of the cutting blade

30 body. One embodiment has the first cutting edge on one end of the cutting blade body (e.g., located along a leading edge of the cutting blade body), with the first perimeter wall having the notch on an opposite end of the cutting blade body (e.g., located along a trailing edge of the cutting blade body). The first perimeter surface of the notch may be at least generally parallel with the first cutting edge in this instance, the second perimeter

surface of the notch may be parallel with the first cutting edge in this instance, or both. Another embodiment has the first cutting edge being on one end of the cutting blade body, with the first perimeter wall having the notch being on or part of what may be characterized as a side or side wall of the cutting blade body (e.g., a wall that extends from a front end of the cutting blade body to a rear end of the cutting blade body).

There are a number of other characterizations of and/or relationships involving the first and/or second perimeter surfaces of the notch in the case of the cutting blade of the first aspect. Generally, the first and second perimeter surfaces of the notch may be disposed in any appropriate location, including relative to the first cutting edge surface of the cutting blade, relative to each other, or both. The cutting blade body may include upper and lower surfaces, and the first and second perimeter surfaces of the notch each may be perpendicular to both the upper and lower surfaces. The first and second perimeter surfaces of the notch each may have a planar configuration. One option would be to dispose these planar first and second perimeter surfaces of the notch within a common reference plane. Another option would be to dispose these planar first and second perimeter surfaces of the notch parallel to each other so that they are offset.

The first perimeter wall on which the notch is formed in accordance with the first aspect may extend between first and second primary surfaces of the cutting blade body, including that portion of the first perimeter wall that defines the perimeter of the notch. The second perimeter surface of the notch may extend from the first primary surface of the cutting blade body (e.g., its upper surface) toward, but not to, the second primary surface of the cutting blade body (e.g., its lower surface). At least part of the first perimeter surface of the notch may extend from the second perimeter surface of the notch to the second primary surface of the cutting blade body such that the second perimeter surface and the noted portion of the first perimeter surface define the vertical extent of the first perimeter wall at a particular location. Portions of the first perimeter surface of the notch may also extend all the way from the first primary surface of the cutting blade body to the second primary surface of the cutting blade body on what may be characterized as the two opposite ends of the second perimeter surface in a plan view. This particular configuration of the first perimeter surface may be characterized as being at least generally U-shaped in plan view. One way to realize this configuration is to etch part of the way through an appropriate substrate to define a score at least generally of the above-described type (e.g., that which provides a separation function), one wall of which will then define the second perimeter surface and which may be in the form of a planar

surface. This etched score surface may be perpendicular to one or both of the first and second primary surfaces of the substrate, and the etched score surface may extend from the first primary surface toward, but not to, the second primary surface. Any subsequent fracturing of the portion of the substrate from the "bottom" of the score to the second primary surface would then define at least part of the first perimeter surface of the notch. This first perimeter surface could be at least generally coplanar with the second perimeter surface (e.g., one wall of the above-noted score).

The second perimeter surface of the notch associated with the first aspect is not limited to being a wall of a score used to facilitate the fracturing of a remaining structural interconnection between the cutting blade and a substrate. In this regard, the first perimeter surface may protrude beyond the second perimeter surface or be offset therefrom. Consider the case where the second perimeter surface is defined by etching all the way from a first primary surface of a substrate to an oppositely disposed second primary surface of the substrate in defining part of the perimeter of the cutting blade body at least generally in accordance with the foregoing. A score may be formed in any appropriate manner across at least part of a structural interconnection that remains between the cutting blade body and the substrate after the completion of this perimeter-defining etch. This score may be offset from the noted second perimeter surface to thereby offset the first perimeter surface of the notch from the second perimeter surface of the notch. That is, since the first perimeter surface will generally extend from the bottom of the score to the second primary surface of the substrate, and since the score is not aligned with the noted second perimeter surface in this example, the first and second perimeter surfaces of the notch will be offset from each other in this case. It should be appreciated that the score could also be aligned with this particular second perimeter surface to provide the above-noted coplanar relationship with the first perimeter surface as well.

The location of the first perimeter surface of the notch in the case of the first aspect may be characterized as any location that would be spaced at least some degree from a supporting surface when the first perimeter wall of the cutting blade body is disposed on this supporting surface. That is, the first perimeter surface is recessed in relation to at least one other portion of the first perimeter wall of the cutting blade body. In one embodiment, the first perimeter wall includes first and second sections that are disposed on opposite sides of the notch (in a plan view of the first perimeter wall). A third perimeter surface of the notch intersects with the first section of the first wall, while

a fourth perimeter surface of the notch intersects with the second section of the first perimeter wall. The third and fourth perimeter surfaces may be characterized as defining a depth of the notch or an amount that the notch extends toward an interior location within the cutting blade body (e.g., in a direction of the first cutting edge of the cutting blade). The first and second perimeter surfaces of the notch may define or be at least part of a perimeter surface that extends between and interconnects these third and fourth perimeter surfaces. In one embodiment, the second perimeter surface is that portion of the perimeter defining the notch that is most recessed. Stated another way, the second perimeter surface may define one extreme of the first perimeter wall (e.g., be disposed furthest in one direction), while the above-noted first and second sections of the first perimeter wall may define another extreme of the first perimeter wall (e.g., be disposed furthest in the opposite direction). It should be appreciated that the second perimeter surface of the notch and the first perimeter surface of the notch in this instance may have any of the above-noted characteristics, alone or in any combination. Therefore, the second perimeter surface of the notch may have an etched texture, whereas the first perimeter surface of the notch may have a different texture as a result of being defined by fracturing a structural interconnection that remains between the cutting blade body and a substrate at some point in time after the completion of the etch that defines part of the perimeter of the cutting blade body.

A second aspect of the present invention is directed to a cutting blade having a body. The cutting blade body includes a first cutting edge and a first perimeter wall having a notch. In one embodiment, the entire perimeter of this notch is defined by an etch, except for the first perimeter surface of the notch. Another embodiment of this second aspect uses an etch to define all surfaces of the cutting blade body that extend from an upper surface of the cutting blade body at least generally toward a lower surface of the cutting blade body, that extend from this lower surface at least generally toward this upper surface, or that extend all the way between these upper and lower surfaces, except for the first perimeter surface of the notch. Yet another embodiment of this second aspect is directed to a configuration where, aside from upper and lower surfaces of the cutting edge body and the first perimeter surface of the notch, all other surfaces of the cutting blade body are defined by an etch.

Various refinements exist of the features noted in relation to the second aspect of the present invention. Further features may also be incorporated in the second aspect of the present invention as well. These refinements and additional features may exist

individually or in any combination. For instance, the various features discussed above in relation to the first aspect may be utilized by this second aspect, individually or any combination.

5 A third aspect of the present invention is generally directed toward what may be characterized as a cutting blade wafer. For instance, the third aspect may be in the form of the cutting blade discussed above in relation to the first aspect prior to separation from a substrate or wafer from which this cutting blade has been fabricated.

10 One cutting blade wafer in accordance with the third aspect includes a wafer, that in turn includes what may be characterized as a frame or a supporting structure. At least one cutting blade (hereafter a "first cutting blade") having a first cutting edge is interconnected with this wafer frame. In this regard, at least one blade support tab may interconnect its associated cutting blade with the wafer frame. There will then be at least one blade support tab that interconnects the first cutting blade with the wafer frame, and this may then be characterized as a first blade support tab. A width of the first blade support tab is defined between its first and second sides. A first space separates the first side of the first blade support tab (which encompasses the entire first side, but more typically only part thereof) and a first portion of the first cutting blade. Similarly, a second space separates the second side of the first blade support tab (which encompasses the entire second side but more typically only part thereof) and a second portion of the first cutting blade.

20 Various refinements exist of the features noted in relation to the third aspect of the present invention. Further features may also be incorporated in the third aspect of the present invention as well. These refinements and additional features may exist individually or in any combination. The wafer associated with this third aspect may be formed from those materials that were discussed above in relation to the fabrication of the first cutting blade of the first aspect. Similarly, the various features discussed above in relation to the cutting blade of the first aspect may be utilized by this third aspect, individually or any combination. Generally, part of the notch discussed above in relation to the first aspect may be disposed on each side of that portion of the first blade support tab that enters into this notch to merge or interconnect with the first cutting blade. Fracturing the first blade support tab (e.g., along at least one score) may then complete the definition of the notch discussed above in relation to the first aspect.

30 The wafer used by the third aspect may include upper and lower surfaces. What may be characterized as a first perimeter opening may extend from the upper surface of

the wafer to its lower surface (all the way through the wafer), and further may extend about the entire perimeter of the first cutting blade except for where the first blade support tab merges or interconnects with the first cutting blade. Different parts of this first perimeter opening may then define the above-noted first and second spaces that are again located between the sides of the first blade support tab and different portions of the first cutting blade.

The first blade support tab extending between the first cutting blade and the wafer frame may include one or more scores. Any such score may be used to facilitate fracturing the first blade support tab in at least somewhat of a predetermined manner to separate the first cutting blade from the first blade support tab, and thereby to separate the first cutting blade from the wafer frame or the remainder of the wafer. A first score is preferably located so that the surface defined by this fracture is recessed relative to other surfaces of the cutting blade that are disposed along a common wall of the cutting blade in the manner discussed above in relation to the first aspect.

Consider the case where a first score extends across at least part of the first blade support tab in the case of the third aspect. That is, the first score progresses along the first blade support tab in a direction that is toward, but not necessarily to, its first and second sides. For instance, the first score may have a pair of oppositely disposed ends. In one embodiment, neither end of the first score intersects with the first or second side of the first blade support tab. Stated another way, each end of the first score is spaced inwardly from either the first or second side of the first blade support tab.

The above-noted first score that may be utilized by the third aspect may extend completely through the wafer. More preferably, the first score extends only partially through the wafer. In one embodiment, the first score extends into the wafer an amount anywhere within a range of about 2% to about 75% of the thickness of the wafer. In another embodiment, the first score extends into the wafer an amount anywhere within a range of about 2% to about 5% of the thickness of the wafer. Yet another embodiment has the first score extending into the wafer an amount anywhere within a range of about 10 microns to about 30 microns.

Any technique may be utilized to form the first score that may be utilized in relation to the third aspect. In one embodiment, the first score is defined by an etch (e.g., anisotropic). The first score may also be of any appropriate configuration. One embodiment has the first score defined by a pair of planar score surfaces that intersect along a first line. This line of intersection between the pair of planar score surfaces,

including the first score in general, may be aligned with a crystallographic plane of the wafer to increase the potential for fracturing the first blade support tab along a predetermined crystal plane. These planar score surfaces may be disposed in any appropriate orientation. One of these planar score surfaces may be perpendicular with the upper and lower surfaces of the first blade support tab, while the other may be disposed at an angle.

GROUP 9

A first aspect of the present invention is generally directed to a microkeratome cutting tool that includes a blade having first and second oppositely disposed major surfaces (e.g., an upper surface and an oppositely disposed lower surface). The blade further includes a first cutting edge surface that extends between the first and second major surfaces, and further that is disposed at an angle relative to each of the first and second major surfaces. A first cutting edge for the blade is defined at the intersection of the first cutting edge surface and the first major surface.

Another component of the microkeratome cutting tool of the first aspect is a blade handle. This blade handle is mounted on the blade such that a lower surface of the blade handle faces a corresponding portion of the first major surface of the blade. The blade handle is positioned on the blade so as to be spaced back from the first cutting edge of the blade.

Various refinements exist of the features noted in relation to the first aspect of the present invention. Further features may also be incorporated in the first aspect of the present invention as well. These refinements and additional features may exist individually or in any combination. The microkeratome cutting tool of the first aspect may utilize multiple cutting edges (e.g., at least one cutting edge in addition to the first cutting edge, any of which may have the characteristics of or relating to the first cutting edge to be described herein in relation to the microkeratome cutting tool of the first aspect). Any cutting edge in addition to the first cutting edge may be defined by the intersection of one or more surfaces, including being defined in the same manner as the first cutting edge to be described herein.

Any suitable material may be utilized by the first aspect in relation to the blade, for instance a wafer that is appropriate for use in semiconductor processing. Representative suitable materials for the blade include ceramic, silicon, and quartz. Single crystal materials in general are desirable for the blade in the case of the first aspect (e.g., single crystal silicon; single crystal quartz). Utilizing a single crystal material for a

substrate from which the blade is formed, where there is at least one etchant that is selective to at least one crystal plane of the particular single crystal material, allows for a desirable formation of the first cutting edge surface that at least assists in the definition of the first cutting edge for the microkeratome cutting tool of the first aspect, as well as possibly other features of this microkeratome cutting tool (e.g., at least one registration feature for the microkeratome cutting tool). That is, those single crystal materials that may be etched to a particular crystal plane, and have the etch in effect stop after reaching this particular crystal plane, may be particularly suited for use in the fabrication of the blade used by the microkeratome cutting tool of the first aspect.

10 The first and second major surfaces of the blade used by the microkeratome cutting tool of the first aspect may be planar and disposed in parallel relation. In one embodiment, at least one of the first and second major surfaces of the blade is defined by a first set of three Miller indices, where at least one of these three Miller indices has an absolute value that is greater than three (and thereby including both the positive and negative intercepts). Another embodiment has both the first and second major surfaces of the blade defined by the same first set of three Miller indices, where at least one of these three Miller indices has an absolute value that is greater than three. Having at least one of, and more preferably both of, the first and second major surfaces of the blade defined by the noted first set of three Miller indices increases the likelihood of being able to fabricate the first cutting edge at a particular blade angle (again defined by the intersection of the first cutting edge surface with the first major surface in the case of the first aspect). A variety of blade angles may be utilized in relation to the first aspect in this case. However, it should be appreciated that at least certain blade angles may be realized in accordance with the first aspect without the requirement that the first and/or second major surfaces of the blade be defined by a set of three Miller indices having at least one of the three Miller indices with an absolute value greater than three.

30 Semiconductor processing techniques may be used to fabricate the blade from a wafer in relation to the first aspect as generally noted above. This wafer may have at least one, and more preferably both, its top and bottom major surfaces defined by the same first set of three Miller indices noted above in relation to the blade, where at least one of these three Miller indices has an absolute value that is greater than three. This wafer, or any other appropriate substrate for that matter, may undergo an anisotropic etch to define the first cutting edge surface for the blade of the microkeratome cutting tool of the first aspect. The first cutting edge surface may correspond with a particular crystal plane that

defines a desired blade angle for the first cutting edge, and that in effect acts as an etch stop for the anisotropic etch (e.g., the first cutting edge surface may be characterized as planar). The first cutting edge surface may then be properly characterized as an "etched surface." In one embodiment, the first cutting edge surface of the microkeratome cutting tool is parallel with a crystal plane within the {111} family of crystal planes (including both the positive and negative intercepts). Any relative angular relationship may be utilized between the first cutting edge surface and the first major surface of the blade body, although the first cutting edge surface and the first major surface of the blade body will typically be disposed in other than perpendicular relation. In one embodiment, an acute angle is defined between the first cutting edge surface and the first major surface of the blade.

One or more registration surfaces on the blade may be utilized by the microkeratome cutting tool of the first aspect. Each such registration surface may be used to position the blade handle of the microkeratome cutting tool in a certain predetermined relationship with the first cutting edge of the blade. In one embodiment, each such registration surface is parallel with the first cutting edge, is parallel with the first cutting edge surface, or both. Multiple registration surfaces may be disposed within a common reference plane (e.g., in a coplanar relationship).

A first registration surface that may be utilized by the first aspect is spaced from the first cutting edge and may be parallel with the first cutting edge surface. Each registration surface may have the characteristics of or relating to this first registration surface. The blade handle may include a first registrant that interfaces with the first registration surface in a manner so as to at least contribute to accurately disposing the first cutting edge of the blade in a desired alignment. The first cutting edge of the blade may be accurately aligned to a reference surface of the blade handle using the first registration surface of the blade and the first registrant of the blade handle. This in turn allows the first cutting edge to be accurately positioned on a microkeratome cutting head assembly using the reference surface of the blade handle.

As noted above, a wafer or other appropriate substrate may undergo an anisotropic etch to define the first cutting edge surface used by the microkeratome cutting tool of the first aspect. This same anisotropic etch may also define the above-noted first registration surface. In any case, the first registration surface may correspond with a particular crystal plane, and that in effect acts as an etch stop for the anisotropic etch. The first registration surface may then be properly characterized as an "etched surface." In one embodiment,

the first registration surface of the microkeratome cutting tool of the first aspect is parallel with a crystal plane within the {111} family of crystal planes (including both the positive and negative intercepts). Any relative angular relationship may be utilized between the first registration surface and the first major surface of the blade, although typically the first cutting edge surface and the first major surface of the blade will typically be disposed in other than perpendicular relation. These characteristics of the first registration surface may be implemented in combination with those characteristics discussed herein in relation to the first cutting edge surface, individually or in any combination.

10 The first registration surface that may be utilized by the microkeratome cutting tool of the first aspect may extend the entire distance between the first and second major surfaces of the blade. In this case, the first cutting edge surface could extend between the first cutting edge at the first major surface of the blade and a first edge at the second major surface, while the first registration surface could extend between a second edge at the first major surface of the blade and a third edge at the second major surface of the blade. The first edge associated with the first cutting edge surface and the third edge associated with the first registration cavity may be disposed within a first reference plane that is parallel with a second reference plane that contains the first cutting edge associated with the first cutting edge surface and the second edge associated with the first registration cavity.

20 The blade handle used by the microkeratome cutting tool of the first aspect may include a first registrant for interfacing with at least part of the above-noted first registration surface of the blade. In one embodiment, the first registrant of the blade handle interfaces with the first registration surface of the blade only at the intersection of the first registration surface of the blade and the first major surface of the blade. Multiple registration surfaces again may be utilized by the blade utilized by the microkeratome cutting tool of the first aspect as noted. The blade handle may include at least one registrant for each registration surface of the blade. In the case where the blade includes first and second registration surfaces: 1) these first and second registration surfaces may be disposed within a common reference plane; 2) the blade handle may include first and second registrants that are positioned along a reference axis that is parallel with the first cutting edge; 3) the blade handle may include first and second registrants that are equally spaced from the first cutting edge; or 4) any combination thereof.

At least one concave registration cavity may be disposed on the first major surface of the blade, and the blade handle may include at least one registrant that extends at least within each such registration cavity in the case of the microkeratome cutting tool of the first aspect. Each registration cavity utilized by the blade may have the same characteristics as or relating to a first registration cavity that will now be described. The first registration cavity may be spaced from the first cutting edge and include first and second ends (e.g., with the first end being disposed or located between the cutting edge and the second end). The second end of the first registration cavity may include the above-noted first registration surface, and will more typically be defined entirely by the first registration surface. In any case, this first registration cavity may extend partially within the blade (i.e., extend from the first major surface of the blade toward, but not to, the second major surface of the blade), or may extend all the way through the blade (i.e., all the way from the first major surface to the second major surface). In one embodiment, the first end of the first registration cavity is disposed in any appropriate orientation relative to the first major surface of the blade (e.g., perpendicular), while the second end is disposed at an angle other than perpendicular relative to the first major surface.

The above-noted first registrant of the blade handle may extend at least within the above-noted first registration cavity in the case of the first aspect. There are a number of characterizations that may be made in relation to registering the blade handle to the blade using the first registrant of the blade handle and the first registration cavity of the blade. One is that the first registrant of the blade handle may be spaced from the above-noted first end of the first registration cavity (e.g., by a distance of at least about 1 millimeter in one embodiment). Another is that the contact between the first registrant of the blade handle and the blade may be limited to no more than along a line, and including only at the intersection of the first major surface of the blade and the second end of the first registration cavity. One or more separate and distinct point contacts between the blade handle and blade could be used for the registration as well.

Multiple first registration cavities at least generally of the above-noted type may be formed on the blade of the microkeratome cutting tool of the first aspect, and again the blade handle may include multiple, corresponding registrants. Each registration cavity of the blade and registrant of the blade handle may further contribute to accurately disposing the cutting edge in a desired alignment. Consider the case where the blade includes first and second registration cavities, and where the blade handle includes first and second registrants for these first and second registration cavities, respectively. The first and

second registrants of the blade handle may be positioned such that the first and second registrants are disposed along a line that is parallel with the first cutting edge of the blade. Another way to characterize the position of the second registrant relative to the first registrant is that they are equidistantly disposed from the first cutting edge of the blade.

5 The blade handle used by the microkeratome cutting tool of the first aspect may be formed from any appropriate material. Any appropriate way for mounting the blade handle on the blade may be utilized. Preferably the blade handle is attached or anchored to the blade so that there is no substantial movement therebetween. Stated another way, the blade handle and the blade function as a single unit and move together during
10 operation of a microkeratome cutting head assembly that uses the microkeratome cutting tool of the first aspect. Any appropriate way of maintaining the blade handle in a fixed relative positional relationship with the cutting blade may be used, including any appropriate adhesive (e.g., an epoxy; a UV curable epoxy; an epoxy with spacing spheres), or by deforming some portion of the handle by melting or heat-staking. The
15 blade handle may directly interface with part of the first major surface of the blade, although there may be one or more intermediate adhesive layers.

GROUP 10

A first aspect of the present invention is directed to a cutting head assembly for a microkeratome of the type that is typically used to cut eye tissue for LASIK eye
20 procedures. The cutting head assembly includes an eye flap receptacle and a blade. Generally, the blade is used to cut an eye flap or the like from the patient's eye, while the eye flap receptacle is an area into which the eye flap may be directed from the cut provided by the blade. Relevant components of the blade in relation to the first aspect are first and second major surfaces that are disposed opposite of each other, a first cutting
25 edge surface, and a first cutting edge. The first cutting edge surface extends all the way from the first major surface of the blade to the oppositely disposed second major surface of the blade, and such that the first cutting edge is defined by the intersection of the first cutting edge surface and the first major surface. This may be characterized as a single-bevel configuration for the blade. In any case, what is key in relation to the first aspect is
30 the configuration/orientation of the blade. Specifically, the first major surface of the blade is disposed above its second major surface. Recall that the first cutting edge again is defined by the intersection of the first cutting edge surface and the first major surface. Typically the first cutting edge of the blade will be the leading portion of the blade in a cutting operation, although such is not a requirement of the first aspect.

Various refinements exist of the features noted in relation to the first aspect of the present invention. Further features may also be incorporated in the first aspect of the present invention as well. These refinements and additional features may exist individually or in any combination. There are a number of other ways in which the orientation of the blade within the microkeratome cutting head assembly may be described. One is that the first cutting edge surface at least generally faces the patient's eye during a cutting operation. Another is that the first major surface of the blade may be characterized as being located somewhere between the second major surface of the blade and the eye flap receptacle of the cutting head assembly, while the second major surface of the blade may be characterized as being located somewhere between the first major surface of the blade and the patient's eye during a cutting operation. Yet another is that the "underside" of an eye flap being cut by the microkeratome cutting head assembly interfaces with the part of the first major surface of the blade and not the first cutting edge surface.

The microkeratome cutting head assembly of the first aspect may further include a first blade support that is associated with the first major surface. This first blade support includes a first leading edge that is spaced from the first cutting edge of the blade in a dimension that is parallel with the first major surface. Although the first blade support will typically interface with the first major surface of the blade in the case of the first aspect, the first aspect also encompasses having the first blade support be slightly spaced from the first major surface of the blade.

The first leading edge of the above-noted first blade support is spaced from the first cutting edge of the blade by a distance of no more than about 1 millimeter in one embodiment, and by a distance of no more than about 0.7 millimeters in another embodiment. This spacing is again measured in a dimension that is parallel with the first major surface of the blade. In one embodiment and including when utilizing a spacing within the above-noted limit, the blade angle associated with the blade may be selected so as to be no more than about 19° in one case, and no more than about 35° in another case. The blade angle is the angle between the first cutting edge surface of the blade and the first major surface of the blade in the case of the first aspect. Any appropriate blade angle may be used in relation to the first aspect.

A portion of the above-noted first blade support may define at least part of a boundary for the eye flap receptacle. One function of the first blade support may be to provide at least some degree of control of the blade position in the vertical dimension.

Another function of the first blade support may be to direct the patient's eye flap into the eye flap receptacle while being cut by the microkeratome cutting head assembly of the first aspect. In this regard and in one embodiment, the first blade support may include an at least generally concave and/or arcuate surface that extends at least generally away from its first leading edge.

There are a number of ways to further characterize the configuration of the blade and/or its orientation in the microkeratome cutting head assembly in the case of the first aspect. The first cutting edge surface of the blade again extends all away from the first major surface to its second major surface, with the first cutting edge again being at the intersection of the first cutting edge surface and the first major surface. The intersection of the first cutting edge surface and the second major surface may be characterized as defining a first edge. How the blade is configured and oriented in the microkeratome cutting head assembly may be described in relation to the first cutting edge and the first edge of the blade, together with the first leading edge of the first blade support. Consider the case of a reference plane that is perpendicular to the first major surface of the blade, that contains the first edge (the intersection of the first cutting edge surface and the second major surface of the blade), and that intersects with the first major surface of the blade at a first location. Stated another way, the first location is the projection of the first edge onto the first major surface of the blade in a dimension that is perpendicular to the second major surface of the blade. One characterization in accordance with the foregoing is that the blade is configured and oriented in the microkeratome cutting head assembly such that the first leading edge of the first blade support is disposed or located somewhere between the first cutting edge of the blade and the above-noted first location in a dimension that is parallel with the first major surface. Another characterization in accordance with the foregoing is that the blade may be configured and oriented in the microkeratome cutting head assembly such that the first leading edge of the first blade support is disposed closer to the first cutting edge of the blade than the above-noted first location (e.g., measured in a dimension that is parallel with the first major surface of the blade).

The microkeratome cutting head assembly of the first aspect may include a second blade support in addition to the above-noted first blade support. This second blade support is associated with the second major surface of the blade. Although the second blade support will typically interface with the second major surface of the blade in the case of the first aspect, the first aspect also encompasses having the second blade support

be slightly spaced from the second major surface of the blade. In any case, the second blade support may also include a second leading edge. In one embodiment, the first leading edge of the first blade support is closer to the first cutting edge of the blade than the second leading edge of the second blade support, measured in a dimension that is parallel with the first major surface of the blade.

A second aspect of the present invention is directed to a cutting head assembly for a microkeratome of the type that is typically used to cut eye tissue for LASIK eye procedures. The cutting head assembly includes an eye flap receptacle, a blade, and a first blade support. Generally, the first blade support is associated with the first surface of the blade, includes a first leading edge, and provides at least some degree of control/support for the blade while the same is cutting an eye flap from the patient's eye, while the eye flap receptacle is an area into which the eye flap may be directed from the cut provided by the blade. Relevant components of the blade in relation to the second aspect are first and second major surfaces that are disposed opposite of each other, a first cutting edge, a first cutting edge surface that extends from the first cutting edge to the second major surface, and a first edge defined by the intersection of the first cutting edge surface and the second major surface. Typically the first cutting edge of the blade will be the leading portion of the blade in a cutting operation, although such is not a requirement of the second aspect.

Consider the case of a first reference plane that is perpendicular to the first major surface of the blade utilized by the second aspect, that contains the first edge (again, the intersection of the first cutting edge surface and the second major surface of the blade), and that intersects with a second reference plane that contains the first major surface of the blade at a first location (thereby including intersecting directly with the first major surface). Stated another way, the first location is the projection of the first edge at the second major surface onto a reference plane that contains the first major surface (or again directly on the first major surface of the blade) in a dimension that is perpendicular to the first major surface of the blade. In the case of the second aspect, the blade is configured and oriented in the microkeratome cutting head assembly such that the leading edge of the first blade support is disposed or located somewhere between the first cutting edge of the blade and the above-noted first location in a dimension that is parallel with the first major surface.

Various refinements exist of the features noted in relation to the second aspect of the present invention. Further features may also be incorporated in the second aspect of

the present invention as well. These refinements and additional features may exist individually or in any combination. There are a number of ways in which the orientation of the blade within the microkeratome cutting head assembly may be described. One is that the first major surface of the blade is disposed above its second major surface.

5 Another is that the first cutting edge surface at least generally faces the patient's eye during a cutting operation. Yet another is that the first major surface of the blade may be characterized as being located somewhere between the second major surface of the blade and the eye flap receptacle of the cutting head assembly, while the second major surface of the blade may be characterized as being located somewhere between the first major
10 surface of the blade and the patient's eye during a cutting operation. Yet another is that the "underside" of an eye flap being cut by the microkeratome cutting head assembly interfaces with the part of the first major surface of the blade and not the first cutting edge surface.

Any appropriate blade angle may be utilized by the blade in the case of the second
15 aspect. The blade may be formed so as to have a blade angle of no more than about 19° in one embodiment, and no more than about 35° in another embodiment. This blade angle may be defined as the angle between the first cutting edge surface of the blade and the first major surface of the blade. That is, the blade in the case of the second aspect may be of a single-bevel configuration where the first cutting edge surface extends all the
20 way from the first major surface of the blade to the second major surface of the blade, and where the first cutting edge is defined by the intersection of the first cutting edge surface and the first major surface. Therefore, the various features discussed above in relation to the first aspect may be used by this second aspect as well.

The first leading edge of the first blade support may be characterized as being
25 spaced from the first cutting edge of the blade in a dimension that is parallel with the first major surface in the case of the second aspect. The first leading edge of the first blade support is spaced from first cutting edge of the blade by a distance of no more than about 1 millimeter in one embodiment, and by a distance of no more than about 0.7 millimeters in another embodiment. This spacing again may be measured in a dimension that is
30 parallel with the first major surface of the blade. Another characterization of the configuration of the blade and its orientation in the microkeratome cutting head assembly in the case of the second aspect is that the first leading edge of the first blade support may be disposed closer to the first cutting edge of the blade than the first location (again, the intersection of the first cutting edge surface and the second major surface of the blade).

This measurement may be in a dimension that is parallel with the first major surface of the blade.

A portion of the first blade support may define at least part of a boundary for the eye flap receptacle in the case of the second aspect. One function of the first blade support may be to provide at least some degree of control/support of the blade position in the vertical dimension. Another function of the first blade support may be to direct the patient's eye flap into the eye flap receptacle while being cut by the microkeratome cutting head assembly of the second aspect. In this regard and in one embodiment, the first blade support may include an at least generally concave and/or arcuate surface that extends at least generally away from its first leading edge.

The microkeratome cutting head assembly of the second aspect may include a second blade support in addition to the above-noted first blade support. This second blade support may then be associated with the second major surface of the blade. Although the second blade support may typically interface with the second major surface of the blade in the case of the second aspect, the second aspect also encompasses having the second blade support be slightly spaced from the second major surface of the blade. In any case, the second blade support may also include a second leading edge. In one embodiment, the first leading edge of the first blade support is closer to the first cutting edge of the blade than the second leading edge of the second blade support. This measurement may be in a dimension that is parallel with the first major surface of the blade.

A third aspect of the present invention is directed to a cutting head assembly for a microkeratome of the type that is typically used to cut eye tissue for LASIK eye procedures. The cutting head assembly includes an eye flap receptacle, a blade, an upper blade support, and a lower blade support. Generally, the upper and lower blade supports provide at least some degree of control/support for the blade while the same is cutting an eye flap from the patient's eye, while the eye flap receptacle is an area into which the eye flap may be directed from the cut provided by the blade. Relevant components of the blade in relation to the third aspect are first and second major surfaces that are disposed opposite of each other, as well as a first cutting edge. The upper blade support is associated with the first major surface of the blade and includes a first leading edge that is spaced back from the first cutting edge of the blade, while the lower blade support is associated with the second major surface of the blade and includes a second leading edge that is also spaced back from the first cutting edge of the blade. Typically the first cutting

edge of the blade will be the leading portion of the blade in a cutting operation, although such is not a requirement of the third aspect. In any case, the first leading edge of the upper blade support is positioned closer to the first cutting edge of the blade than the second leading edge of the lower blade support.

5 Various refinements exist of the features noted in relation to the third aspect of the present invention. Further features may also be incorporated in the third aspect of the present invention as well. These refinements and additional features may exist individually or in any combination. Initially, the various features discussed above in relation to the first and second aspects may be used by this third aspect, individually or in
10 any appropriate combination. In one embodiment, "closer" in the case of the third aspect means measured in a dimension that is parallel with the first major surface of the blade.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

15 Figure 1 is a side view of one embodiment of a microkeratome.

Figure 2A is a top-based perspective view of a cutting blade of the cutting tool utilized by the microkeratome of Figure 1.

Figure 2B is a top view of the cutting blade of the cutting tool utilized by the microkeratome of Figure 1.

20 Figure 2C is a plan view of a modified registration cavity that may be used by the cutting blade of Figures 2A-B.

Figure 3A is a cross-sectional view of the cutting blade of Figure 2B take along line 3-3.

25 Figure 3B is a cross-sectional view of an alternative embodiment of a cutting blade, namely in relation to the definition of its cutting edge in relation to that illustrated in Figure 3A.

Figure 4 is a side-based perspective view of the cutting tool utilized by the microkeratome of Figure 1.

30 Figure 5 is a top-based perspective view of the cutting tool utilized by the microkeratome of Figure 1.

Figure 6 is a bottom-based perspective view of the cutting tool utilized by the microkeratome of Figure 1.

Figure 7 is an exploded, perspective view of the cutting tool utilized by the microkeratome of Figure 1.

Figure 8A is a cutaway, bottom view illustrating one registrant of the blade handle of the cutting tool utilized by the microkeratome of Figure 1, while engaging a registration surface of the cutting blade.

5 Figure 8B is a cutaway, side view illustrating a registrant of a blade handle of the cutting tool utilized by the microkeratome of Figure 1, while engaging a registration surface of the cutting blade.

Figure 8C is a cutaway, side view illustrating an alternative embodiment of a registrant of the blade handle of the cutting tool utilized by the microkeratome of Figure 1, while engaging the registration surface of the cutting blade.

10 Figure 8D is a cutaway, side view illustrating yet another alternative embodiment of a registrant of the blade handle of the cutting tool utilized by the microkeratome of Figure 1, while engaging the registration surface of the cutting blade.

Figure 9A is a cross-sectional view of a pair of masking layers formed on opposing surfaces of a substrate or wafer.

15 Figure 9B is a cross-sectional view after a cutting blade mask has been transferred onto one of the masking layers of Figure 9A, along with the resulting openings in the masking layer.

Figure 9C is a top plan view of the openings in the masking layer illustrated in Figure 9B

20 Figure 9D is a cross-sectional view after the substrate/wafer has been etched to define the cutting blade of the cutting tool utilized by the microkeratome of Figure 1.

Figure 10 is a flowchart illustrating one method of fabricating multiple blades from a wafer, including steps that correspond with Figures 9A-D.

25 Figure 11 is a plan view of a wafer with alignment slots etched therein for aligning a blade mask relative to the wafer.

Figure 12 is a plan view of a wafer having a plurality of cutting blades fabricated therefrom in accordance with the protocol of Figure 10.

Figure 13A is an enlarged, plan view of the interconnection between a single cutting blade and the wafer from Figure 12.

30 Figure 13B is an enlarged, cutaway view of one embodiment of a blade separation score that is only schematically illustrated in Figure 13A and which is used to separate the cutting blade from a corresponding blade support tab of the wafer.

Figure 13C is an enlarged, plan view of a portion of the rear of the cutting blade of Figure 13A after its separation from the wafer along the score of Figure 13B.

Figure 13D is a plan view of a blade mask perimeter profile and one embodiment of an actual perimeter profile produced when anisotropically etching a wafer based upon this blade mask perimeter profile.

Figure 14 is a perspective view of one embodiment of a fixture and base plate for
5 installing blade handles on the cutting blades from the wafer of Figure 12.

Figure 15 is an exploded, perspective view of the blade handle mounting fixture and base plate of Figure 14.

Figure 16 is a perspective view of an upper surface of the blade handle mounting fixture of Figure 14.

10 Figure 17 is a perspective view of a lower surface of the blade handle mounting fixture of Figure 14.

Figure 18 is an enlarged, perspective view of a portion of the upper surface of the blade handle mounting fixture of Figure 14 that would interface with one of the cutting blades.

15 Figure 19 is an enlarged, perspective view of a portion of the upper surface of the blade handle mounting fixture of Figure 14 when supporting one of the cutting blades.

Figure 20 is a perspective view of one embodiment of a blade separation fixture for separating blades from the wafer of Figure 12.

Figure 21 is an exploded perspective view of the blade separation fixture of Figure
20 20.

Figure 22 is an enlarged perspective view of a portion of one of the cutting edge cavities and one of the registrant/pivot cavities used by the blade separation fixture of Figure 20.

Figure 23 is an enlarged perspective view of one of the cutting tools from the
25 wafer of Figure 12 being positioned over the cutting edge cavity and registrant/pivot cavity illustrated in Figure 22.

Figure 24 is a perspective view of another embodiment of a cutting tool that may be utilized by the microkeratome of Figure 1.

Figure 25 is a cutaway, side view of portions of a blade handle and blade used by
30 the cutting tool of Figure 24, illustrating a registrant of the blade handle engaging an edge associated with a registration cavity of the cutting blade.

Figure 26A is a schematic of the double-bevel cutting blade of Figure 3B being used by another embodiment of a microkeratome to cut an eye flap.

Figure 26B is a schematic of the cutting tool of Figure 24, having a single-bevel cutting blade in an upside-down orientation and when incorporated in the microkeratome illustrated in Figure 26A.

Figures 27A and 27B present one side-by-side comparison of the cutting blades
5 used by the microkeratomes in Figures 26A and 26B, respectively.

Figures 28A and 28B present another side-by-side comparison of the blades used by the microkeratomes in Figures 26A and 26B, respectively.

DETAILED DESCRIPTION OF THE INVENTION

10 The present invention will now be described in relation to the accompanying drawings which at least assist in illustrating its various pertinent features. A schematic of one embodiment of a microkeratome 4 that may be used to perform a LASIK procedure on a patient's eye (not shown) is illustrated in Figure 1. The microkeratome 4 generally includes a cutting head assembly 10 having a presser or applanation member 6, a cut flap
15 receiver 8, and a cutting tool receiver 12 with a cutting tool 20 disposed therein. Generally, the presser 6 pushes down on the front of the patient's eye while the cutting tool 20 is brought into engagement with and cuts a flap from the patient's eye. Cutting operations generally entail moving the cutting tool 20 in an appropriate manner relative to the patient's eye (e.g., by oscillation of the cutting tool 20 relative to the head assembly 10
20 in a direction that is parallel with a cutting edge 80 associated with the cutting tool 20 (in and out of the page in the view presented in Figure 1), as well as by a movement of the head assembly 10 in the direction of the arrow A (e.g., along a linear path; along an arcuate path). In any case, the resulting eye flap (with a portion typically still remaining attached to the patient) is then directed into the cut flap receiver 8 formed in the head
25 assembly 10 of the microkeratome 4.

There are two primary components of the cutting tool 20, namely a blade handle 24 and a cutting blade 56. The cutting blade 56 includes the above-noted cutting edge 80. This cutting edge 80 is formed on its forward end. The blade handle 24 interfaces with the cutting blade 56 so as to desirably align or register the position of the cutting edge 80
30 of the blade 56 with a microkeratome registration surface 28 of the blade handle 24 with enhanced accuracy. This microkeratome registration surface 28 in turn interfaces with a cutting tool registration surface 14 associated with the head assembly 10 of the microkeratome 4. More specifically, the cutting tool 20 is disposed within a cutting tool receiver 12 formed within the head assembly 10. A pair of support surfaces 13 of the

head assembly 10 engage corresponding portions of a bottom surface 64 of the cutting blade 54 to "vertically" support the cutting blade 54 (shown in slightly vertically spaced relation in Figure 1 for clarity), while other portions of this bottom surface 64 of the cutting blade 54 are disposed and maintained in spaced relation to the underlying portion
5 of the head assembly 10. A support 7 of the head assembly 10 also engages part of a top surface 60 of the blade 56. This support 7 of the head assembly 10 may be contoured to direct the eye flap into the cut flap receiver 8.

The microkeratome registration surface 28 of the blade handle 24 also engages the cutting tool registration surface 14 of the head assembly 10 of the microkeratome 4.
10 Because the position of the cutting edge 80 is registered relative to the microkeratome registration surface 28 of the blade handle 24, and because the position of the microkeratome registration surface 28 of the blade handle 24 is registered relative to the cutting tool registration surface 14 of the head assembly 10 of the microkeratome 4, the position of the cutting edge 80 of the blade 56 is likewise registered relative to this cutting
15 tool registration surface 14. Enhancing the accuracy of the positioning of the cutting edge 80 for a LASIK procedure is of course very desirable.

Additional views of the cutting blade 56 are presented in Figures 2A-B and 3A. The cutting blade 56 includes a top wall or surface 60 and a bottom wall or surface 64. A pair of side walls or surfaces 68 of the cutting blade 56 are laterally spaced from a central,
20 longitudinal reference axis 58 associated with the cutting blade 56. Herein, the term "laterally" spaced, extending, or the like means being at least generally in or along a direction that is perpendicular to the central, longitudinal reference axis 58 of the blade 56. Longitudinally spaced from the cutting edge 80 of the cutting blade 56 is a rear wall or surface 106. Herein, the term "longitudinally" spaced, extending, or the like means
25 being at least generally in or along a direction that is collinear with or parallel to the central, longitudinal reference axis 58 of the blade 56. Both the side surfaces 68 and the rear surface 106 extend between and interconnect the top surface 60 and bottom surface 64 of the blade 56. The distance between the top surface 60 and the bottom surface 64 thereby defines a thickness of the cutting blade 56. In one embodiment, the thickness of
30 the cutting blade 56 is within a range of about 230 microns to about 250 microns.

The rear surface 106 of the blade 56 includes a notch or recess 110 that is centrally disposed relative to the central, longitudinal reference access 58. In this regard, the rear surface 106 includes what may be characterized as a pair of first sections 112, a second section 114 that is longitudinally spaced from the first section 112 in the direction

of the cutting edge 80, and a pair of laterally spaced third sections 116 that interconnect the second section 114 with one of the first sections 112. Generally, the configuration of the rear surface 106 facilitates the removal of the cutting blade 56 from a wafer from which a plurality of cutting blades 56 may be fabricated in a batch process. This will be discussed in more detail below.

In the illustrated embodiment of the cutting blade 56: 1) each side surface 68 includes a first section 69 that extends rearwardly from the cutting edge 80 perpendicularly thereto, as well as a second section 70 that extends rearwardly from its corresponding first section 69 and at least generally toward the central, longitudinal reference axis 58; 2) the pair of first sections 112 and the second section 114 associated with the notch 110 on the rear surface 106 are all parallel with the cutting edge 80; and 3) the pair of laterally spaced (relative to the central, longitudinal reference axis 58) third sections 116 associated with the notch 110 are parallel with the central, longitudinal reference axis 58. Other configurations for the cutting blade 56 may be appropriate depending upon the application, as well as other configuration/orientations for the various parts thereof unless otherwise noted herein as being required.

A planar first cutting edge surface 72 is disposed at an angle relative to the top surface 60 of the blade 56 and intersects with this top surface 60 at an upper edge 76. The first cutting edge surface 72 extends between this upper edge 76 and the cutting edge 80 of the cutting blade 56. In the illustrated embodiment, the first cutting edge surface 72 also intersects with the bottom surface 64 of the cutting blade 56. As such, that portion of the bottom surface 64 of the cutting blade 56 that is adjacent to the cutting edge 80 and intersects with the first cutting edge surface 72 may be characterized as a second cutting edge surface 66 for the cutting blade 56. The first cutting edge surface 72 is disposed at an angle θ (Figure 3A) relative to the second cutting edge surface 66, and this may be characterized as the blade angle θ . Any appropriate blade angle θ may be utilized by the cutting blade 56 and which may depend upon the application in which the blade 56 is to be used. In one embodiment for the case of biological applications (e.g., cutting tissue, such as a human eye), the blade angle θ is preferably within a range of about 15° to about 25°.

Other options exist for defining the cutting edge 80 and the blade angle θ of the cutting blade 56. One example is presented in Figure 3B where the cutting edge 80' is defined by a second cutting edge surface 66' that is disposed at an angle relative to the bottom surface 64 of the blade 56' and that intersects with the first cutting edge surface

72'. This of course disposes the cutting edge 80' at what may be characterized as an "intermediate elevation" between the elevation of the top surface 60 and the elevation of the bottom surface 64 of the cutting blade 56'.

Features are incorporated into the structure of the cutting blade 56 for purposes of registering or aligning the cutting edge 80 to a particular position when installed on the microkeratome 4. These same features are incorporated in each cutting blade 56 so that the cutting edge 80 of each cutting tool 20 that is installed in the microkeratome 4 is registered or aligned to the same position, preferably within a tolerance of 25 microns. That is, the variance of the position of the cutting edge 80 relative to the desired position is no more than about 25 microns in any dimension for each cutting tool 20 that may be installed in the microkeratome 4. This variation principally relates to the geometry of the blade handle 24 and the adhesion of the blade handle 24 to the cutting blade 56.

The cutting blade 56 includes a pair of registration cavities 84 that interface or cooperate with the blade handle 24 in a manner so as to register or align the cutting edge 80 to the desired position when installed in the microkeratome 4. Any appropriate number of registration cavities 84 may be utilized and disposed in any appropriate position on the cutting blade 56. However, utilizing a pair of registration cavities 84 in the position of the illustrated embodiment provides a number of advantages, including facilitating parallel orientation of the blade handle 24 relative to the cutting edge 80 of the blade 56.

Both registration cavities 84 of the cutting blade 56 are identical. Only one registration cavity 84 then need be described herein. The registration cavity 84 extends through the entire thickness of the cutting blade 56 in the illustrated embodiment, although such may not be required for all applications that may utilize the blade 56 or cutting tool 20. For instance, the registration cavity 84 could be formed on the top surface 60 of the blade 56 and extend down toward, but not to, the bottom surface 64. However, preferably the "bottom" of the registration cavity 84 (more specifically a lower edge 102 of a registration wall or surface 94 associated with the registration cavity 84) and the cutting edge 80 are disposed at the same elevation or distance from the top surface 60 (measured perpendicularly to the top surface 60). In any case, the registration cavity 84 may be characterized as being at least generally concave or "upwardly open" in relation to the top surface 60 of the cutting blade 56 (e.g., accessible through the top surface 60 of the blade 56).

Each registration cavity 84 includes a front wall 92, a rear wall or registration surface 94 that is longitudinally spaced from the front wall 92, and a pair of laterally spaced side walls 88 that extend between and interconnect the front wall 92 with the registration surface 94. Generally, the front wall 92 and side walls 88 of the registration cavity 84 may be of any appropriate shape/configuration/orientation, as it is the registration surface 94 that provides the desired registration in relation to the cutting edge 80. How far the registration surface 94 and the corresponding front wall 92 should be longitudinally spaced (represented by distance "S" in Figure 8B) is at least by a distance that would allow the blade handle 24 to first be installed on the cutting blade 56, and then moved parallel with the top surface 60 of the cutting blade 56 to register or align the blade handle 24 relative to the cutting blade 56 using the registration surface(s) 94. The spacing between the side walls 88 of the registration cavities 84 may provide a "lateral" registration feature for the blade handle 24 relative to the cutting blade 56 as will be discussed in more detail below.

Registration or alignment of the cutting edge 80 relative to the microkeratome registration surface 28 of the blade handle 24, and thereby relative to the cutting tool registration surface 14 of the head assembly 10 of the microkeratome 4, is provided in the case of the cutting blade 56 by having the registration surface 94 be a planar surface that is parallel with the planar first cutting edge surface 72. That is, the registration surface 94 of each registration cavity 84 utilized by the cutting blade 56 is a planar surface that extends from an upper edge 98 (at the intersection with the top surface 60 in the illustrated embodiment) to a lower edge 102 (at the intersection with the bottom surface 64 in the illustrated embodiment) in the same orientation that the planar first cutting edge surface 72 extends from its upper edge 76 to the cutting edge 80. The lower edge 102 of each registration cavity 84 is parallel with the cutting edge 80. In the illustrated embodiment, the upper edge 76 of the first cutting edge surface 72 and the upper edge 98 of each registration surface 94 are disposed within a first reference plane that is parallel with a second reference plane, that in turn contains the cutting edge 80 associated with the first cutting edge surface 72 and the lower edge 102 of each registration surface 94 (and parallel with the top surface 60 and bottom surface 64 of the blade 56 for that matter). Moreover, the pair of registration surfaces 94 of the registration cavities 84 are disposed within a common reference plane. As such, the registration cavities 84 are disposed equidistantly from the cutting edge 80, as are their corresponding registration surfaces 94.

One preferable way to fabricate the cutting blade 56 is by using an anisotropic etch, at least for purposes of defining the first cutting edge surface 72 and the registration surface 94 of each registration cavity 84. Preferably the entire cutting blade 56 is defined by a single anisotropic etch. This allows the various structures to be very precisely positioned. For instance, the registration cavities 84 may be very precisely positioned relative to the cutting edge 80. The maximum variation in the location of the cutting edge 80 relative to the lower edge 102 of each registration cavity is about 6 microns. This variation may be influenced by a number of factors. Referring to Figure 2A, the upper edge 76 of the first cutting edge surface 72 and the upper edge 98 of each registration cavity 84 are formed to within a tolerance of 1 micron or better. This is due to the fact that they may be defined using the same photolithographic mask as will be discussed in more detail below in relation to Figures 9A-D and Figure 10. Figures 9A-D and Figure 10 are specifically directed to the fabrication of the cutting blade 56. Any variation in the location of the first cutting edge surface 72 relative to the registration surface 94 of each registration cavity 84 would be due to errors in the position of one or more of the upper edge 76 of the first cutting edge surface 72 and the upper edge 98 of each registration cavity 84, coupled with errors associated with the etch process. However, any variation in the location of the first cutting edge surface 72 relative to the registration surface 94 of each registration cavity 84 should be no more than about 2 microns. This in turn will then influence the location of the cutting edge 80 relative to the lower edge 102 of each registration cavity 84, as will the geometry of the planes that intersect to form the edges 80, 76, 98, and 102. Once again, the maximum variation between the location of the cutting edge 80 relative to the lower edge 102 of each registration cavity 84 should be no more than about 6 microns for a blade angle θ of 19 degrees that will be discussed in more detail below (e.g., 2 microns, divided by the sine of 19 degrees).

It should be appreciated that the structure of the blade 56 set forth herein is "idealized" in accordance with its corresponding blade mask as noted above, and therefore that the resulting shape of the various components of the blade 56 may not conform exactly to the illustrations provided herein. For instance, Figures 2A-B illustrate the shape of the registration cavities 84 in accordance with the blade mask. The anisotropic etch may actually produce a profile that is illustrated in Figure 2C, where a "single prime" designation again is used to identify an alternative configuration for the registration cavity 84' (along with its corresponding upper edge 98', registration surface 94', lower edge 102', side walls 88', and front wall 92').

There are a number of features of the cutting blade 56 that accommodate or relate in at least some manner to using an anisotropic etch fabrication technique for the blade 56. One that is key in relation to the above-described registration feature is that the first cutting edge surface 72 and the registration surface 94 of each registration cavity 84 should be coplanar or parallel with a common crystal plane that the selected anisotropic etchant will etch to, but not through. In one embodiment where the anisotropic etchant is KOH and where the cutting blade 56 is etched from single crystal silicon, the first cutting edge surface 72 and the registration surface 94 of each registration cavity 84 are coplanar or parallel with a plane in the {111} family of planes (which includes both the positive and negative intercepts). That is, a plane within the {111} family of planes in effect is an etch stop for the anisotropic etch. Other crystal planes could be selected for the first cutting edge surface 72 and the registration surface 94 of each registration cavity 84. However, an appropriate anisotropic etchant must of course be selected for the material being etched and the crystal plane that is to be used to define the orientation of the first cutting edge surface 72 and the registration surface 94 of each registration cavity 84 in the described manner.

Both the top surface 60 and the bottom surface 64 of the cutting blade 56 should be planar surfaces, including for purposes of accommodating using an anisotropic etchant to define the first cutting edge surface 72 and the registration surface 94 of each registration cavity 84. Flexibility in relation to the definition of the cutting edge 80, more specifically in relation to its associated blade angle θ (Figure 3A), may be realized by forming the top surface 60 and bottom surface 64 of the cutting blade 56 in a certain manner. At least one Miller index of the set of three Miller indices that define the top surface 60 and the bottom surface 64 of the cutting blade 56 should have an absolute value greater than "3" and be within the family of planes defined by the set of three Miller indices {ABC}, where "A", "B", and "C" each represent one Miller index, where at least one of the three indexes has an absolute value greater than "3", and where "A", "B", and "C" each include both the positive and negative intercepts.

Each of the side surfaces 68 of the cutting blade 56, the front wall 92 and pair of side walls 88 of each registration cavity 84, and the rear surface 106 of the cutting blade 56 may be of any orientation relative to the top surface 60 and bottom surface 64 of the blade 56. In one embodiment and for the case where the cutting blade 56 is fabricated from single crystal silicon: the front wall 92 of each registration cavity 84 and the rear surface 106 of the cutting blade 56 are both perpendicular to the top surface 60 and

bottom surface 64 of the blade 56, and further are coplanar with or parallel with a crystal plane in the {111} family of planes (including both the positive and negative intercepts); and the side surfaces 68 of the cutting blade 56 and the side walls 88 of each registration cavity 84 are not perpendicular to the top surface 60 and bottom surface 64 of the blade 56, and are not necessarily coplanar with a crystal plane in the {111} family of planes (including both the positive and negative intercepts).

Cooperation between the cutting blade 56 and the blade handle 24 of the cutting tool 20 is at least one component of registering or aligning the cutting blade 56 in a desired position relative to a patient when installed in the microkeratome 4, more specifically its cutting edge 80. Various features of the blade handle 24 are presented in Figures 4-7 for the case of the configuration of the head assembly 10 utilized by the microkeratome 4 of Figure 1. It should be appreciated that other configurations for the blade handle 24 may be required for different applications of the cutting blade 56, different types of microkeratomes 4, or different head assemblies. Moreover, not all applications of the cutting blade 56 will necessarily require an "intermediate" blade handle.

The blade handle 24 is attached or anchored to the cutting blade 56 so that there is no substantial movement therebetween. Stated another way, the blade handle 24 and the cutting blade 56 function as a single unit and move together during operation of the microkeratome 4. Any appropriate way of maintaining the blade handle 24 in a fixed relative positional relationship with the cutting blade 56 may be used, including any appropriate adhesive (e.g., an epoxy; a UV curable epoxy; an epoxy with spacing spheres), or by deforming some portion of the handle 24 by melting or heat-staking.

Features may be incorporated into the structure of the blade handle 24 for interfacing with the head assembly 10 of the microkeratome 4 or otherwise. The blade handle 24 includes a pair of laterally spaced guide rails 52 in the illustrated embodiment that are disposed along a portion of the side surfaces 68 of the cutting blade 56 (more specifically the second sections 70) when the blade handle 24 is mounted on the cutting blade 56. In one embodiment, the surface 54 of each of the guide rail 52 that projects toward the corresponding portion of the side surface 68 of the cutting blade 56 is planar and disposed in parallel relation with the corresponding portion of the side surface 68 of the cutting blade 56. Other profiles may be appropriate. There may be a space between at least a portion of this surface 54 of the guide rails 52 and their corresponding side surface 68 when the blade handle 24 is registered or aligned with the cutting blade 56.

Registration or alignment of the cutting edge 80 of the cutting blade 56 in the desired position in the microkeratome 4 utilizes the microkeratome registration surface 28 of the blade handle 24. This microkeratome registration surface 28 again interfaces with the cutting tool registration surface 14 on the head assembly 10 of the microkeratome 4.

5 Although the cutting tool registration surface 14 is disposed on the "foreword" end of the blade handle 24, it may be disposed in any appropriate position so as to cooperate with a corresponding registration surface on the head assembly 10 of the microkeratome 4.

Multiple features of the blade handle 24 relate in at least some manner to the accurate positioning of the cutting edge 80 of the cutting blade 56 relative to the blade
10 handle 24, more specifically its microkeratome registration surface 28. One is a planar bottom surface 48 of the blade handle 24 that interfaces with the planar top surface 60 of the cutting blade 56. This provides what may be characterized as a "vertical" registration feature between the blade handle 24 and cutting blade 56. Both a lateral and a longitudinal or "fore/aft" registration feature between the blade handle 24 and the cutting
15 blade 56 may be provided by the blade handle 24 including at least one registrant 32. Each registrant 32 extends or projects at least generally downwardly from the planar bottom surface 48 of the blade handle 24. A pair of registrants 32 are utilized by the blade handle 24 in the illustrated embodiment, one for each registration cavity 84 of the cutting blade 56. These registrants 32 are disposed along a common line that is parallel
20 with the cutting edge 80 of the blade 56 when the blade 56 is properly registered to the blade handle 24.

Each registrant 32 includes a peripheral wall 36 that intersects with a bottom wall 40. Four side walls or surfaces 37a-d (Figures 8A-B) define the peripheral wall 36 in the illustrated embodiment, with the side walls 37a and 37c being parallel with each other,
25 and with the side walls 37b and 37d being parallel with each other. In the illustrated embodiment, the bottom wall 40 is rectangular. These four side walls 37a-d of the peripheral wall 36 of each registrant 32 are disposed perpendicular to the bottom surface 48 of the blade handle 24 in the illustrated embodiment. Lateral registration of the blade handle 24 relative to the cutting blade 56 may be provided by the having the side walls
30 37b and 37d of each registrant 32 be spaced apart the same distance as the side walls 88 of the corresponding registration cavity 84 in which the registrant 32 is disposed. This will then dispose the side walls 37b, 37d of a given registrant 32 in interfacing or at least closely spaced relation with the corresponding side wall 88 of the corresponding registration cavity 84. Other configurations/orientations of the peripheral wall 36 for

each registrant 32 may be appropriate and provide at least a degree of lateral registration. Longitudinal registration of the blade handle 24 to the cutting blade 56 is provided by cooperation between each registrant 32 and its corresponding registration surface 94, namely that which is associated with the registration cavity 84 in which the registrant 32 is disposed.

Mounting the blade handle 24 on the cutting blade 56 may generally entail disposing an appropriate adhesive on at least one of the top surface 60 of the cutting blade 56 and the bottom surface 48 of the blade handle 24. A light curable epoxy is a particularly desirable way to attach the blade handle 24 to the cutting blade 56. Each registrant 32 on the bottom surface 48 of the blade handle 24 is then disposed within its corresponding registration cavity 84 on the cutting blade 56. Although only relative movement is required, in one embodiment the blade handle 24 is advanced toward a stationary cutting blade 56. In any case, preferably the registrants 32 are initially disposed within the corresponding registration cavity 84 so as to not contact its rear wall or registration surface 94. This may be utilized to seat the planar bottom surface 48 of the blade handle 24 on the planar top surface 60 of the cutting blade 56. The cutting blade 56 is now supporting the blade handle 24 by itself. The blade handle 24 may then be moved relative to the cutting blade 56 so as to increase the spacing between the microkeratome registration surface 28 of the blade handle 24 and the cutting edge 80 of the cutting blade 56, or stated another way so as to increase the spacing "S" between the registrant 32 of the blade handle 24 and the front wall 92 of its corresponding registration cavity 84 on the blade 56. Preferably, the bottom surface 48 of the blade handle 24 is maintained in interfacing relation with the top surface 60 of the cutting blade 56 during this movement. Stated another way, the noted relative movement between the blade handle 24 and cutting blade 56 is in a direction that is at least generally parallel with the top surface 60 of the cutting blade 56 and the bottom surface 48 of the blade handle 24. The blade handle 24 is moved relative to the cutting blade 56 in this manner until each registrant 32 cooperates with its corresponding registration surface 94, more typically a portion thereof. This then registers or aligns the cutting edge 80 of the cutting blade 56 relative to the microkeratome registration surface 28 of the blade handle 24, which in turn registers or aligns the cutting edge 80 of the cutting blade 56 in a desired position within the microkeratome 4. In one embodiment, each registrant 32 is separated from its corresponding front wall 92 by a distance of at least about 1 millimeter when the registrant 32 is interfacing with its corresponding registration surface 94.

The blade handle 24 is fixed to the cutting blade 56 when in the above-noted registered position. This emphasizes the desirability of using a light curable epoxy, including a UV curable epoxy. That is, a light curable epoxy allows the blade handle 24 to be mounted on the blade 56 in the above-noted manner so as to register the position of the blade handle 24 relative to the cutting blade 56 before the light curable epoxy sets. An appropriate light source (e.g., UV) may then be directed at the light curable epoxy to cure the same (in less than 10 seconds in the case of at least certain UV curable epoxies) and thereby fix the position of the blade holder 24 relative to the cutting blade 56. Having the position of the cutting edge 80 of the blade 56 registered relative to the microkeratome registration surface 28 of the blade handle 24 registers the position of the cutting edge 80 when installed in the microkeratome 4. Once again, the microkeratome registration surface 28 of the blade handle 24 is registered or aligned relative to the cutting tool registration surface 14 of the head assembly 10 of the microkeratome 4.

Any appropriate cooperation between a given registrant 32 of the blade handle 24 and its corresponding registration surface 94 of the cutting blade 56 may be utilized that provides the desired registration or alignment of the cutting edge 80 of the cutting blade 56 relative to the microkeratome registration surface 28 of the blade handle 24 in the longitudinal or fore-aft dimension. In one embodiment, the contact between a registrant 32 and its corresponding registration surface 94 is limited to being at least generally along a line. Stated another way, the interface between a given registrant 32 and its corresponding registration surface 94 is limited to a "line contact" in one embodiment. This may be provided in any number of manners. Three options are illustrated in Figures 8B-D. Figure 8B illustrates that the registrant 32 actually extends below the bottom surface 64 of the cutting blade 56, such that the lower edge 102 of the registration surface 94 engages a portion of the peripheral wall 36 of the registrant 32, namely the side wall 37c. Figure 8C illustrates that the lower edge 102 of the registration surface 94 engages a registrant 32' of the blade handle 24' at least generally at the intersection between the peripheral wall 36 and the bottom wall 40 of the registrant 32. Figure 8D illustrates that the intersection between the peripheral wall 36 and the bottom wall 40 of the registrant 32 engages its corresponding registration surface 94 somewhere between the lower edge 102 of the registration surface 94 and the upper edge 98 of this registration surface 94. Preferably, the registrant 32 interfaces with its corresponding registration surface 94 closer to the lower edge 102 than its upper edge 98, and including at the intersection

between the bottom surface 64 of the blade 56 and the corresponding registration surface 94.

Standard semiconductor processing techniques may be utilized to fabricate the cutting blade 56 of the cutting tool 20. One significant advantage of using this technique is the accuracy with which the cutting blade 56 may be fabricated, particularly the accuracy of the position of the cutting edge 80 relative to the position of the registration surface 94 of each registration cavity 84 of the cutting blade 56. Figures 9A-D illustrate a number of steps in one method by which the cutting blade 56 may be fabricated using standard semiconductor processing techniques. Initially, a suitable material is selected for the fabrication of the cutting blade 56. Suitable materials for fabrication of the cutting blade 56 using the process described herein include without limitation single crystal silicon, single crystal quartz, and potentially other single crystal material having suitable crystal-plane selective etchants. Those materials that are suitable for fabrication of the cutting blade 56 generally are those that may be etched so that the etch will stop at a predetermined place/position within the material (e.g., at a particular crystal plane within the same material, that in effect acts as an etch stop), and further where the same etch behavior exists regardless of the location of the opening in the mask being utilized for the etch. Regarding the latter characterization, the material must be such that a particular etchant will behave the same anywhere within the material that is to be etched. It is really the combination of the material and the selected etchant that allows the etchant to anisotropically etch the material in the desired manner to define the cutting blade 56.

The material from which the cutting blade 56 is fabricated in accordance with Figures 9A-D generally may be characterized as a substrate 130, and will more typically be in the form of a wafer 130. It should be appreciated that wafers that are "commonly available" for the fabrication of semiconductor devices (e.g., silicon wafers having top and bottom surfaces parallel with either the (110) and (100) crystal planes) may not be suitable in relation to defining the desired blade angle θ for one or more applications of the cutting blade 56. In any case, masking layers 118, 126 are defined on an upper surface 134 and a lower surface 138, respectively, of the wafer 130 using conventional semiconductor processing techniques. This is illustrated in Figure 9A. The masking layers 118, 126 may be formed on the corresponding surface 134, 138 of the wafer 130 in any appropriate manner (e.g., chemical vapor deposition, physical vapor deposition, or thermal growth in the case of silicon dioxide on silicon). Any material that may be

patterned for a subsequent selective etching of the wafer 130 may be utilized by the masking layers 118, 126 (e.g., silicon nitride, silicon oxide).

What may be characterized as a blade mask is transferred onto the upper masking layer 118 in a manner known in the art for purposes of defining the cutting blade 56 and as illustrated in Figures 9B-C. Multiple masking layer openings or apertures 122a-c are formed on the upper masking layer 118 to define each cutting blade 56 that is to be fabricated from the wafer 130. These masking layer apertures 122a-c extend entirely through the upper masking layer 118 to expose desired, selective portions of the upper surface 134 of the wafer 130. Any appropriate technique may be utilized for transferring the blade mask onto the upper masking layer 118, including photomasking, masking, photolithography, microlithography, which is then followed by a suitable technique of etching the pattern into the upper masking layer 118 by means of wet chemical etching, plasma etching, reactive ion etching, or ion beam milling. The creation of the hard mask can also be accomplished using a dual step process of using the photoresist to define the pattern into an intermediate layer of silicon dioxide. Once the photoresist is stripped, the silicon dioxide is then used as an etch mask layer to define the silicon nitride by means of hot phosphoric acid.

The masking layer aperture 122a is sized and configured to define the first cutting edge surface 72 of the cutting blade 56 and the perimeter of the cutting blade 56 (the cutting edge 80, side surfaces 68, and rear surface 106). Each masking layer aperture 122b is "interiorly" disposed (inwardly of what will ultimately be the perimeter of the cutting blade 56) and is sized and configured to define a registration cavity 84 for the cutting blade 56. A masking layer aperture 122c is also formed through the upper masking layer 118 to define a score or score line within the wafer 130 to facilitate the removal of the cutting blade 56 from the wafer 130 after the blade 56 has been fabricated by an anisotropic etch (identified by reference numeral 132 in Figures 12 and 13A). This score need not, but may, pass through the entire vertical extent of the wafer 130.

No portion of the lower surface 138 of the wafer 130 needs to be patterned to fabricate the cutting blade 56 from the wafer 130. As such, no portion of the lower surface 138 needs to be exposed to an etchant for the fabrication of the cutting blade 56. However, a masking layer opening or aperture would be formed in the lower masking layer 126 in order to define the second cutting edge surface 66' of the cutting blade 56' of Figure 3B.

After the upper masking layer 118 (and lower masking layer 126 if required by the desired cutting edge configuration) has been processed to define the desired configuration for the cutting blade 56 and the various individual surfaces thereof, the wafer 130 is exposed to a suitable etchant. One way to execute the desired etching operation is to
5 dispose the wafer 130 in an etchant bath. In any case, those portions of the upper surface 134 of the wafer 130 that are exposed to the etchant will have material removed to define the configuration illustrated in Figure 9D, which corresponds with the cutting blade 56. The etchant simultaneously defines the first cutting edge surface 72 and the registration surface 94 of each registration cavity 84 utilized by the blade 56, and also defines the
10 perimeter of the cutting blade 56. A small portion of the cutting blade 56 remains attached to the wafer 130 in the form of a blade support tab at this time (see Figure 12 to be discussed below, where this blade support tab is identified by reference numeral 131). This blade support tab is disposed under the portion of the upper mask 118 identified by reference numeral 119 in Figure 9C. The etchant also etches at least partially through
15 the wafer 130 through the mask aperture 122c to define a score (see Figure 12 to be discussed below, where this score is identified by reference numeral 132). Generally, the cutting blade 56 is thereafter separated from the remainder of the wafer 130 by fracturing or breaking the wafer 130 along this score.

As noted above, an anisotropic etchant is utilized to fabricate the cutting blade 56.
20 The anisotropic etchant simultaneously forms the first cutting edge surface 72 and the registration surface 94 of each registration cavity 84 as planar, parallel surfaces. This is done by selecting an anisotropic etchant that will in effect stop etching when reaching a certain crystal plane that defines the desired orientation for the first cutting edge surface 72 relative to the top surface 60 of the cutting blade 56. Generally, the material defining
25 the wafer 130 and the selected etchant must be such that the behavior of the etchant is the same, regardless of the location of any mask aperture in the upper masking layer 118 (or the lower masking layer 126 for that matter). For the case of the wafer 130 being single crystal silicon and the first cutting edge surface 72 and the registration surface 94 of each registration cavity 84 being parallel with a {111} crystal plane, an appropriate anisotropic
30 etchant for simultaneously defining the first cutting edge surface 72 and each registration surface 94 is KOH. That is, the KOH etchant will etch to, but not through, the first (111) crystal plane that is disposed under the edge of the upper masking layer 118 (corresponding with the upper edge 76 and the upper edge 98).

Fabricating the cutting blade 56 in the above-noted manner provides a number of advantages. Initially, the position of the cutting edge 80 relative to the position of each registration surface 94 can be done with a very high degree of accuracy due to the high degree of accuracy with which mask apertures can be formed in a mask in accordance with the foregoing. Moreover, the first cutting edge surface 72 is simultaneously formed with the registration surface 94 of each registration cavity 84, and this is done so that the cutting edge surface 72 and the registration surface 94 of each registration cavity 84 are disposed in parallel relation to a high degree of accuracy. As noted above, the anisotropic etch will proceed to the same exact crystal plane when defining each of the first cutting edge surface 72 and the registration surface 94 of each registration cavity 84. The etch will then have the same effect on both the first cutting edge surface 76 and the registration surface 94 of each registration cavity 84. Each of these factors contributes to being able to enhance the precision with which the cutting edge 80 of the blade 56 is disposed relative to a particular structure.

Figure 10 depicts one embodiment of a protocol 140 for fabricating one or more cutting blades 56 from the wafer 130. This protocol 140 utilizes the basic steps/results that are illustrated in Figures 9A-D. Step 142 of the protocol 140 is directed to forming a masking layer on a wafer (e.g., wafer 130). In the illustrated embodiment, what is commonly referred to in the art as a "hard mask" will ultimately be formed from this particular masking layer. Silicon nitride is used for the masking layer by step 142, although other materials may be appropriate. Any appropriate way of forming the silicon nitride masking layer on the wafer may be utilized by step 142.

A first photoresist layer is formed on the silicon nitride masking layer in accordance with step 146 of the protocol 140. Either a positive-acting or negative-acting photoresist material may be used by step 146. Any appropriate way of forming the first photoresist layer on the silicon nitride masking layer may be utilized by step 146. What may be characterized as an alignment slot mask is then transferred onto the first photoresist layer through execution of step 150. Generally, this alignment slot mask is used to define certain structures on the wafer to thereafter align what may be characterized as a "blade mask" to the wafer in a certain manner, more specifically to align the blade mask to a certain crystal orientation associated with the wafer. This "blade mask" is that which has a layout of masking layer openings extending therethrough such that selected portions of the wafer will be etched in a manner so as to simultaneously fabricate/define a plurality of cutting blades 56.

Step 154 of the protocol 140 indicates that the first photoresist layer is developed in accordance with the alignment slot mask to create a plurality of openings that extend completely through the first photoresist layer in a layout that will be discussed in more detail below in relation to Figure 11. "Developing" the first photoresist layer includes
5 both exposing portions of the first photoresist layer to an appropriate type of light (either that portion of the first photoresist material that is to be removed in the case of a positive-acting photoresist material, or that portion of the first photoresist layer that is to remain in the case of a negative-acting photoresist material), and thereafter exposing the "light treated" first photoresist layer to an appropriate developer to remove portions of the first
10 photoresist layer in accordance with the alignment slot mask. Openings in accordance with the desired/required layout are formed through the entire vertical extent of the first photoresist layer to expose the underlying silicon nitride masking layer.

Appropriate openings are next etched through the entire vertical extent of the silicon nitride masking layer in accordance with step 158 of the protocol 140. The layout
15 of these openings is in accordance with the openings in the first photoresist layer, and thereby in accordance with the alignment slot mask. In one embodiment, a reactive ion etch is used to define the openings in the silicon nitride masking layer in the layout required by the alignment slot mask. Other types of etches may be appropriate. In any case, this then exposes selected portions of the upper surface of the underlying wafer.
20 The first photoresist layer is then stripped (step 162) from the now patterned silicon nitride masking layer, and another etch is initiated to form alignment slots that extend within, but typically not through, the wafer. In one embodiment, the etch from step 166 of the protocol 140 is a KOH etch. Other etches may be appropriate. The etch from step 166 reaches the wafer through the openings in the silicon nitride masking layer associated
25 with step 158 of the protocol 140, and thereby in accordance with the alignment slot mask of step 150.

The alignment slots on the wafer formed in accordance with steps 146-166 of the protocol 140 are analyzed to determine which alignment slot(s) is suitably aligned with a particular crystal orientation associated with the wafer. This is represented by step 170 of
30 the protocol 140 of Figure 10. The alignment slot(s) that are aligned with a particular crystal orientation associated with the wafer are then identified (step 174 of the protocol 140) for subsequent use in aligning/orienting the blade mask to the wafer.

Figure 11 illustrates one way in which the alignment slots referred to by the protocol 140 of Figure 10 may be formed on the wafer 130 to orient the blade mask

relative to the wafer 130. The wafer 130 includes a flat 206 that is disposed at the 6:00 o'clock position. A reference axis 218 extends from the 3:00 o'clock position to the 9:00 o'clock position, through a center 212 of the wafer 130. Generally, a plurality of alignment slots 210a-k are formed on one side of the wafer 130, while a plurality of alignment slots 214a-k are formed on an opposite side of the wafer 130. Any number of alignment slots 210a-k, 214a-k may be utilized. The alignment slot 210a corresponds with the alignment slot 214a, the alignment slot 210b corresponds with the alignment slot 214b, and so forth. Corresponding alignment slots 210a-k/214a-k are disposed along a common axis that extends through the center 212 of the wafer 130. That is, the alignment slots 210a, 214a are positioned along a common axis that extends through the center 212 of the wafer 130, the alignment slots 210b, 214b are positioned along a common axis that extends through the center 212 of the wafer 130, and so forth. The axes along which corresponding slots 210a-k, 214a-k are disposed are preferably equally spaced about the center 212 of the wafer 130. That is, the axis along which the alignment slots 210b, 214b are disposed is rotated counterclockwise a predetermined amount from the axis along which the slots 210a, 214a are disposed, the axis along which the alignment slots 210c, 214c are disposed is rotated counterclockwise this same predetermined amount from the axis along which the slots 210b, 212b are disposed, and so forth.

The alignment slots 210a-k, the alignment slots 214a-k, or both may be analyzed to identify which corresponding pair of alignment slots (e.g., (210a, 214a); (210b, 214b); (210c, 214c), etc) may be used to align the blade mask to the wafer 130 for purposes of step 182 of the protocol 140 of Figure 10. This analysis may be done in any appropriate manner, including optically. This analysis is undertaken pursuant to step 170 of the protocol 140 of Figure 10 that was discussed above. Generally, the alignment slot 210a-k that is narrowest or of the smallest width ("width" being the dimension that is perpendicular to its length dimension, which is along a radius extending from the center 212 of the wafer 130) is that which is most closely aligned with a predetermined crystal plane of the wafer. The same is true for the alignment slots 214a-k.

Once a corresponding pair of alignment slots 210, 214 has been identified as being suitably aligned with a predetermined crystal plane of the wafer (if one alignment slot 210 is identified, its corresponding alignment slot 214 will also be of the narrowest width from the group of alignment slots 214a-k, and vice versa), this pair of alignment slots 210, 214 is "selected" as noted by step 174 of the protocol 140 of Figure 10. That is, the location of this particular pair of alignment slots 210, 214 is noted such that alignment

marks on the blade mask may be aligned thereto in accordance with step 182 of the protocol 140. More specifically, a second photoresist layer is formed on the silicon nitride masking layer in accordance with step 178 of the protocol 140 and in any appropriate manner. Either a positive-acting or negative-acting photoresist again began
5 may be utilized. In any case, the blade mask is aligned with the selected alignment slots in accordance with step 182 of the protocol 140, and the blade mask is thereafter transferred onto the second photoresist layer in accordance with step 186. The blade mask is such that the alignment slots 210a-k, 214a-k will not interfere with the fabrication of the individual cutting blades 56 (e.g., the alignment slots 210a-k, 214a-k are disposed
10 beyond the region of the wafer on which cutting blades 56 are fabricated).

Step 190 of the protocol 140 indicates that the second photoresist layer is developed in accordance with the blade mask to create openings that extend completely through the second photoresist layer. "Developing" the second photoresist layer includes both exposing portions of the second photoresist layer to an appropriate type of light
15 (either that portion of the second photoresist material that is to be removed in the case of a positive-acting photoresist material, or that portion of the second photoresist layer that is to remain in the case of a negative-acting photoresist material), and thereafter exposing the "light treated" second photoresist layer to an appropriate developer to remove the desired portions of the second photoresist layer. Openings in accordance with the
20 desired/required layout are formed through the entire vertical extent of the second photoresist layer to expose the underlying silicon nitride masking layer.

Appropriate openings in accordance with the blade pattern are next etched through the entire vertical extent of the silicon nitride masking layer pursuant to step 194 of the protocol 140. The layout of these openings is in accordance with the openings in the
25 second photoresist layer, and thereby in accordance with the blade mask. In one embodiment, a reactive ion etch is used to define these openings in the silicon nitride masking layer required by the blade mask. Other types of etches may be appropriate. In any case, this then exposes selected portions of the upper surface of the underlying wafer. The second photoresist layer is then stripped (step 198) from the now patterned silicon
30 nitride masking layer, and another etch is initiated through step 202 of the protocol 140. This particular etch defines the various blades 56 that are included in the blade mask associated with step 186 of the protocol 140, and the result of which corresponds with Figure 9D. In one embodiment, the etch of step 202 is a KOH etch. Other etches may be appropriate.

Any number of blades 56 may be simultaneously fabricated in accordance with the protocol 140 of Figure 10, depending of course on the size of the blades 56 and the size of the wafer 130 from which the blades 56 are fabricated. One blade pattern that may be utilized by the protocol 140 results in the layout illustrated in Figure 12. Here, a number of rows and columns of blades 56 have been fabricated on the wafer 130 utilizing the protocol 140 of Figure 10. Each blade 56 remains attached to the wafer 130 by at least one blade support tab 131 of the wafer 130 at this point in time (more than one blade support tab 131 could be provided for each blade 56, and the blade support tab(s) 131 for a particular blade 56 may be disposed at any appropriate location along the perimeter of the corresponding blade 56). This is the only "interconnection" between each blade 56 and the wafer 130 at this time, and which is the result of the etch of step 202 of the protocol 140. All portions of the wafer 130 other than the blades 56 and their corresponding blade support tabs 131 may be characterized as a frame or skeleton 128 of the wafer 130 (e.g., a remainder). As such, a blade 56 may be characterized as being attached to its blade support tab 131, that in turn is attached to the frame 128.

Referring now to Figures 12 and 13A-B and as previously noted, a score 132 is formed on each blade support tab 131 to facilitate the removal of the corresponding blade 56 from the remainder of the wafer 130 in a manner that will be discussed in more detail below. Any appropriate number of scores 132 could be used in relation to each blade support tab 131. Each score 132 may, but preferably does not, extend through the entire vertical extent of the wafer 130. In one embodiment, the depth of each score 132 is within a range of about 2% to about 75% of the thickness of the wafer 130. In another embodiment, the depth of each score 132 is on the order of about 10-30 microns, where the thickness of the wafer 130 is about 240 microns.

A pair of planar score surfaces 133a, 133b intersect at a location identified by reference numeral 133c in Figure 13B (hereafter "intersection 133") to define the corresponding score 132 in the illustrated embodiment (e.g., a V-shaped configuration). The planar score surfaces 133a, 133b may each be disposed in any appropriate angular orientation. In the illustrated embodiment, the planar score surface 133a is parallel with the cutting edge surface 72, while the planar score surface 133b is perpendicular to the top surface 60 and bottom surface 64 of the blade 56. Other configurations may be appropriate for the score 132 and yet still facilitate separation of the cutting blade 56 from the wafer 130 in a desired manner.

It should be noted that the score 132 associated with each blade 56 preferably does not extend across the entire lateral extent of its corresponding blade support tab 131. That is, each score 132 preferably does not extend up to and intersect with that portion of the second section 114 of the notch 110 that is defined by the etch associated with step 202 of the fabrication protocol 140 of Figure 10. One benefit of this preferred configuration is that it enhances the structural integrity of the blade support tabs 131. Stated another way, having each score 132 extend all the way across its corresponding blade support tab 131 could possibly weaken the interconnection between the blade support tab 131 and its corresponding blade 56. That is, in a situation where the score 132 did extend across the entire lateral extent of the blade support tab 131 (not shown), the etch associated with step 202 of the fabrication protocol 140 of Figure 10 may further reduce the lateral extent of that end of the blade support tab 131 that interfaces with its corresponding blade 56. This could weaken the "joint" between the blade support tab 131 and its corresponding blade 56 to the point of being susceptible to premature separation of the corresponding cutting blade 56 from the remainder of the wafer 130. The depth of the score 132 may also of course have an effect on the structural integrity of the blade support tab 131, or stated another way on the ability for the blade 56 to remain attached to the wafer 130, including while mounting a blade handle 24 thereon. In one embodiment, a portion of the blade support tab 131 is disposed beyond each end of the score 132 such that the score 132 does not extend across the entire width or lateral extent of the blade support tab 131, and the score 132 is about 2%-5% of the thickness of the blade 56. This provides sufficient structural integrity for the blade 56 to remain attached to the wafer 130 during handling and while mounting the handle 24 on the blade 56, and yet still facilitates separation of the blade 56 from the wafer 130 at least substantially along the score 132 at the desired time.

The configuration of the blade support tab 131, the location of the score 132 along the blade support tab 131, or both also may have an influence on how the fracture occurs. In one embodiment, the score 132 is disposed along the length dimension of the blade support tab 131 at a location where the blade support tab 131 is of its minimum width (e.g., so that the shape of the blade support tab 131 acts as a stress concentrator, to cause the greatest stress to occur at the location of its corresponding score(s) 132 to further facilitate the fracture). The blade support tab 131 may be shaped to generate the greatest stress at the location of the corresponding score(s) 132 to further facilitate the fracture.

There are a number of other characteristics of note in relation to the scores 132. Initially, each score 132 is preferably aligned with a crystallographic plane such that the separation of the blades 56 occurs at least substantially along a crystallographic plane, and in one embodiment the intersection 133c of the planar score surfaces 133a, 133b of a given score 132 is aligned with a crystallographic plane. Moreover, preferably each score 132 is parallel with its corresponding cutting edge 80. Another is that the scores 132 are longitudinally offset from their corresponding first sections 112 of the rear surface 106 of the corresponding blade 56. That is, the scores 132 are "longitudinally recessed" relative to the rear edge of the corresponding cutting blade 56. Other configurations of the rear surface 106 of the blade 56 may be utilized and still provide this "longitudinally recessed" feature. That is, what is of importance is that the score 132 be positioned at a location that is longitudinally recessed from a most rearwardly disposed portion of the rear surface 106 of the blade 56. Stated another way, the score 132 is preferably disposed closer to the cutting edge 80 than the most rearwardly disposed portion of the rear surface 106 of the blade 56 (both measured along/parallel to the central, longitudinal reference axis 58 associated with the blade 56). This may be of benefit if one or more sharp edges develops during the separation of the blade 56 from the wafer 130 at least generally along its corresponding score 132.

Separation of the cutting blade 56 from the remainder of the wafer 130 utilizing the score 132 produces the configuration that is illustrated in Figure 13C. Locations A and B correspond with the locations where the blade support tab 131 had previously merged with the cutting blade 56. It can be seen that the planar score surface 133b of the score 132 has become part of the cutting blade 56. This also illustrates the preferred approach where the score 132 and the portion of the second section 114 of the notch 110 on the opposite sides thereof are both defined by an etch, and thereby are similarly shaded. In contrast, the region that is bounded by the pair of dashed lines, and further that does not include planar score surface 133b, is defined by fracturing the wafer 130. Reference numeral 133d identifies this fracture region and utilizes a different shading than the surfaces defining the planar score surface 133b and the second section 114. The fracture region 133d is longitudinally spaced from the rear-most portion of the cutting blade 56. In one embodiment, the fracture region 133d is coplanar with the second section 114, and may be considered as part thereof. In another embodiment, the fracture region 133d is parallel to, but longitudinally offset from, the second section 114 of the

blade 56 (not illustrated). In this latter instance, the fracture regions 133d desirably still does not define the most rearwardly disposed portion of the cutting blade 56.

As noted above, there may be some variation between the blade mask and the resulting configuration of the blade 56 when etched from the wafer 130. For instance, Figure 13D includes a reference numeral 57a that represents the blade mask perimeter profile for the blade 56. The entire blade mask perimeter profile 57a for a blade 56 is illustrated in Figure 13D, as well as a portion of its corresponding blade support tab 131. Reference numeral 57b in Figure 13D represents an actual perimeter profile of a blade 56 when fabricated from the wafer 130 by an anisotropic etch. That is, the actual perimeter profile 57b is that which is actually achieved when using an anisotropic etch from a blade mask have the blade mask perimeter profile 57a. Only a portion of the actual perimeter profile 57b is illustrated in Figure 13D for convenience.

Blades 56 are separated from the remainder of the wafer 130 generally by first mounting a blade handle 24 on an individual cutting blade 56 in the above-noted manner so as to properly register the blade handle 24 to the cutting blade 56. Once the adhesive has cured an appropriate amount or once the blade handle 24 is otherwise sufficiently fixed to an individual blade 56, the blade handle 24 is moved (e.g., manually) relative to the wafer 130 so as to cause the wafer 130 to fracture along its corresponding score 132. In the illustrated embodiment, blade handles 24 are attached to each of the individual blades 56 on a wafer 130 while in a blade handle mounting fixture 224 (Figures 14-19). The wafer 130 with the blade handles 24 mounted on its various blades 54 is then transferred to a blade separation fixture 300 where the individual blades 56, with a blade handle 24 mounted thereon, are separated from the remainder of the wafer 130 (Figures 20-23).

Figures 14-19 illustrate a desirable configuration for allowing blade handles 24 to be mounted on individual cutting blades 56 while still attached to and thereby part of the wafer 130. A base plate 220 is appropriately attached to a bottom surface 278 of a blade handle mounting fixture 224. One or more appropriate fasteners (not shown) are directed through mounting holes 222 in the base plate 220 and into mounting holes 296 formed on the bottom surface 278 of the blade handle mounting fixture 224. Any appropriate way of interconnecting the base plate 220 with the blade handle mounting fixture 224 may be utilized.

The base plate 220 generally cooperates with the blade handle mounting fixture 224 to define a vacuum chamber 284 (Figure 17). More specifically, an annular groove

288 is defined on the bottom surface 278 of the blade handle mounting fixture 224. An annular seal ring 292 is disposed within this annular groove 288 and seats against an annular portion of a inner surface 223 of the base plate 220 that projects toward or faces the bottom surface 278 of the blade handle mounting fixture 224. The perimeter of the vacuum chamber 284 thereby corresponds with the annular seal ring 292, while the top and bottom of the vacuum chamber 284 are defined by the bottom surface 278 of the blade handle mounting fixture 224 and the inner surface 223 of the base plate 220, respectively.

A vacuum is generated within the noted vacuum chamber 284 by fluidly interconnecting a vacuum pump or the like (not shown) to a vacuum pull-down port 276 associated with the blade handle mounting fixture 224. This vacuum pull-down port 276 extends within the body of the fixture 224 and intersects with a vacuum linking port 280. This vacuum linking port 280 is disposed inwardly of the annular seal ring 292 and intersects with the bottom surface 278 of the fixture 224 so as to be fluidly interconnected with the vacuum chamber 284. A plurality of vacuum holes 268 are also disposed inwardly of the annular seal ring 292 so as to interface with the vacuum chamber 284. These vacuum holes 268 extend from the bottom surface 278 of the blade handle mounting fixture 224 to an upper surface 228 of the fixture 224 on which the wafer 130 is disposed.

The upper surface 228 of the blade handle mounting fixture 224 is configured to suitably support the wafer 130 and maintain the same in a fixed position while installing the blade handles 24 on the individual blades 56 when still part of the wafer 130. Generally, less than the entirety of the lower surface 138 of the wafer 130 is in actual contact with the upper surface 228 of the fixture 224. Moreover, the upper surface 228 of the fixture 224 is configured so as to reduce the potential for damage to the cutting edge 80 of each blade 56 while mounting the blade handles 24 on the individual blades 56 the wafer 130. The upper surface 228 of the fixture 224 is also configured so as to allow the bottom surface 48 of each blade handle 24 to properly seat on the top surface 60 of its corresponding blade 56 (e.g., so as to be in interfacing relation, or at least in closely spaced and parallel relation). When adhesives are used, there will of course be a bond line between the blade handle 24 and the blade 56. Finally, the blade 56 itself is directly supported by the fixture 224 (in one embodiment in coplanar relation with non-blade portions of the wafer 130 and including at least part of the above-noted frame 128),

preferably in a manner such that the net moment about the corresponding score 132 is zero (i.e., no torque) when mounting a blade handle 24 on the cutting blade 56.

The upper surface 228 of the blade handle mounting fixture 224 includes a recess 232 having a base 236 that is vertically offset from an annular perimeter portion 230 of the upper surface 228. This base 236 includes a planar wafer supporting surface 238, a plurality of cutting edge cavities 244, and a plurality of registrant cavities 256. An annular side wall 240 of the recess 232 extends from the lower elevation wafer supporting surface 238 of the base 236 of the recess 232 to the higher elevation annular perimeter portion 230 of the upper surface 228 of the fixture 224. This annular side wall 240 at least substantially approximates a perimeter of the wafer 130. Preferably, the annular side wall 240 and the perimeter of the wafer 130 are disposed in closely spaced relation (e.g., such that there is no more than about a 1 millimeter gap between any portion of the annular side wall 240 and a corresponding portion of the perimeter of the wafer 130).

At least one notch 272 is formed on the upper surface 228 of the blade handle mounting fixture 224. Each notch 272 has a base 274 that is vertically offset from the wafer supporting surface 238 of the base 236 of the recess 232. The base 274 of each notch 272 is disposed at a lower elevation than the wafer supporting surface 238 of the base 236 of the recess 232. There is thereby a space between the wafer 130 and the base 274 of each notch 272. This space facilitates installation of the wafer 130 within the recess 232 of the blade handle mounting fixture 224, as well as the removal of the wafer 130 from the blade handle mounting fixture 224. Both manual (e.g., human operator) and a machine(s) are contemplated for one or both of the installation and removal of the wafer 130 relative to the blade handle mounting fixture 224.

Multiple features are incorporated in the configuration of the base 236 of the recess 232 that is formed on the upper surface 228 of the blade handle mounting fixture 224 for receipt of the wafer 130. One is that the various vacuum holes 268 intersect with the base 236 of the recess 232. Preferably these vacuum holes 268 intersect with the wafer supporting surface 238 of the base 236 of the recess 232 (Figure 16). The wafer supporting surface 238 interfaces with the lower surface 138 of the wafer 130 to vertically support the wafer 130 while on the fixture 224. When the wafer 130 is disposed within the recess 232, a vacuum is pulled through the various vacuum holes 268 against the overlying wafer 130, through the vacuum chamber 284, through the vacuum linking port 280, and through the vacuum pull-down port 276 by an appropriate source. Suction forces thereby retain the lower surface 138 of the wafer 130 against the planar wafer

supporting surface 238 of the base 236 of the recess 232. Exactly how the suction or vacuum force is generated and transferred to the wafer 130 to retain the same against the fixture 224 is not of particular importance. Other configurations may be utilized to generate this type of retention force for the wafer 130 on the fixture 224.

- 5 Another feature of the base 236 of the recess 232 formed on the upper surface 228 of the blade handle mounting fixture 224 is that it includes multiple cutting edge cavities 244. Each cutting edge cavity 244 is defined by a base 248 that is vertically spaced from the wafer supporting surface 238, and a side wall 252 that extends from the lower elevation base 248 to the higher elevation wafer supporting surface 238 (e.g., Figure 18).
- 10 In the illustrated embodiment, at least part of the side wall 252 of each cutting edge cavity 244 is disposed in perpendicular relation to the adjacent portion of the wafer supporting surface 238 of the base 236 of the recess 232. Any appropriate orientation of the side wall 252 of the various cutting edge cavities 244 may be utilized.

- What is of principal importance in relation to each cutting edge cavity 244 is that
- 15 they be sized and oriented on the upper surface 228 of the fixture 224 such that the cutting edge 80 of each blade 56 will be disposed over one of the cutting edge cavities 244 when the wafer 130 is disposed within the recess 232 of the fixture 224. That is, the cutting edge 80 of each blade 56 is disposed in vertically spaced relation to the blade handle mounting fixture 224. Preferably, the cutting edge 80 of each blade 56 never
- 20 contacts the fixture 224 while the wafer 130 is positioned thereon. In the illustrated embodiment, a given cutting edge cavity 244 accommodates the cutting edge 80 for multiple blades 56. More specifically, a plurality of the cutting edge cavities 244 are disposed in equally spaced rows along the base 236 of the recess 232. A given cutting edge cavity 244 accommodates all of the blades 56 in a corresponding row on the wafer
- 25 130 (i.e., provides a space below the cutting edge 80 of each blade 56 in a given row on the wafer 130) in the illustrated embodiment. It should be appreciated that the base 236 of the recess 232 could be configured such that the cutting edge 80 of each individual blade 56 has its own individual cutting edge cavity 244 (not shown).

- Multiple registrant cavities 256 are also formed on the base 236 of the recess 232
- 30 of the blade handle mounting fixture 224. Generally, these registrant cavities 256 are sized so that the registrants 32 on the bottom surface 48 of the blade handle 24 do not contact the fixture 224 while mounting a blade handle 24 on a particular cutting blade 56. Each registrant cavity 256 is defined by a base 260 that is vertically spaced from wafer supporting surface 238, and a side wall 264 that extends from the lower elevation base

260 to the higher elevation wafer supporting surface 238 (e.g., Figure 18). In the illustrated embodiment, at least part of the side wall 264 of each registrant cavity 256 is disposed in perpendicular relation to the adjacent portion of the wafer supporting surface 238 of the base 236 of the recess 232. Any appropriate orientation of the side wall 264 of the various registrant cavities 256 may be utilized.

What is of principal importance in relation to each registrant cavity 256 is that they be sized and oriented on the upper surface 228 of the blade handle mounting fixture 224, such that each registration 84 of each blade 56 will be disposed over one of the registrant cavities 256 when the wafer 130 is disposed within the recess 232 on the fixture 224. More specifically, each registrant cavity 256 should be sized and oriented on the upper surface 228 of the fixture 224 such that a registrant cavity 256 is disposed below each registrant 32 of each blade handle 24 to keep the bottom wall 40 of each registrant 32 of each blade handle 24 in vertically spaced relation to the blade handle mounting fixture 224. In the illustrated embodiment, some registrant cavities 256 (those on an end of a row of registrant cavities 256) accommodate a single registrant 32 from a single blade handle 24, while other registrant cavities 256 accommodate a registrant 32 from a pair of blade handles 24 mounted on adjacently disposed blades 56 within a given row on the wafer 130. Although a plurality of rows of registrant cavities 256 could be utilized and spaced such that a given single registrant cavity 256 accommodated the registrant 32 of each blade handle 24 mounted on all of the blades 56 within a given row on the wafer 130 (not shown), the illustrated configuration is advantageous in relation to how the wafer 130 is supported by the fixture 224 for installation of the blade handles 24.

Appropriate support of the wafer 130 is provided by the illustrated configuration of the blade handle mounting fixture 224 when installing the blade handles 24 on the individual blades 56 that are still attached to and part of the wafer 130. Portions of the wafer supporting surface 238 that are disposed under, interface with, and support the representative blade 56 illustrated in Figure 19, are shown by the dashed lines in Figure 19. In this regard, each blade 56 of the wafer 130 is supported by the blade supporting surface 238 of the fixture 224 across the entire width of the blade 56 over a region that is spaced back from its cutting edge 80, which again is disposed over one of the cutting edge cavities 244 so as to be spaced from the fixture 224. Each blade 56 is also supported by the blade supporting surface 238 of the fixture 224 across the entire width of the blade 56 at or toward the rear of the blade 56 (e.g., proximate the rear surface 106). Finally, the blade 56 is also supported by the blade supporting surface 238 of the fixture 224 under its

corresponding blade support tab 131 and along a longitudinally extending region between the registrant cavities 84. Therefore, the blades 56 do not tend to deflect downwardly a significant degree when installing blade handles 24 on the blades 56 at a time when these blades 56 are still attached to and part of the wafer 130. As noted above, preferably the
5 blade 56 itself is directly supported by the fixture 224 (in one embodiment in coplanar relation with non-blade portions of the wafer 130), in a manner such that the net moment about the corresponding score 132 is zero (i.e., no torque) when mounting a blade handle 24 on the cutting blade 56.

Summarizing the manner in which blade handles 24 are mounted on the blades 56,
10 the wafer 130 with the blades 56 formed thereon is disposed within the recess 232 of the blade handle mounting fixture 224 in the manner illustrated in Figure 14. A vacuum is drawn so as to retain portions of the wafer 130 against the wafer supporting surface 238 associated with the fixture 224. An appropriate adhesive may be applied on at least one of the top surface 60 of one or more of the cutting blades 56 and the bottom surface 48 of
15 a corresponding number of blade handles 24. Each registrant 32 on the bottom surface 48 of a particular blade handle 24 is then disposed within a corresponding registration cavity 84 on a particular blade 56 by moving the blade handle 24 toward the fixture 224. Preferably, the registrants 32 of this blade handle 24 are initially disposed within the corresponding registration cavity 84 of the particular blade 24 so as to not contact its rear
20 wall or registration surface 94. This may be utilized to seat the planar bottom surface 48 of the blade handle 24 on the planar top surface 60 of the cutting blade 56. The blade handle 24 may then be moved generally rearwardly until each registrant 32 cooperates with its corresponding registration surface 94, more typically a portion thereof. This then registers or aligns the cutting edge 80 of the particular cutting blade 56 relative to the
25 microkeratome registration surface 28 of its corresponding blade handle 24, which in turn registers or aligns the cutting edge 80 of the cutting blade 56 in a desired position within the microkeratome 4. Once again, the microkeratome registration 28 of the blade handle 24 is registered or aligned relative to the cutting tool registration surface 14 of the head assembly 10 of the microkeratome 4.

30 Multiple cutting blades 56 may be formed on the wafer 130 prior to being positioned on the blade handle mounting fixture 224. A blade handle 24 may be mounted on each cutting blade 56 in the above-described manner. Blade handles 24 may be sequentially mounted on the various individual cutting blades 56, multiple blade handles 24 may be simultaneously mounted on multiple cutting blades 56, or blade handles 24

may be simultaneously mounted on all cutting blades 56 formed on the wafer 130. Regardless of how many cutting blades 56 are formed on the wafer 130 and the sequence of installing any blade handle(s) 24 thereon, the wafer 130 may be removed from the fixture 224 with a blade handle 24 being mounted on at least one cutting blade 56 and
5 with the cutting blade(s) 56 remaining part of the wafer 130. That is, after a blade handle 24 has been mounted on at least one cutting blade 56, the wafer 130 may be removed from the fixture 224 and without having separated any such cutting blade 56 (with a blade handle 24 mounted thereon) from the wafer 130. Thereafter, the various individual cutting blades 56 with a blade handle 24 mounted thereon may be separated from the
10 remainder of the wafer 130.

Figures 20-23 illustrate a desirable configuration for allowing blades 54 and their corresponding blade handles 24 to be separated from the wafer 130. Various characteristics of one configuration of a blade separation fixture 300 is disclosed by Figures 20-23. Initially, the wafer 130 is retained on the blade separation fixture 300
15 using a vacuum in the same manner discussed above in relation to the blade handle mounting fixture 224 of Figures 14-19. Therefore, the bottom surface of the blade separation fixture 300 will similarly include an annular groove and an annular seal ring of the type used by the blade handle mounting fixture 224, so that the base plate 220 may be attached to the fixture 300 in the same manner as the blade mounting fixture 224 to define
20 a vacuum chamber. The blade separation fixture 300 will then also include a vacuum pull-down port, a vacuum linking port, and vacuum holes (not shown) of the type used by the blade mounting fixture 224 to draw a vacuum for retaining the wafer 130 on the fixture 300. Additional vacuum ports may be included on the upper surface 304 of the fixture 300 so as to retain the cutting tool 20 against the fixture 300 after its
25 corresponding blade 56 has been separated from the remainder of the wafer 130 (e.g., by including vacuum ports on a blade interface wall 352 of the fixture 300).

An upper surface 304 of the blade separation fixture 300 is configured to suitably support the wafer 130 and maintain the same in a fixed position while separating blades 56 from the remainder of the wafer 130 using the blade handle 24 previously mounted
30 thereon (e.g., in accordance with Figures 14-19). Generally, less than the entirety of the lower surface 138 of the wafer 130 is in actual contact with the upper surface 304 of the fixture 300. Moreover, the upper surface 304 of the fixture 300 is configured so as to reduce the potential for damage to the cutting edge 80 of each blade 56 while separating blades 56 from the remainder of the wafer 130. Finally, the upper surface 304 of the

fixture 300 is configured so as to allow the bottom surface 48 of each blade handle 24 to remain properly seated on the top surface 60 of its corresponding blade 56 and in spaced relation to the fixture 300 (e.g., so as to be in interfacing relation, or at least in closely spaced and parallel relation).

5 The upper surface 304 of the blade separation fixture 300 includes a recess 312 having a base 320 that is vertically offset from an annular perimeter portion 308 of the upper surface 304. This base 320 includes a planar wafer supporting surface 324 (which includes a blade support tab section 326 for interfacing with and supporting each blade support tab 131 of the wafer 130, which again provides the interconnection between the
10 blades 56 and the remainder of the wafer 130), a plurality of cutting edge cavities 328, and a plurality of registrant/pivot cavities 340. An annular side wall 316 of the recess 312 extends from the lower elevation wafer supporting surface 324 of the base 320 of the recess 312 to the higher elevation annular perimeter portion 308 of the upper surface 304 of the fixture 300. This annular side wall 316 at least substantially approximates a
15 perimeter of the wafer 130. Preferably, the annular side wall 316 and the perimeter of the wafer 130 are disposed in closely spaced relation (e.g., such that there is no more than about a 1 millimeter gap between any portion of the annular side wall 316 and a corresponding portion of the perimeter of the wafer 130).

At least one notch 305 is formed on the upper surface 304 of the blade separation
20 fixture 300. Each notch 305 has a base 306 that is vertically offset from the wafer supporting surface 324 of the base 320 of the recess 312. The base 306 of each notch 304 is disposed at a lower elevation than the wafer supporting surface 324 of the base 320 of the recess 312. There is thereby a space between the wafer 130 and the base 306 of each notch 305. This space facilitates installation of the wafer 130 within the recess 312
25 of the blade separation fixture 300, as well as the removal of the wafer 130 from the blade separation fixture 300. Both manual (e.g., human operator) and a machine(s) are contemplated for one or both of the installation and removal of the wafer 130 relative to the blade separation fixture 300.

Multiple features are incorporated in the configuration of the base 320 of the
30 recess 312 that is formed on the upper surface 304 of the blade separation fixture 300 for receipt of the wafer 130. One is that the various vacuum holes (not shown) intersect with the base 320 of the recess 312. Preferably these vacuum holes intersect with the wafer supporting surface 324 of the base 320 of the recess 312. The wafer supporting surface 324 interfaces with the lower surface 138 of the wafer 130 to vertically support the wafer

130 while on the fixture 300. When the wafer 130 is disposed within the recess 312, a vacuum is pulled against the lower surface 138 of the wafer 130 through the various vacuum holes, through the vacuum chamber, through the vacuum linking port, and through the vacuum pull-down port by an appropriate source and in the same manner
5 discussed above in relation to the blade handle mounting fixture 224. Suction forces thereby retain the lower surface 138 of the wafer 130 against the planar wafer supporting surface 324 of the base 320 of the recess 312. Exactly how the suction or vacuum force is generated and transferred to the wafer 130 to retain the same against the fixture 300 is not of particular importance. Other configurations may be utilized to generate this type of
10 retention force for the wafer 130 on the fixture 300.

Another feature of the base 320 of the recess 312 formed on the upper surface 304 of the blade separation fixture 300 is that it includes multiple cutting edge cavities 328. Each cutting edge cavity 328 is defined by a base 332 that is vertically spaced from the wafer supporting surface 324, and a side wall 336 that extends from the lower elevation
15 base 332 to the higher elevation wafer supporting surface 328 (e.g., Figure 22). In the illustrated embodiment, at least part of the side wall 336 of each cutting edge cavity 328 is disposed in perpendicular relation to the adjacent portion of the wafer supporting surface 324 of the base 320 of the recess 312. Any appropriate orientation of the side wall 336 of the various cutting edge cavities 328 may be utilized.

20 What is of principal importance in relation to each cutting edge cavity 328 is that they be sized and oriented on the upper surface 304 of the fixture 300 such that the cutting edge 80 of each blade 56 will be disposed over one of the cutting edge cavities 328 when the wafer 130 is disposed within the recess 312 on the fixture 300. That is, the cutting edge 80 of each blade 56 is disposed in vertically spaced relation to the blade
25 separation fixture 300. In the illustrated embodiment, a given cutting edge cavity 328 accommodates the cutting edge 80 for multiple blades 56. More specifically, a plurality of the cutting edge cavities 328 are disposed in equally spaced rows along the base 320 of the recess 312. A given cutting edge cavity 328 accommodates all of the blades 56 in a corresponding row on the wafer 130 (i.e., provides a space below the cutting edge 80 of
30 each blade 56 in a given row on the wafer 130) in the illustrated embodiment. It should be appreciated that the base 320 of the recess 312 could be configured such that the cutting edge 80 of each individual blade 56 had its own individual cutting edge cavity 328 (not shown).

Multiple registrant/pivot cavities 340 are also formed on the base 320 of the recess 312 of the blade separation fixture 300. Each registrant/pivot cavity 340 is defined by a base 344 that is vertically spaced from wafer supporting surface 324, a side wall 348 that extends from the lower elevation base 344 to the higher elevation wafer supporting surface 324 (e.g., Figure 22), and a blade interface wall 352. In the illustrated embodiment, at least part of the side wall 348 of each registrant/pivot cavity 340 is disposed in perpendicular relation to the adjacent portion of the wafer supporting surface 324 of the base 320 of the recess 312. Any appropriate orientation of the side wall 348 of the various registrant/pivot cavities 340 may be utilized. The blade interface wall 352 defines the forward boundary of the corresponding registrant/pivot cavity 340 and is configured to interface with the bottom surface 64 of a blade 56 after being separated from the wafer 130 in a manner that will be discussed in more detail below.

What is of principal importance in relation to each registrant/pivot cavity 340 is that they be sized and oriented on the upper surface 304 of the fixture 300 such that each registration cavity 84 of each blade 56 will be disposed over one of the registrant/pivot cavities 340 when the wafer 130 is disposed within the recess 312 on the fixture 300. More specifically, each registrant/pivot cavity 340 should be sized and oriented on the upper surface 304 of the fixture 300 such that the registrant/pivot cavity 340 is disposed below each registrant 32 of each blade handle 24 to keep the bottom wall 40 of each registrant 32 of each blade handle 24 in vertically spaced to the blade separation fixture 300. In the illustrated embodiment, a given registrant/pivot cavity 340 accommodates the registrants 32 of multiple cutting tools 20. More specifically, a plurality of the registrant/pivot cavities 340 are disposed in equally spaced rows along the base 320 of the recess 312. A given registrant/pivot cavity 340 accommodates all of the blades 56 in a corresponding row on the wafer 130 (i.e., provides a space below the registrant cavities 84 of each blade 56 in a given row on the wafer 130) in the illustrated embodiment. It should be appreciated that the base 320 of the recess 312 could be configured such that each individual blade 56 had its own registrant/pivot cavity 340 (not shown).

The various blades 56 of the wafer 130 are suspended above the upper surface 304 of the blade separation fixture 300. That is, the blades 56 are disposed in vertically spaced relation to the underlying base 320 of the recess 312 of the blade separation fixture 300. Those portions of the wafer 130 that are disposed between the rows of blades 56, as well as the outer perimeter of the wafer 130 (e.g., the above-noted frame 128), interface with and are supported by the wafer supporting surface 324 of the fixture 300.

Part of the wafer supporting surface 324, namely structures in the form of a plurality of blade supporting tab sections 326, interfaces with and supports the various blade support tabs 131 that interconnect each of the blades 56 with the remainder of the wafer 130. Each blade support tab section 326 extends toward, but not beyond, the score 132 of the
5 corresponding blade support tab 131. Preferably, the distal end of each blade support tab section 326 is vertically aligned with a score 132.

A blade supporting surface 356 is located under the various blades 56 in a given row of the wafer 130 at a location that is longitudinally between the corresponding cutting edge cavity 328 and the corresponding registrant/pivot cavity 340. This blade supporting
10 surface 356 is a planar surface, is parallel with the wafer supporting surface 324, and is recessed relative to the wafer supporting surface 324. That is, the blade supporting surface 356 is disposed at a lower elevation than the wafer supporting surface 324. Overlying blades 56 are thereby initially separated from the corresponding blade supporting surface 356 by a space when the wafer 130 is in the fixture 300. The above-
15 noted blade interface wall 352 extends from the blade supporting surface 356 down to the base 344 of the corresponding registrant/pivot cavity 340. This blade interface wall 352 is a planar surface and is disposed at an angle α (Figure 22) that is preferably within a range of about 15 degrees to about 30 degrees.

Summarizing the manner in which blades 56 are separated from the remainder of
20 the wafer 130, the wafer 130 is disposed within the recess 312 on the blade separation fixture 300 and in the manner illustrated in Figure 20. Blade handles 24 typically will have been mounted to each of the blades 56 of the wafer 130 (utilizing the blade handle mounting fixture 224 discussed above in relation Figures 14-19) at this time, although any number of blades 56 may have a blade handle 224 mounted thereon and still utilize the
25 blade separation fixture 300. A vacuum is drawn so as to retain portions of the wafer 130 (e.g., its frame 128) against the wafer supporting surface 324 associated with the fixture 300 by "pulling down" on portions of the wafer 130.

An at least generally downwardly directed force is then exerted on a particular blade handle 24 to separate its corresponding blade 56 from the wafer 130 in one
30 embodiment. In another embodiment, this force is exerted directly on the blade 56. In either case, this may be done manually (e.g., by hand) or by a machine(s) (e.g., manually activated or in an automated manner). In one embodiment, this force is directed so as to be least generally perpendicular to the top surface 60 of the corresponding cutting blade 56. In any case, this type of force will cause the cutting blade 56 to deflect down toward

the underlying blade supporting surface 356 a sufficient degree to cause the blade 56 (with its blade handle 24 mounted thereon) to separate from the remainder of the wafer 130 at least generally along its corresponding score 132. This separation preferably occurs before the blade 56 contacts the upper surface 304 of the fixture 300. The cutting edge 80 moves toward, but does not contact, the underlying fixture 300 during this deflection. One benefit of the configuration of the rear surface 106 of the cutting blade 56, namely by having the score 132 disposed within the notch 110 on the back surface 106 of the blade 56, is that even if the fracture does not occur exactly along the score 132, the wafer surface exposed by the fracture should still be longitudinally offset or spaced relative to the first sections 112 of the rear surface 106 of the blade 56.

Once the blade 56 has separated from the wafer 130 in the above-noted manner, the now separated blade 56 will continue in a downward direction until it contacts the underlying blade supporting surface 356. Since the force is being exerted on the blade 56 through its corresponding blade handle 24, the bottom surface 64 of the blade 56 will tend to move toward and most likely interface with an underlying blade interface wall 352. As noted above, suction forces or a vacuum may be used to retain the bottom surface 64 of each cutting blade 56 against an underlying blade interface wall 352 after being separated from the remainder of the wafer 130 in the above-noted manner. In any case, this of course moves its corresponding cutting edge 80 further away from the blade separation fixture 300 (e.g., by a pivoting or pivotal-like motion) so as to further reduce the potential for the cutting edge 80 being damaged during separation of the blade 56 from the wafer 130. A given cutting edge 80 thereby first moves at least generally toward the underlying fixture 300, and then at least generally away from the fixture 300.

The blade 56 again preferably moves into contact with the fixture 300 only after separating from the wafer 130. It initially does so by landing on the blade supporting surface 356 of the fixture 300. This blade supporting surface 356 is in effect a laterally extending beam about which the blade 56 pivots into contact with the inclined blade interface wall 352. Therefore, the cutting edge 80 first moves toward, but not to, the fixture 300 when the blade 56 is being separated from the wafer 130. When the cutting blade 56 does contact the fixture 300 after separation from the wafer 130 (the noted blade supporting surface 356), the cutting edge 80 of the blade 56 is still spaced from the fixture 300 by being over/within a cutting edge cavity 328. The blade 56 then pivots in a direction to move the cutting edge 80 away from the fixture 300, and in turn move its rear edge toward the fixture 300 (e.g., a teeter-totter-like action). The bottom surface 64 of

the blade 56 will then interface with the inclined blade interface wall 352 such that the rear surface 106 of the blade 56 (or an associated edge) is disposed on the base 352 of the registrant/pivot cavity 340 (e.g., projecting at least generally downward) and further such that its cutting edge 80 is projecting at least generally upward and in spaced relation to the
5 fixture 300. Therefore, the cutting edge 80 also preferably never contacts the fixture 300.

It is contemplated that each of the blades 56 may be sequentially removed from the remainder of the wafer 130 in the above-described manner (that is, one at a time), in one or more groups, or all simultaneously. In this regard, multiple cutting blades 56 may be formed on the wafer 130 prior to being positioned on the blade separation fixture 300.
10 A blade handle 24 may be mounted on each cutting blade 56 as well before the wafer 130 is positioned on the fixture 300. Cutting blades 56 may be sequentially separated from the remainder of the wafer 130 in the above-noted manner, multiple cutting blades 56 may be simultaneously separated from the remainder of the wafer 130 in the above-noted manner, or all cutting blades 56 formed on the wafer 130 may be simultaneously
15 separated from the remainder of the wafer 130 in the above-noted manner. Regardless of how many cutting blades 56 are formed on the wafer 130 and the sequence of separating cutting blades 56 from the remainder of the wafer 130, the wafer 130 may be removed from the fixture 300 after at least one cutting blade 56 has been separated from the remainder of the wafer 130. All cutting blades 56 are preferably separated from the wafer
20 130 prior to removing the wafer 130 from the fixture 300. However, any cutting blade 56 that has been separated from the remainder of the wafer 130 may be removed from the fixture 300 prior to or after the wafer 300 is removed from the fixture 300.

Another embodiment of a cutting tool is illustrated in Figure 24 and is identified by reference numeral 20'. The same reference numeral is used for the embodiment of
25 Figure 24 as for the embodiment of Figures 4-7 since the cutting tool 20' of Figure 24 uses the same blade handle 24 and cutting blade 56 that are used by the cutting tool 20 of Figures 4-7. However, the "single prime" designation in relation to the Figure 24 embodiment conveys that there is at least one difference between these two embodiments. The primary difference between the cutting tool 20 of Figures 4-7 and the cutting tool 20'
30 of Figure 24 is that the blade handle 24 is installed on the top surface 60 of the cutting blade 56 in the case of the cutting tool 20 of Figures 4-7, whereas the blade handle 24 is installed on the bottom surface 64 of the cutting blade 56 in the case of the cutting tool 20' of Figure 24. That is, the cutting blade 56 is "upside-down" in the case of the cutting tool 20' of Figure 24 in comparison to the cutting tool 20 of Figures 4-7. Stated another way,

the bottom surface 64 of the cutting blade 56 is disposed above the top surface 60 of the cutting blade 56 when the cutting tool 20' is being used for a cutting operation. Summarily and for the application where the cutting tool 20' is being used to cut an eye flap in a manner that will be discussed in more detail below, this upside-down orientation of the cutting blade 56 relative to the blade handle 24 reduces the area of the cutting blade 56 that remains in contact with the eye flap after it has been initially formed and while the cutting tool 20' continues to be advanced to further define the eye flap (a portion of the bottom surface 64 of the cutting blade 56 would thereby interface with the underside of the eye flap in the case of the cutting tool 20', and not the top surface 60 of the cutting blade 56). This in turn reduces the potential for adverse interactions between the blade 56 and the eye and/or eye flap. Representative "adverse interactions" include shear forces acting on the eye flap, causing deformation of the eye flap, or resulting in damage to the eye flap or the cut surfaces of the eye and/or eye flap.

The blade handle 24 is registered to the cutting blade 56 in the case of the cutting tool 20' in the same general manner discussed above in relation to the cutting tool 20. As such, the discussion presented above is equally applicable to the Figure 24 embodiment, unless otherwise noted herein. Referring to Figure 25, each registrant 32 of the blade handle 24 is disposed within its corresponding registration cavity 84 on the cutting blade 56 so as to dispose the bottom surface 48 of the blade handle 24 on or in close proximity to the bottom surface 64 of the cutting blade 56. An appropriate adhesive may actually separate the bottom surface 48 of the blade handle 24 from the bottom surface 64 of the cutting blade 56 (e.g., there may be a bond line of sorts between the bottom surface 48 of the blade handle 24 and the bottom surface 64 of the cutting blade 56). Nonetheless, the bottom surface 48 of the blade handle 24 faces the bottom surface 64 of the cutting blade 56. The blade handle 24 is then moved relative to the cutting blade 56 in the direction of the edge 102 associated with its corresponding registration cavity 84 (e.g., in a direction that is at least generally away from the cutting edge 80 of the blade 56 in the illustrated embodiment). The edge 102 associated with each registration cavity 84 of the cutting blade 56 again is defined by the intersection of its corresponding registration surface 94 with the bottom surface 64 of the cutting blade 56. Each registrant 32 of the blade handle 24 (more specifically a portion of its corresponding peripheral wall 36) will eventually contact at least a portion of its corresponding edge 102 on the cutting blade 56 to register the blade handle 24 relative to the cutting blade 56.

Once again, the registrant(s) 32 used by the blade handle 24 may be of any appropriate configuration that would allow the same to contact at least a portion of its corresponding edge 102 to provide for a registration of the blade handle 24 relative to the cutting blade 56 in the case of the cutting tool 20' of Figures 24-25. The illustrated
5 rectangular or square profile for the peripheral wall 36 of each registrant 32 allows for a line contact between each registrant 32 and its corresponding edge 102. It should be appreciated that other "degrees" or "levels" of contact between each registrant 32 and its corresponding edge 102 may be appropriate, including without limitation one or more areas of a "point contact". This may be realized by modifying the peripheral wall 36 of
10 each registrant 32, the edge 102 associated with each registration cavity 84, or both. Lengths for the registrant(s) 32 other than that illustrated in Figure 25 may be utilized as well, for instance in accordance with Figures 8C-D noted above.

A microkeratome using the cutting tool 20' of Figure 24 is able to realize certain advantages over a microkeratome using either the cutting tool 20 of Figures 4-7 or a
15 microkeratome using a double-bevel cutting blade (e.g., the cutting blade 56' of Figure 3B). Figure 26A illustrates a microkeratome 4' that is generally the same as that illustrated in Figure 1. The "single prime" designation indicates that there are at least some differences. One is the configuration of the presser 6' in relation to what may be characterized as its leading edge. Another is that the configuration of the support 7',
20 which has been modified to facilitate directing an eye flap 364 into the cut flap receiver 8'. The support 7' is arcuately shaped for at least a certain extent progressing away from its leading edge 7a to facilitate the direction of an eye flap into the cut flap receiver 8'. Yet another is that the blade 56 has been replaced by the blade 56' (still using the same blade handle 24, however). All other portions of the microkeratome 4' in Figure 26A are
25 the same as that illustrated in Figure 1.

Continuing to refer to Figure 26A, the cutting head assembly 10' of the microkeratome 4' advances relative to the patient's eye 360 at least generally in the direction of the arrow A (e.g., "across" the eye). One option is for the cutting head assembly 10' to move along a linear path. Another option is for the cutting head assembly
30 10' to move along an arcuate path. Other types of motion that provide for a movement of the cutting head assembly 10' at least generally in the direction of the arrow A may be utilized. The cutting head assembly 10' of the microkeratome 4' also may oscillate within an at least generally horizontal plane in the view presented in Figure 26A (e.g., parallel with the cutting edge 80').

There are a number of notables in relation to the configuration presented in Figure 26A. One is the distance between a leading edge 7a of the support 7' of the microkeratome 4' and the cutting edge 80' of the cutting blade 56'. Another is the contact between the first cutting edge surface 72' of the cutting blade 56' and the eye flap 364, including as the eye flap 364 continues to be formed by a continued movement of the cutting head assembly 10' relative to the eye 360 at least generally in the direction of the arrow A. The eye flap 364 and the first cutting edge surface 72' are shown in spaced relation in Figure 26A, but in actuality would typically be disposed in interfacing relation. Contrast this with Figure 26B, where the cutting blade 56' has been replaced by the cutting blade 56 in conjunction with the blade handle 24 in the form of the cutting tool 20' of Figure 24 to define a variation of the microkeratome 4' and cutting head assembly 10' of Figure 26A (and thereby, the "double prime" designation is used to identify these components in Figures 26B, 27B, and 28B). Note that the leading edge 7a of the support 7' is now much closer to the cutting edge 80 of the cutting blade 56 compared to the Figure 26A configuration. There are of course further distinctions relating to the upside-down orientation of the cutting blade 56 when the cutting tool 20' is installed in the cutting head assembly 10" of the microkeratome 4". For instance, the bottom surface 64 of the cutting blade 56 would face/interface with the underside of the eye flap 364, while the top surface 60 of the cutting blade 56 would face/interface with the remainder of the patient's eye 360 when the cutting tool 20' is installed in the cutting head assembly 10" of the microkeratome 4" and during a cutting operation. Another is that the bottom surface 64 of the cutting blade 56 is actually disposed above the top surface 60 of the cutting blade 56 when the cutting tool 20' is installed in the cutting head assembly 10" of the microkeratome 4". Another is that the bottom surface 64 of the cutting blade 56 is located generally between the cut flap receiver 8' and the top surface 60 of the cutting blade 56, while the top surface 60 of the cutting blade 56 would be located generally between the bottom surface 64 of the cutting blade 56 and the patient's eye 360 when the cutting tool 20' is installed in the cutting head assembly 10" of the microkeratome 4" and during a cutting operation.

Figures 27A-B and 28A-B present side-by-side comparisons of the cutting blade 56' from Figure 26A and the cutting blade 56 from Figure 26B, respectively. In the case of the cutting blade 56' in Figures 26A, 27A, and 28A, the edge 76' and edge 67 are located along a line (illustrated by the dashed line in Figure 27A) that is perpendicular to both the top surface 60 (or a reference plane containing the same) and the bottom surface

64 (or a reference plane containing the same). Stated another way, the projection of the edge 67 onto a reference plane containing the top surface 60 of the cutting blade 56' or the top surface 60 of the cutting blade 56' (that surface which faces the blade handle 24 in the case of the cutting tool 20), along a line that is perpendicular with the top surface 60 and bottom surface 64 of the cutting blade 56', is located at the edge 76'. The edge 76' again is defined by the intersection of the first cutting edge surface 72' and the top surface 60 of the cutting blade 56', while the edge 67 is defined by the intersection of the second cutting edge surface 66 and the bottom surface 64 of the cutting blade 56'. The edge 76' is located between the leading edge 7a of the support 7' of the microkeratome 4' and the cutting edge 80' of the cutting blade 56' in a dimension that is parallel with the top surface 60 of the cutting blade 56'. The location of the edge 76' of the blade 56', leading edge 7a of the support 7', and the cutting edge 80' of the blade 56' are established in this dimension by their respective perpendicular to this dimension. Stated another way, the edge 76' of the blade 56' is located closer to the cutting edge 80' of the blade 56' than the leading edge 7a of the support 7' is to the cutting edge 80' of the blade 56', measured along a common axis or parallel axes.

In the case of the orientation of the cutting blade 56 illustrated in Figures 26B, 27B, and 28B and corresponding with the cutting tool 20' of Figure 24 being part of the cutting head assembly 10" of the microkeratome 4", the projection of the edge 76 onto the bottom surface 64 of the cutting blade 56 (that surface which faces the blade handle 24 in the case of the cutting tool 20') or a reference plane containing the same, along a line that is perpendicular with the top surface 60 and bottom surface 64 of the cutting blade 56, corresponds with location B in Figures 26B and 27B. The edge 76 again is defined by the intersection of the first cutting edge surface 72 and the top surface 60 of the cutting blade 56. In contrast to the cutting blade 56' illustrated in Figures 26A, 27A, and 28A, now the leading edge 7a of the support 7' of the microkeratome 4' is located between the noted location B and the cutting edge 80 of the cutting blade 56 in a dimension that is parallel with the bottom surface 64 of the cutting blade 56. The location of the edge 76 of the blade 56, leading edge 7a of the support 7', and the cutting edge 80 of the blade 56 are established in this dimension by their respective perpendicular to this dimension. Stated another way, the leading edge 7a of the support 7' is located closer to the cutting edge 80 than location B on the bottom surface 64 is to the cutting edge 80, measured along a common axis or parallel axes. This is of course in direct contrast to the situation

presented above with regard to the cutting blade 56' illustrated in Figures 26A, 27A, and 28A.

With further regard to characterizing the distinctions between the cutting blade 56' in the case of the microkeratome 4' of Figures 26A, 27A, and 28A and the orientation of the cutting blade 56 in the case of the microkeratome 4" illustrated in Figures 26B, 27B, and 28B, one such characterization again relates to the distance between the cutting edge 80' of the blade 56' and the leading edge 7a of the support 7' of the microkeratome 4', compared to the distance between the cutting edge 80 of the blade 56 and the leading edge 7a of the support 7' of the microkeratome 4". The leading edge 7a of the support 7' of the microkeratome 4' is disposed a distance D_1 from the cutting edge 80' of the cutting blade 56' and as illustrated in Figure 28A. The leading edge 7a of the support 7' of the microkeratome 4" is disposed a distance D_2 from the cutting edge 80 of the cutting blade 56 and as illustrated in Figure 28B. The distance D_2 is less than the distance D_1 . In one embodiment, the distance D_2 is no more than about 1 millimeter, and in another embodiment is no more than about 0.7 millimeters. The distance D_3 represents the difference between the distances D_1 and D_2 , or the amount that the leading edge 7a of the support 7' has been moved forward from the relative position illustrated in Figures 26A, 27A, and 28A to the relative position illustrated in Figures 26B, 27B, and 28B.

There are other ways to characterize the incorporation of the cutting tool 20' into the cutting head assembly 10" of the microkeratome 4" of Figures 26B, 27B, and 28B. For instance, the leading edge 7a of the upper blade support 7' (associated with the surface 64 of the cutting blade 56) is closer to the first cutting edge 80 of the cutting blade 56 than a leading edge 13a of the lower blade support 13 (associated with the surface 60 of the cutting blade 56) is to the cutting edge 80 in a dimension that is parallel with the bottom surface 64 of the cutting blade 56. The location of the cutting edge 80 of the blade 56, the leading edge 7a of the upper blade support 7', and the leading edge 13a of the lower blade support 13 are established in this dimension by their respective perpendicular to this dimension. This is represented by distances D_4 (the separation distance between the leading edge 13a of the support 13 and the cutting edge 80 of the blade 56, measured in the noted manner) and D_2 (the separation distance between the leading edge 7a of the support 7' and the cutting edge 80 of the blade 56, measured in the noted manner) in Figure 26B. The distance D_2 is less than the distance D_4 .

Yet another characterization of the position of the blade support 7' relative to the cutting blade 56, in the case of the microkeratome 4" of Figures 26B, 27B, and 28B, is in

relation to the total surface area of the cutting blade 56 that is exposed and that may interface with the underside of the eye flap 364 while cutting the patient's eye 360. This particular region is that which is between the leading edge 7a of the blade support 7' and the cutting edge 80 of the cutting blade 56. In one embodiment, the maximum surface area of this particular region is about 1 millimeter times the width of the cutting blade 56 (measured parallel with the cutting edge 80 of the blade 56). Therefore, the maximum surface area of the eye flap 364 that would contact the cutting blade 56 is about 1 millimeter times the width of the eye flap 364, where the width of the eye flap 364 is a dimension that is parallel to the cutting edge 80 of the cutting blade 56.

Positioning the leading edge 7a of the support 7' of the microkeratome 4" closer to the cutting edge 80 in the case of the orientation of the cutting blade 56 utilized in Figures 26B, 27B, and 28B reduces the surface area of the cutting blade 56 that may remain in contact with the eye flap 364 as the same is being formed. This then reduces the potential for deformation and/or damage to the eye flap 364 during the cutting of the patient's eye 360, as well as possibly damage the remainder of the eye 360.

Relatively shallow blade angles θ may be used for the cutting blade 56 in the case of the cutting tool 20' where the upper blade support 7' is disposed close to the cutting edge 80 of the cutting blade 56 as described above and for the case of the microkeratome 4" (e.g., where the surface area of the "exposed" region of the blade 56 that may interface with the underside of the eye flap 364 is within the above-noted limits). One embodiment has a blade angle θ of no more than about 19 degrees for the cutting tool 20', while another embodiment has a blade angle θ of no more than about 35 degrees for the cutting tool 20'. It may be that the angle of the single-bevel cutting blade 56 relative the horizontal dimension (and in the orientation used by the cutting tool 20') may need to be modified from that used by a double-bevel blade (e.g., blade 56'). In any case, preferably the first cutting edge surface 72 is disposed at an angle relative to the exposed surface of the patient's eye 360 when being cut by the microkeratome 4" such that the edge 76 of the blade 56 is disposed at a higher elevation than the cutting edge 80 of the blade 56 as illustrated in Figures 26B and 27B (e.g., an angle of about 5° or 6° relative to horizontal).

The cutting blades 56 and 56' described herein may be used for any appropriate application. Moreover, the cutting blades 56 and 56' described herein each may be used without any blade handle or with a blade handle having a configuration other than as described herein. Both the cutting tool 20 and the cutting tool 20' may be used for any appropriate application as well, and may be adapted for use in any cutting head assembly

of any microkeratome. For instance, the cutting tools 20, 20' could be adapted for use in the cutting head assemblies disclosed in U.S. Patent Nos. 5,624,456 to Hellenkamp and 6,554,847 to Cull, the entire disclosures of which are incorporated by reference herein. Therefore, the cutting tools 20, 20' may be used in a cutting head assembly that is
5 configured to realize "zero compression" of the eye flap 364 in the general manner described by the above-noted U.S. Patent No. 6,554,847.

The foregoing description of the present invention has been presented for purposes of illustration and description. Furthermore, the description is not intended to limit the invention to the form disclosed herein. Consequently, variations and
10 modifications commensurate with the above teachings, and skill and knowledge of the relevant art, are within the scope of the present invention. The embodiments described hereinabove are further intended to explain best modes known of practicing the invention and to enable others skilled in the art to utilize the invention in such, or other
embodiments and with various modifications required by the particular application(s) or
15 use(s) of the present invention. It is intended that the appended claims be construed to include alternative embodiments to the extent permitted by the prior art.

CLAIMS

What is claimed is:

1. A cutting tool, comprising:
a blade comprising first cutting edge surface, a second cutting edge surface, a
5 cutting edge defined by an intersection of said first and second cutting edge surfaces, and
a first registration surface spaced from said cutting edge and parallel with said first
cutting edge surface; and
a blade handle interconnected with said blade and comprising a first registrant that
interfaces with at least part of said first registration surface.
- 10 2. A cutting tool, as claimed in Claim 1, wherein:
said blade further comprises top and bottom surfaces that are planar and disposed
in parallel relation, wherein said first cutting edge surface is disposed at an angle relative
to and intersects with said top surface, and wherein said bottom surface comprises said
second cutting edge surface.
- 15 3. A cutting tool, as claimed in Claim 1, wherein:
said blade further comprises top and bottom surfaces that are planar and disposed
in parallel relation, wherein both said first cutting edge surface and said first registration
surface are disposed at an angle relative to and intersect with said top surface, wherein
said bottom surface comprises said second cutting edge surface, and wherein said first
20 registration surface is disposed at an angle relative to and intersects with said bottom
surface.
4. A cutting tool, as claimed in Claim 1, wherein:
said first cutting edge surface extends from a first edge to said cutting edge,
wherein said first registration surface extends from a second edge to a third edge, wherein
25 said first and second edges are disposed within a first reference plane, wherein said
cutting edge and said third edge are disposed within a second reference plane, and
wherein said first and second reference planes are parallel.
5. A cutting tool, as claimed in Claim 1, wherein:
said blade comprises a second registration surface spaced from said cutting edge
30 and parallel with said first cutting edge surface; and
wherein said blade handle comprises a second registrant that interfaces with at
least part of said second registration surface.
6. A cutting tool, as claimed in Claim 5, wherein:
said first and second registration surfaces are coplanar.

7. A cutting tool, as claimed in Claim 1, wherein:
said blade comprises a concave first registration cavity spaced from said cutting edge and comprising first and second ends with said first end being disposed between said cutting edge and said second end, wherein said second end comprises said first
5 registration surface.
8. A cutting tool, as claimed in Claim 7, wherein:
said first registration cavity extends entirely through said blade.
9. A cutting tool, as claimed in Claim 7, wherein:
said blade comprises a planar top surface, wherein said first end of said first
10 registration cavity is perpendicular to said planar top surface, and wherein said first registration surface is disposed at an angle other than perpendicular relative to said planar top surface.
10. A cutting tool, as claimed in Claim 7, wherein:
said first registrant is separated from said first end by a space.
- 15 11. A cutting tool, as claimed in Claim 7, wherein:
said blade further comprises a concave second registration cavity spaced from said cutting edge and comprising third and fourth ends with said third end being disposed between said cutting edge and said fourth end, wherein said fourth end comprises a second registration surface that is parallel with said first cutting edge surface and coplanar
20 with said first registration surface; and
wherein said blade handle comprises a second registrant that interfaces with at least part of said second registration surface.
12. A cutting tool, as claimed in Claim 1, wherein:
an interface between said first registrant and said first registration surface is
25 limited to being at least substantially along a line.
13. A cutting tool, as claimed in Claim 1, wherein:
said blade further comprises top and bottom surfaces, wherein an intersection between said first registration surface and said top surface defines a first edge, and wherein an intersection between said first registration surface and said bottom surface
30 defines a second edge.
14. A cutting tool, as claimed in Claim 13, wherein:
said first registrant interfaces with said first registration surface closer to said second edge than said first edge.

15. A cutting tool, as claimed in Claim 13, wherein:
said first registrant interfaces with said first registration surface along said second edge.

16. A cutting tool, as claimed in Claim 13, wherein:
5 said first registrant extends below said second edge.

17. A cutting tool, as claimed in Claim 1, wherein:
said blade handle comprises a second registrant, wherein said second registrant disposes said blade handle in a predetermined position relative to a microkeratome when said cutting tool is installed on the microkeratome.

10 18. A cutting tool, comprising:
a blade comprising a first cutting edge surface, a second cutting edge surface, a cutting edge defined by an intersection of said first and second cutting edge surfaces, a concave first registration cavity spaced from said cutting edge and comprising first and second ends with said first end being disposed between said first cutting edge and said
15 second end; and

a blade handle interconnected with said blade and comprising a first registrant that extends within said first registration cavity, wherein said first registrant interfaces with at least part of said second end of said first registration cavity and is spaced from said first end of said first registration cavity.

20 19. A cutting tool, as claimed in Claim 18, wherein:
said first registration cavity extends entirely through said blade.

20. A cutting tool, as claimed in Claim 18, wherein:
said blade comprises a planar top surface, wherein said first end of said first registration cavity is perpendicular to said planar top surface, and wherein said second
25 end of said first registration cavity is disposed at an angle other than perpendicular relative to said planar top surface.

21. A cutting tool, as claimed in Claim 18, wherein:
said first registrant is separated from said first end of said first registration cavity by a distance of at least about 1 millimeter.

30 22. A cutting tool, as claimed in Claim 18, wherein:
said blade further comprises a concave second registration cavity spaced from said cutting edge and comprising third and fourth ends with said third end being disposed between said cutting edge and said fourth end; and

wherein said blade handle comprises a second registrant that interfaces with at least part of said fourth end and is spaced from said third end.

23. A cutting tool, as claimed in Claim 22, wherein:

5 said first and second registrants are positioned along a reference axis that is parallel with said cutting edge.

24. A cutting tool, as claimed in Claim 22, wherein:

said first and second registrants are equidistant from said cutting edge.

25. A cutting tool, as claimed in Claim 22, wherein:

10 said second end of said first registration cavity comprises a first registration surface that is spaced from said first cutting edge and parallel with said first cutting edge surface;

wherein said fourth end of said second registration cavity comprises a second registration surface that is spaced from said cutting edge and parallel with said first cutting edge surface; and

15 wherein said second registrant interfaces with at least part of said second registration surface.

26. A cutting tool, as claimed in Claim 25, wherein:

said first and second registration surfaces are coplanar.

27. A cutting, tool, as claimed in Claim 18, wherein:

20 said second end of said first registration cavity comprises a first registration surface that is spaced from said cutting edge and parallel with said first cutting edge surface, wherein said first registrant interfaces with at least part of said first registration surface.

28. A cutting tool, as claimed in Claim 27, wherein:

25 said blade further comprises top and bottom surfaces that are planar and disposed in parallel relation, wherein said first cutting edge surface is disposed at an angle relative to and intersects said top surface, and wherein said bottom surface comprises said second cutting edge surface.

29. A cutting tool, as claimed in Claim 27, wherein:

30 said blade further comprises top and bottom surfaces that are planar and disposed in parallel relation, wherein both said first cutting edge surface and said first registration surface are disposed at an angle relative to and intersects with said top surface, wherein said bottom surface comprises said second cutting edge surface, and wherein said first

registration surface is disposed at an angle relative to and intersects with said bottom surface.

30. A cutting tool, as claimed in Claim 27, wherein:

5 said first cutting edge surface extends from a first edge to said cutting edge, wherein said first registration surface extends from a second edge to a third edge, wherein said first and second edges are disposed within a first reference plane, wherein said cutting edge and said third edge are disposed within a second reference plane, and wherein said first and second reference planes are parallel.

31. A cutting tool, as claimed in Claim 27, wherein:

10 an interface between said first registrant and said first registration surface is limited to being at least substantially along a line.

32. A cutting tool, as claimed in Claim 27, wherein:

15 said blade further comprises top and bottom surfaces, wherein an intersection between said first registration surface and said top surface defines a first edge, and wherein an intersection between said first registration surface and said bottom surface defines a second edge.

33. A cutting tool, as claimed in Claim 32, wherein:

said first registrant interfaces with said first registration surface closer to said second edge than said first edge.

20 34. A cutting tool, as claimed in Claim 32, wherein:

said first registrant interfaces with said first registration surface along said second edge.

35. A cutting tool, as claimed in Claim 32, wherein:

said first registrant extends below said second edge.

25 36. A cutting tool, as claimed in Claim 18, wherein:

said blade handle comprises a second registrant, wherein said second registrant disposes said blade handle in a predetermined position relative to a microkeratome when said cutting tool is installed on the microkeratome.

37. A cutting tool, comprising:

30 a blade comprising first cutting edge surface, a second cutting edge surface, a cutting edge defined by an intersection of said first and second cutting edge surfaces, and a first registration surface spaced from said cutting edge and parallel with said first cutting edge surface.

38. A cutting tool, as claimed in Claim 37, wherein:

said blade further comprises top and bottom surfaces that are planar and disposed in parallel relation, wherein said first cutting edge surface is disposed at an angle relative to and intersects with said top surface, and wherein said bottom surface comprises said
5 second cutting edge surface.

39. A cutting tool, as claimed in Claim 37, wherein:

said blade further comprises top and bottom surfaces that are planar and disposed in parallel relation, wherein both said first cutting edge surface and said first registration surface are disposed at an angle relative to and intersect with said top surface, wherein
10 said bottom surface comprises said second cutting edge surface, and wherein said first registration surface is disposed at an angle relative to and intersects with said bottom surface.

40. A cutting tool, as claimed in Claim 37, wherein:

said first cutting edge surface extends from a first edge to said cutting edge, wherein said first registration surface extends from a second edge to a third edge, wherein
15 said first and second edges are disposed within a first reference plane, wherein said cutting edge and said third edge are disposed within a second reference plane, and wherein said first and second reference planes are parallel.

41. A cutting tool, as claimed in Claim 37, wherein:

said blade comprises a second registration surface spaced from said cutting edge and parallel with said first cutting edge surface.
20

42. A cutting tool, as claimed in Claim 41, wherein:

said first and second registration surfaces are coplanar.

43. A cutting tool, as claimed in Claim 37, wherein:

said blade comprises a concave first registration cavity spaced from said cutting edge and comprising first and second ends with said first end being disposed between said cutting edge and said second end, wherein said second end comprises said first
25 registration surface.

44. A cutting tool, as claimed in Claim 43, wherein:

said first registration cavity extends entirely through said blade.
30

45. A cutting tool, as claimed in Claim 43, wherein:

said blade comprises a planar top surface, wherein said first end of said first registration cavity is perpendicular to said planar top surface, and wherein said first

registration surface is disposed at an angle other than perpendicular relative to said planar top surface.

46. A cutting tool, as claimed in Claim 43, wherein:
said blade further comprises a concave second registration cavity spaced from said cutting
5 edge and comprising third and fourth ends with said third end being disposed between
said cutting edge and said fourth end, wherein said fourth end comprises a second
registration surface that is parallel with said first cutting edge surface and coplanar with
said first registration surface.

47. A method for fabricating a blade from a substrate comprising a first
10 surface, said method comprising the steps of:
forming a masking layer on said first surface of said substrate;
transferring a blade mask onto said masking layer; and
etching said substrate through first and second openings in said blade mask that
each expose a predetermined portion of said first surface of said substrate and that defines
15 a first cutting edge surface and a first registration feature, respectively, for a first blade.

48. A method, as claimed in Claim 47, further comprising the step of:
aligning said blade mask to a first crystallographic plane associated with said
substrate before said transferring step.

49. A method, as claimed in Claim 47, wherein:
20 said transferring step comprises using a technique selected from the group
consisting of photomasking, masking, photolithography, and microlithography.

50. A method, as claimed in Claim 47, wherein:
said etching step comprises an anisotropic etch of said substrate.

51. A method, as claimed in Claim 47, wherein:
25 said etching step is a chemical etch.

52. A method, as claimed in Claim 47, wherein:
said etching step comprises etching said substrate to the same crystallographic
plane at each of first and second spaced locations to define said first cutting edge surface
and said first registration feature, respectively.

53. A method, as claimed in Claim 47, wherein:
30 said etching step comprises simultaneously forming said first cutting edge surface
and said first registration feature.

54. A method, as claimed in Claim 47, wherein,
said etching step comprises defining first and second planar and parallel surfaces
at first and second locations, respectively, wherein said first cutting edge surface
comprises said first planar surface, and wherein said first registration feature comprises
5 said second planar surface.

55. A method, as claimed in Claim 47, wherein:
an intersection between said first cutting edge surface and a second surface of said
substrate defines a first cutting edge, wherein said first and second surfaces of said
substrate are oppositely disposed, and wherein said etching step comprises etching
10 entirely through said substrate from only a first side of said substrate to define said first
cutting edge.

56. A method, as claimed in Claim 55, wherein:
said etching step comprises etching entirely through said substrate from only said
first side of said substrate to define said first registration feature.

15 57. A method, as claimed in Claim 47, wherein:
said etching step comprises etching entirely through said substrate from only one
side of said substrate to define said first registration feature.

58. A method, as claimed in Claim 47, wherein:
said etching step comprises etching said substrate to define a first registration
20 cavity, wherein said first registration cavity is defined in part by a first registration
surface, wherein said first registration surface comprises said first registration feature, and
wherein said first cutting edge surface and said first registration surface are disposed in
parallel relation.

59. A method, as claimed in Claim 58, wherein:
25 said etching step comprises defining at least a portion of a perimeter of said first
blade, wherein an entirety of said first registration cavity is disposed inwardly of said
perimeter.

60. A method, as claimed in Claim 58, wherein:
said etching step comprises etching entirely through said substrate to define said
30 first registration cavity.

61. A method, as claimed in Claim 58, wherein:
said first cutting edge surface extends between a first edge and a first cutting edge,
wherein said first edge is defined by an intersection of said first cutting edge surface and
said first surface of said substrate; and

said first registration surface extends between second and third edges, wherein said second edge is defined by an intersection between said first registration surface and said first surface of said substrate, and wherein said third edge and said first cutting edge are disposed within a common reference plane that is parallel with said first surface.

5 62. A method, as claimed in Claim 61, wherein:

said substrate comprises a second surface that is disposed opposite of said first surface, wherein said third edge is defined by an intersection between said first registration surface and said second surface of said substrate.

10 63. A method, as claimed in Claim 47, further comprising the steps of:
etching said substrate through a third opening in said blade mask that exposes a predetermined portion of said first surface of said substrate and that defines a second registration feature for said first blade.

15 64. A method, as claimed in Claim 63, wherein:
said etching step comprises etching said substrate to the same crystallographic plane at each of first, second, and third spaced locations to define said first cutting edge surface, said first registration feature, and said second registration feature, respectively.

 65. A method, as claimed in Claim 63, wherein:
said etching step comprises simultaneously forming said first cutting edge surface, said first registration feature, and said second registration feature.

20 66. A method, as claimed in Claim 63, wherein,
said etching step comprises defining first, second, and third planar surfaces at first, second, and third locations, respectively, wherein said first cutting edge surface comprises said first planar surface, wherein said first registration feature comprises said second planar surface, wherein said second registration feature comprises said third
25 planar surface, and wherein said first planar surface is parallel with each of said second and third planar surfaces.

 67. A method, as claimed in Claim 66, wherein:
said second and third planar surfaces are disposed within a common reference plane.

30 68. A method, as claimed in Claim 63, wherein:
said etching step comprises etching said substrate to define first and second registration cavities, wherein said first and second registration cavities are defined in part by first and second registration surfaces, respectively, wherein said first and second registration surfaces comprise said first and second registration features, respectively,

wherein said first cutting edge surface is disposed in parallel relation with each of said first and second registration surfaces, and wherein said first and second registration surfaces are disposed in spaced relation.

69. A method, as claimed in Claim 68, wherein:
5 said etching step comprises defining a perimeter of said first blade, wherein an entirety of each of said first and second registration cavities is disposed inwardly of said perimeter.

70. A method, as claimed in Claim 68, wherein:
said first and second registration surfaces are disposed within a common reference
10 plane.

71. A method for fabricating a blade from a substrate, said method comprising the steps of:
executing a first etching step comprising etching said substrate at a first location to define a first cutting edge surface of a first blade; and
15 executing a second etching step comprising etching said substrate at a second location to define a first registration cavity of said first blade, wherein said first location is spaced from said second location.

72. A method, as claimed in Claim 71, wherein:
said first and second etching steps are executed concurrently using the same
20 etchant.

73. A method, as claimed in Claim 72, wherein:
said etchant is an anisotropic etchant.

74. A method, as claimed in Claim 71, wherein:
said first etching step terminates upon reaching a first plane, wherein said second
25 etching step terminates upon reaching a second plane, and wherein said first and second planes are parallel.

75. A method, as claimed in Claim 74, wherein:
said first and second planes each correspond with a common crystallographic
plane.

76. A method, as claimed in Claim 71, wherein:
said second etching step comprises defining a first registration surface that is
30 parallel with said first cutting edge surface.

77. A method, as claimed in Claim 71, wherein:
said second etching step comprises etching entirely through said substrate.

78. A method, as claimed in Claim 71, wherein:

said first cutting edge surface extends between a first edge and a first cutting edge, wherein said first edge is defined by an intersection of said first cutting edge surface and a first surface of said substrate; and

5 said second etching step comprises defining a first registration surface that extends between second and third edges, wherein said second edge is defined by an intersection between said first registration surface and said first surface of said substrate, and wherein said third edge and said first cutting edge are disposed within a common reference plane that is parallel with said first surface.

10 79. A method, as claimed in Claim 78, wherein:

said substrate comprises a second surface disposed opposite of said first surface, wherein said third edge is defined by an intersection between said first registration surface and said second surface of said substrate.

80. A method, as claimed in Claim 71, further comprising the step of:

15 executing a third etching step comprising etching said substrate to define at least a portion of a perimeter of said first blade, wherein an entirety of said first registration cavity is disposed inwardly of said perimeter.

81. A method, as claimed in Claim 71, further comprising the steps of:

20 executing a third etching step comprising etching said substrate at a third location to define a second registration cavity of said first blade, wherein said third location is spaced from each of said first and second locations.

82. A method, as claimed in Claim 81, wherein:

said first, second, and third etching steps are executed concurrently using the same etchant.

25 83. A method, as claimed in Claim 81, wherein:

said first, second, and third etching steps comprise etching said substrate to the same crystallographic plane at each of said first, second, and third spaced locations to define said first cutting edge surface, said first registration cavity, and said second registration cavity, respectively.

30 84. A method, as claimed in Claim 81, wherein:

said first, second, and third etching steps comprise simultaneously forming said first cutting edge surface, said first registration cavity, and said second registration cavity, respectively.

85. A method, as claimed in Claim 81, wherein,
said first, second, and third etching steps comprise defining first, second, and third
planar surfaces, respectively, wherein said first cutting edge surface comprises said first
planar surface, wherein part of said first registration cavity is defined by said second
5 planar surface, wherein part of said second registration cavity is defined by said third
planar surface, and wherein said first planar surface is parallel with each of said second
and third planar surfaces.

86. A method, as claimed in Claim 85, wherein:
said second and third planar surfaces are disposed within a common reference
10 plane.

87. A method, as claimed in Claim 81, further comprising the step of:
executing a fourth etching step comprising etching said substrate to define at least
a portion of a perimeter of said first blade, wherein an entirety of each of said first and
second registration cavities is disposed inwardly of said perimeter.

88. A method, as claimed in Claim 71, further comprising the steps of:
forming a masking layer on a first surface of said substrate;
transferring a blade mask onto said masking layer; and
etching said substrate through first and second openings in said blade mask that
each expose a predetermined portion of said first surface of said substrate and that defines
20 said first cutting edge surface and said first registration cavity, respectively.

89. A method, as claimed in Claim 88, further comprising the step of:
aligning said blade mask to at least one crystallographic plane associated with said
substrate before said transferring step.

90. A method, as claimed in Claim 88, wherein:
25 said transferring step comprises using a technique selected from the group
consisting of photomasking, masking, photolithography, and microlithography.

91. A method for fabricating a blade from a substrate, comprising the
steps of:

30 creating at least one opening that extends completely through said substrate,
wherein said creating step comprises defining at least a portion of a perimeter of a first
blade; and

defining a first registration feature from said substrate that is associated with said
first blade, wherein said defining a first registration feature step is executed during said
creating step.

92. A method for fabricating a blade from a substrate, comprising the steps of:

creating at least one opening that extends completely through said substrate, wherein said creating step comprises defining at least a portion of a perimeter of a first blade; and

defining a first registration feature from said substrate that is associated with said first blade, wherein said defining a first registration feature step comprises using a same technique as said creating step.

93. A method for mounting a blade handle on a blade, comprising the steps of:

positioning a wafer on a first fixture, wherein said wafer comprises a first blade;

maintaining a first cutting edge of said first blade in spaced relation to said first fixture; and

mounting a first blade handle on said first blade while on said first fixture.

94. A method, as claimed in Claim 93, wherein:

said positioning step comprises positioning said wafer in a recess formed on an upper surface of said first fixture.

95. A method, as claimed in Claim 94, wherein:

a perimeter of said recess at least substantially approximates a perimeter of said wafer.

96. A method, as claimed in Claim 93, wherein:

said wafer comprises a first score associated with said first blade, wherein said positioning step comprises supporting said wafer with said first fixture directly under said first score, wherein said first blade may be separated from said wafer utilizing said first score.

97. A method, as claimed in Claim 96, further comprising the step of: aligning said first score with a predetermined crystal plane of said wafer.

98. A method, as claimed in Claim 93, wherein:

said wafer comprises a first score associated with said first blade, wherein said positioning step comprises supporting said wafer such that said mounting step does not result in any net moment about said first score, wherein said first blade may be separated from said wafer utilizing said first score.

99. A method, as claimed in Claim 93, wherein:

said wafer comprises a first cantilever, wherein said first blade is disposed on an end of said first cantilever, wherein said positioning step comprises supporting said first cantilever with said first fixture.

5 100. A method, as claimed in Claim 99, wherein:

said positioning step comprises inhibiting any deflection of said first cantilever during said mounting step.

101. A method, as claimed in Claim 93, further comprising the step of:
biasing said wafer toward said first fixture.

10 102. A method, as claimed in Claim 101, wherein:

said biasing step comprises using a vacuum.

103. A method, as claimed in Claim 93, further comprising the step of:
retaining said wafer on said first fixture using a vacuum.

104. A method, as claimed in Claim 93, wherein:
15 said maintaining step comprises disposing said first cutting edge of said first blade above a first cutting edge cavity formed on an upper surface of said first fixture.

105. A method, as claimed in Claim 93, wherein:
said mounting step comprises maintaining said first blade handle in spaced relation with an entirety of said first fixture.

20 106. A method, as claimed in Claim 93, wherein:
said mounting step comprises applying an adhesive to at least one of said first blade handle and said first blade.

107. A method, as claimed in Claim 106, wherein:
said adhesive is light curable, wherein said method further comprises disposing
25 said first blade handle in a predetermined position relative to said first blade after said applying step, and thereafter exposing at least a portion of said adhesive to light to fix said first blade handle to said first blade.

108. A method, as claimed in Claim 93, wherein:
said mounting step comprises disposing a first registrant extending from a lower
30 surface of said first blade handle into a first registration cavity accessible through an upper surface of said first blade.

109. A method, as claimed in Claim 108, wherein:
said disposing step of said mounting step comprises maintaining said first registrant in spaced relation with said first fixture.

110. A method, as claimed in Claim 109, wherein:
said maintaining step of said disposing step comprises aligning said first registrant of said first blade handle with a first registrant cavity formed on an upper surface of said first fixture.
- 5 111. A method, as claimed in Claim 93, wherein:
said mounting step comprises disposing first and second registrants extending from a lower surface of said first blade handle into first and second registration cavities accessible through an upper surface of said first blade.
112. A method, as claimed in Claim 111, wherein:
10 said disposing step comprises supporting said first blade with said first fixture between said first and second registration cavities.
113. A method, as claimed in Claim 93, wherein:
said mounting step comprises:
disposing said first blade handle on an upper surface of said first blade;
15 executing a first moving step comprising moving said first blade handle relative to said first blade after said disposing step; and
terminating said first moving step upon registering said first blade handle to said first blade.
114. A method, as claimed in Claim 113, wherein:
20 said disposing step comprises moving said first blade handle in a first direction toward said first blade, and wherein said first moving step comprises moving said blade handle in a second direction that is at least generally perpendicular to said first direction.
115. A method, as claimed in Claim 113, wherein:
said first moving step comprises moving said first blade handle at least generally
25 away from said first cutting edge of said first blade.
116. A method, as claimed in Claim 113, wherein:
said first moving step comprises moving said first blade handle in a direction that is at least generally parallel to said upper surface of said first blade.
117. A method, as claimed in Claim 113, wherein:
30 said registering step comprises a first registrant of said first blade handle engaging a first registration surface of said first blade.
118. A method, as claimed in Claim 113, further comprising the step of:
securing said first blade handle to said first blade after said terminating step.

119. A method, as claimed in Claim 93, wherein:

said wafer comprises a plurality of said first blades, wherein said method further comprises repeating both said maintaining and mounting steps for each of said plurality of said first blades.

5 120. A method, as claimed in Claim 93, further comprising the step of:
removing said wafer from said first fixture after said mounting step, wherein said first blade remains part of said wafer while said first blade handle is mounted on said first blade.

10 121. A method for mounting a blade handle on a blade, comprising the steps of:

positioning a wafer on a first fixture, wherein said wafer comprises a first blade;
mounting a first blade handle on said first blade while on said first fixture; and
removing said wafer from said first fixture after said mounting step.

15 122. A method, as claimed in Claim 121, wherein:
said positioning step comprises positioning said wafer in a recess formed on an upper surface of said first fixture.

123. A method, as claimed in Claim 122, wherein:
a perimeter of said recess at least substantially approximates a perimeter of said wafer.

20 124. A method, as claimed in Claim 121, wherein:
said wafer comprises a first score associated with said first blade, wherein said positioning step comprises supporting said wafer with said first fixture directly under said first score, wherein said first blade may be separated from said wafer utilizing said first score.

25 125. A method, as claimed in Claim 124, further comprising the step of:
aligning said first score with a predetermined crystal plane of said wafer.

30 126. A method, as claimed in Claim 121, wherein:
said wafer comprises a first score associated with said first blade, wherein said positioning step comprises supporting said wafer such that said mounting step does not result in any net moment about said first score, wherein said first blade may be separated from said wafer utilizing said first score.

127. A method, as claimed in Claim 121, wherein:

said wafer comprises a first cantilever, wherein said first blade is disposed on an end of said first cantilever, wherein said positioning step comprises supporting said first cantilever with said first fixture.

5 128. A method, as claimed in Claim 127, wherein:

said positioning step comprises inhibiting any deflection of said first cantilever during said mounting step.

129. A method, as claimed in Claim 121, further comprising the step of:
biasing said wafer toward said first fixture.

10 130. A method, as claimed in Claim 129, wherein:

said biasing step comprises using a vacuum.

131. A method, as claimed in Claim 121, further comprising the step of:
retaining said wafer on said first fixture using a vacuum.

132. A method, as claimed in Claim 121, further comprising the step of:
15 maintaining a first cutting edge of said first blade in spaced relation to said first fixture.

133. A method, as claimed in Claim 132, wherein:

said maintaining step comprises disposing said first cutting edge of said first blade above a first cutting edge cavity formed on an upper surface of said first fixture.

20 134. A method, as claimed in Claim 121, wherein:

said mounting step comprises maintaining said first blade handle in spaced relation with an entirety of said first fixture.

135. A method, as claimed in Claim 121, wherein:

25 said mounting step comprises applying an adhesive to at least one of said first blade handle and said first blade.

136. A method, as claimed in Claim 135, wherein:

30 said adhesive is light curable, wherein said method further comprises disposing said first blade handle in a predetermined position relative to said first blade after said applying step, and thereafter exposing at least a portion of said adhesive to light to fix said first blade handle to said first blade.

137. A method, as claimed in Claim 121, wherein:

said mounting step comprises disposing a first registrant extending from a lower surface of said first blade handle into a first registration cavity accessible through an upper surface of said first blade.

138. A method, as claimed in Claim 137, wherein:

said disposing step of said mounting step comprises maintaining said first registrant in spaced relation with said first fixture.

139. A method, as claimed in Claim 138, wherein:

5 said maintaining step of said disposing step comprises aligning said first registrant of said first blade handle with a first registrant cavity formed on an upper surface of said first fixture.

140. A method, as claimed in Claim 121, wherein:

10 said mounting step comprises disposing first and second registrants extending from a lower surface of said first blade handle into first and second registration cavities accessible through an upper surface of said first blade.

141. A method, as claimed in Claim 140, wherein:

said disposing step comprises supporting said first blade with said first fixture between said first and second registration cavities.

15 142. A method, as claimed in Claim 121, wherein:

said mounting step comprises:

disposing said first blade handle on an upper surface of said first blade;

executing a first moving step comprising moving said first blade handle relative to said first blade after said disposing step; and

20 terminating said first moving step upon registering said first blade handle to said first blade.

143. A method, as claimed in Claim 142, wherein:

25 said disposing step comprises moving said first blade handle in a first direction toward said first blade, and wherein said first moving step comprises moving said blade handle in a second direction that is at least generally perpendicular to said first direction.

144. A method, as claimed in Claim 142, wherein:

said first moving step comprises moving said first blade handle at least generally away from a first cutting edge of said first blade.

145. A method, as claimed in Claim 142, wherein:

30 said first moving step comprises moving said first blade handle in a direction that is at least generally parallel to said upper surface of said first blade.

146. A method, as claimed in Claim 142, wherein:

said registering step comprises a first registrant of said first blade handle engaging a first registration surface of said first blade.

147. A method, as claimed in Claim 142, further comprising the step of:
securing said first blade handle to said first blade after said terminating step.

148. A method, as claimed in Claim 121, wherein:

said wafer comprises a plurality of said first blades, wherein said method further
5 comprises repeating said mounting step for each of said plurality of said first blades
before any execution of said removing step.

149. A method for mounting a blade handle on a blade, comprising the
steps of:

disposing a first blade handle on an upper surface of a first blade;
10 executing a first moving step comprising moving said first blade handle relative to
said first blade after said disposing step;

terminating said first moving step upon registering said first blade handle to said
first blade; and

securing said first blade handle to said first blade after said registering step.

150. A method, as claimed in Claim 149, wherein:

said disposing step comprises moving said first blade handle in a first direction
toward said first blade, and wherein said first moving step comprises moving said blade
handle in a second direction that is at least generally perpendicular to said first direction.

151. A method, as claimed in Claim 149, wherein:

20 said first moving step comprises moving said first blade handle at least generally
away from a first cutting edge of said first blade.

152. A method, as claimed in Claim 149, wherein:

said first moving step comprises moving said first blade handle in a direction that
is at least generally parallel to said upper surface of said first blade.

25 153. A method, as claimed in Claim 149, wherein:

said registering step comprises a first registrant of said first blade handle engaging
a first registration surface of said first blade.

154. A method, as claimed in Claim 149, wherein:

30 said securing step comprises applying an adhesive to at least one of said first blade
handle and said first blade before said disposing step, and curing said adhesive.

155. A method, as claimed in Claim 149, further comprising the step of:

positioning a wafer on a first fixture, wherein said wafer comprises said first
blade, and wherein each of said disposing step, said first moving step, said terminating
step, and said securing step are executed with said wafer on said first fixture.

156. A method, as claimed in Claim 155, wherein:

said positioning step comprises positioning said wafer in a recess formed on an upper surface of said first fixture.

157. A method, as claimed in Claim 156, wherein:

5 a perimeter of said recess at least substantially approximates a perimeter of said wafer.

158. A method, as claimed in Claim 155, further comprising the step of: biasing said wafer toward said first fixture.

159. A method, as claimed in Claim 158, further comprising the step of:
10 said biasing step comprises using a vacuum.

160. A method, as claimed in Claim 155, further comprising the step of: retaining said wafer on said first fixture using a vacuum.

161. A method, as claimed in Claim 155, wherein:

said wafer comprises a plurality of said first blades, wherein said method further
15 comprises repeating said disposing step, said first moving step, said terminating step, and said securing step for each of said plurality of said first blades while said wafer is on said first fixture.

162. A method, as claimed in Claim 155, further comprising the step of: removing said wafer from said first fixture after said securing step, wherein said
20 first blade remains part of said wafer while said first blade handle is mounted on said first blade.

163. A method for separating a blade from a wafer, comprising the steps of:

positioning a wafer on a first fixture, wherein said wafer comprises a first blade;
25 maintaining a first cutting edge of said first blade in spaced relation to said first fixture; and

separating said first blade from a remainder of said wafer with said wafer on said first fixture.

164. A method, as claimed in Claim 163, wherein:

said positioning step comprises positioning said wafer in a recess formed on an upper surface of said first fixture.

165. A method, as claimed in Claim 164, wherein:

a perimeter of said recess at least substantially approximates a perimeter of said wafer.

166. A method, as claimed in Claim 163, wherein:
said wafer comprises a lower surface, wherein said positioning step comprises disposing less than an entirety of said lower surface of said wafer in contact with said first fixture.
- 5 167. A method, as claimed in Claim 163, further comprising the step of:
biasing said wafer toward said first fixture.
168. A method, as claimed in Claim 167, wherein:
said biasing step comprises using a vacuum.
169. A method, as claimed in Claim 163, further comprising the step of:
10 retaining said wafer on said first fixture using a vacuum.
170. A method, as claimed in Claim 163, wherein:
said positioning step comprises disposing an entirety of said first blade in spaced relation with said first fixture.
171. A method, as claimed in Claim 163, wherein:
15 said positioning step comprises suspending said first blade above said first fixture.
172. A method, as claimed in Claim 171, wherein:
said wafer comprises a first cantilever, wherein said first blade is disposed on an end of said first cantilever, wherein said positioning step comprises supporting at least a portion of said first cantilever with said first fixture.
- 20 173. A method, as claimed in Claim 171, wherein:
said wafer further comprises a first blade support tab, wherein said first blade is disposed on an end of said first blade support tab, wherein said positioning step comprises supporting at least a portion of said first blade support tab with said first fixture.
174. A method, as claimed in Claim 163, wherein:
25 said maintaining step comprises disposing said first cutting edge of said first blade above a first cutting edge cavity formed on an upper surface of said first fixture.
175. A method, as claimed in Claim 163, wherein:
said maintaining step is executed throughout an entirety of both said positioning and separating steps.
- 30 176. A method, as claimed in Claim 163, wherein:
said separating step comprises fracturing said wafer.
177. A method, as claimed in Claim 163, wherein:
said separating step is executed at least substantially along a line that is at least substantially parallel with said first cutting edge.

178. A method, as claimed in Claim 163, wherein:

said wafer comprises a first score associated with said first blade, wherein said separating step comprises fracturing said wafer at least substantially along said first score.

179. A method, as claimed in Claim 178, wherein:

5 said positioning step comprises supporting said wafer proximate to said first score, while an entirety of said first blade is disposed in spaced relation to said first fixture.

180. A method, as claimed in Claim 163, wherein:

said separating step comprises deflecting said first blade in a direction of said first fixture.

10 181. A method, as claimed in Claim 163, wherein:

said separating step is executed with a first handle mounted on said first blade.

182. A method, as claimed in Claim 181, wherein:

said separating step comprises applying a force on said first handle that is at least generally directed toward said first fixture.

15 183. A method, as claimed in Claim 163, wherein:

said separating step comprises applying a force directly on said first blade that is at least generally directed toward said first fixture.

184. A method, as claimed in Claim 163, wherein:

20 said separating step is completed before any portion of said first blade contacts said first fixture.

185. A method, as claimed in Claim 163, further comprising the steps of:

25 disposing said first blade on said first fixture after said separating step; and
executing said maintaining step throughout said separating step, after said separating step and before said disposing step, and throughout said disposing step.

186. A method, as claimed in Claim 163, wherein:

30 said separating step comprises executing a first moving step, wherein said method further comprises the step of executing a second moving step, wherein said first moving step comprises moving said first cutting edge of said first blade at least generally toward said first fixture without having said first cutting edge contact said first fixture, and wherein said second moving step comprises moving said first cutting edge of said first blade at least generally away from said first fixture before said first moving step causes said first cutting edge to contact said first fixture.

187. A method, as claimed in Claim 163, further comprising the steps of:

moving said first blade into contact with said first fixture after said separating step, and then pivoting said first blade to direct said first cutting edge of said first blade at least generally away from said first fixture.

188. A method, as claimed in Claim 163, further comprising the step of: disposing a lower surface of said first blade against a first surface of said first fixture after said separating step such that a rear edge of said first blade is disposed at a lower elevation relative to said first cutting edge, wherein said first surface is both inclined and planar.

189. A method, as claimed in Claim 188, further comprising the step of: retaining said first blade against said first surface.

190. A method, as claimed in Claim 189, wherein: said retaining step comprises using a vacuum.

191. A method, as claimed in Claim 163, wherein: said wafer comprises a plurality of said first blades, wherein said method further comprises repeating both said maintaining and separating steps for each of said plurality of said first blades, and thereafter removing said wafer from said first fixture.

192. A method for separating a blade from a wafer, comprising the steps of: positioning a wafer on a first fixture, wherein said wafer comprises a first blade; suspending said first blade above said first fixture; and separating said first blade from a remainder of said wafer while said wafer is on said first fixture.

193. A method, as claimed in Claim 192, wherein: said positioning step comprises positioning said wafer in a recess formed on an upper surface of said first fixture.

194. A method, as claimed in Claim 193, wherein: a perimeter of said recess at least substantially approximates a perimeter of said wafer.

195. A method, as claimed in Claim 192, wherein: said wafer comprises a lower surface, wherein said positioning step comprises disposing less than an entirety of said lower surface of said wafer in contact with said first fixture.

196. A method, as claimed in Claim 192, further comprising the step of:
biasing said wafer toward said first fixture.

197. A method, as claimed in Claim 196, wherein:
said biasing step comprises using a vacuum.

5 198. A method, as claimed in Claim 192, further comprising the step of:
retaining said wafer on said first fixture using a vacuum.

199. A method, as claimed in Claim 192, wherein:
said wafer comprises a first cantilever, wherein said first blade is disposed on an
end of said first cantilever, wherein said positioning step comprises supporting at least a
10 portion of said first cantilever with said first fixture.

200. A method, as claimed in Claim 192, wherein:
said wafer further comprises a first blade support tab, wherein said first blade is
disposed on an end of said first blade support tab, wherein said positioning step comprises
supporting at least a portion of said first blade support tab with said first fixture.

15 201. A method, as claimed in Claim 192, wherein:
said suspending step comprises disposing a first cutting edge of said first blade
above a first cutting edge cavity formed on an upper surface of said first fixture.

202. A method, as claimed in Claim 192, wherein:
said separating step comprises fracturing said wafer.

20 203. A method, as claimed in Claim 192, wherein:
said separating step is executed at least substantially along a line that is at least
substantially parallel with said first cutting edge.

204. A method, as claimed in Claim 192, wherein:
said wafer comprises a first score associated with said first blade, wherein said
25 separating step comprises fracturing said wafer at least substantially along said first score.

205. A method, as claimed in Claim 204, wherein:
said positioning step comprises supporting said wafer proximate to said first score,
while an entirety of said first blade is disposed in spaced relation to said first fixture.

206. A method, as claimed in Claim 192, wherein:
30 said separating step comprises deflecting said first blade in a direction of said first
fixture.

207. A method, as claimed in Claim 192, wherein:
said separating step is executed with a first handle mounted on said first blade.

208. A method, as claimed in Claim 207, wherein:

said separating step comprises applying a force on said first handle that is at least generally directed toward said first fixture.

209. A method, as claimed in Claim 192, wherein:

5 said separating step comprises applying a force directly on said first blade that is at least generally directed toward said first fixture.

210. A method, as claimed in Claim 192, wherein:

said separating step is completed before any portion of said first blade contacts said first fixture.

10 211. A method, as claimed in Claim 192, further comprising the steps of:

disposing said first blade on said first fixture after said separating step; and

maintaining a first cutting edge of said first blade in spaced relation to said first fixture throughout said separating step, after said separating step, before said disposing
15 step, and throughout said disposing step.

212. A method, as claimed in Claim 192, wherein:

said separating step comprises executing a first moving step, wherein said method further comprises the step of executing a second moving step, wherein said first moving step comprises moving a first cutting edge of said first blade at least generally toward said
20 first fixture without having said first cutting edge contact said first fixture, and wherein said second moving step comprises moving said first cutting edge of said first blade at least generally away from said first fixture before said first moving step causes said first cutting edge to contact said first fixture.

213. A method, as claimed in Claim 192, further comprising the steps
25 of:

moving said first blade into contact with said first fixture after said separating step, and then pivoting said first blade to direct a first cutting edge of said first blade at least generally away from said first fixture.

214. A method, as claimed in Claim 192, further comprising the steps
30 of:

disposing a lower surface of said first blade against a first surface of said first fixture after said separating step such that a rear edge of said first blade is disposed at a lower elevation relative to a first cutting edge of said first blade that is opposite said rear edge, wherein said first surface is both inclined and planar.

215. A method, as claimed in Claim 192, further comprising the step of:
retaining said first blade against said first surface.

216. A method, as claimed in Claim 215, wherein:
said retaining step comprises using a vacuum.

5 217. A method, as claimed in Claim 192, wherein:
said wafer comprises a plurality of said first blades, wherein said method further
comprises repeating both said maintaining and separating steps for each of said plurality
of said first blades, and thereafter removing said wafer from said first fixture.

218. A method for assembling a cutting tool, comprising the steps of:
10 executing a first positioning step comprising positioning a wafer on a first fixture,
wherein said wafer comprises a first blade;
 mounting a first blade handle on said first blade while said wafer is on said first
fixture;
 removing said wafer from said first fixture after said mounting step;
15 executing a second positioning step comprising positioning said wafer on a second
fixture;
 separating said first blade from a remainder of said wafer while said wafer is on
said second fixture, wherein said separating step is executed after said mounting step.

219. A method, as claimed in Claim 218, wherein:
20 said first positioning step comprises positioning said wafer in a first recess formed
on an upper surface of said first fixture, and wherein said second positioning step
comprises positioning said wafer in a second recess formed on an upper surface of said
second fixture.

220. A method, as claimed in Claim 219, wherein:
25 a perimeter of both said first and second recesses at least substantially
approximates a perimeter of said wafer.

221. A method, as claimed in Claim 218, wherein:
 said wafer comprises a lower surface, wherein each of said first and second
positioning steps comprises disposing less than an entirety of said lower surface of said
30 wafer in contact with said first and second fixtures, respectively.

222. A method, as claimed in Claim 218, further comprising the step of:
 biasing said wafer toward said first fixture when said wafer is on said first fixture,
and biasing said wafer toward said second fixture when said wafer is on said second
fixture.

223. A method, as claimed in Claim 222, wherein:

each said biasing step comprises using a vacuum.

224. A method, as claimed in Claim 218, further comprising the steps of:

5 retaining said wafer on said first fixture using a vacuum, and retaining said wafer on said second fixture using a vacuum.

225. A method, as claimed in Claim 218, further comprising the step of:

maintaining a first cutting edge of said first blade in spaced relation to said first fixture.

10 226. A method, as claimed in Claim 225, wherein:

said maintaining step comprises disposing said first cutting edge of said first blade above a first cutting edge cavity formed on an upper surface of said first fixture.

227. A method, as claimed in Claim 225, wherein:

said maintaining step is executed throughout said mounting step.

15 228. A method, as claimed in Claim 218, wherein:

said wafer comprises a first score associated with said first blade, wherein said first positioning step comprises supporting said wafer with said first fixture directly under said first score, wherein said separating step utilizes said first score.

229. A method, as claimed in Claim 228, further comprising the step of:

20 aligning said first score with a predetermined crystal plane of said wafer.

230. A method, as claimed in Claim 218, wherein:

said wafer comprises a first score associated with said first blade, wherein said first positioning step comprises supporting said wafer such that said mounting step does not result in any net moment about said first score.

25 231. A method, as claimed in Claim 218, wherein:

said wafer comprises a first cantilever, wherein said first blade is disposed on an end of said first cantilever, wherein said first positioning step comprises supporting said first cantilever with said first fixture.

232. A method, as claimed in Claim 231, wherein:

30 said first positioning step comprises inhibiting any deflection of said first cantilever during said mounting step.

233. A method, as claimed in Claim 218, wherein:

said mounting step comprises maintaining said first blade handle in spaced relation with an entirety of said first fixture.

234. A method, as claimed in Claim 218, wherein:

said mounting step comprises applying an adhesive to at least one of said first blade handle and said first blade.

235. A method, as claimed in Claim 234, wherein:

5 said adhesive is light curable, wherein said method further comprises disposing said first blade handle in a predetermined position relative to said first blade after said applying step, and thereafter exposing at least a portion of said adhesive to light to fix said first blade handle to said first blade.

236. A method, as claimed in Claim 218, wherein:

10 said mounting step comprises disposing a first registrant extending from a lower surface of said first blade handle into a first registration cavity accessible through an upper surface of said first blade.

237. A method, as claimed in Claim 236, wherein:

15 said disposing step comprises maintaining said first registrant in spaced relation with said first fixture.

238. A method, as claimed in Claim 236, wherein:

 said disposing step comprises directing said first registrant of said first blade handle toward a first registrant cavity formed on an upper surface of said first fixture that is aligned with said first registrant.

20 239. A method, as claimed in Claim 218, wherein:

 said mounting step comprises disposing first and second registrants extending from a lower surface of said first blade handle into first and second registration cavities accessible through an upper surface of said first blade.

240. A method, as claimed in Claim 239, wherein:

25 said disposing step comprises supporting said first blade with said first fixture between said first and second registration cavities.

241. A method, as claimed in Claim 218, wherein:

 said mounting step comprises:

30 disposing said first blade handle on an upper surface of said first blade;
 executing a first moving step comprising moving said first blade handle relative to said first blade after said disposing step; and
 terminating said first moving step upon registering said first blade handle to said first blade.

242. A method, as claimed in Claim 241, wherein:

said disposing step comprises moving said first blade handle in a first direction toward said first blade, and wherein said first moving step comprises moving said blade handle in a second direction that is at least generally perpendicular to said first direction.

5 243. A method, as claimed in Claim 241, wherein:

said first moving step comprises moving said first blade handle at least generally away from said first cutting edge of said first blade.

244. A method, as claimed in Claim 241, wherein:

10 said first moving step comprises moving said first blade handle in a direction that is at least generally parallel to said upper surface of said first blade.

245. A method, as claimed in Claim 241, wherein:

said registering step comprises a first registrant of said first blade handle engaging a first registration surface of said first blade.

246. A method, as claimed in Claim 241, further comprising the step of:

15 securing said first blade handle to said first blade after said terminating step.

247. A method, as claimed in Claim 218, wherein:

said wafer comprises a plurality of said first blades, wherein said method further comprises repeating said mounting step for each of said plurality of said first blades before said removing step.

20 248. A method, as claimed in Claim 218, further comprising the step of:

maintaining a first cutting edge of said first blade in spaced relation to said second fixture.

249. A method, as claimed in Claim 248, wherein:

25 said maintaining step comprises disposing said first cutting edge of said first blade above a first cutting edge cavity formed on an upper surface of said second fixture.

250. A method, as claimed in Claim 248, further comprising the step of:

30 seating said first blade on said second fixture after said separating step, wherein said maintaining step is executed throughout an entirety of said separating step, from an end of said separating step to a start of said seating step, and throughout an entirety of said seating step.

251. A method, as claimed in Claim 248, further comprising the step of:

executing a second maintaining step comprising maintaining said first cutting edge of said first blade in spaced relation to said first fixture.

252. A method, as claimed in Claim 251, wherein:

said second maintaining step comprises disposing said first cutting edge of said first blade above a first cutting edge cavity formed on an upper surface of said first fixture.

5 253. A method, as claimed in Claim 251, wherein:

said second maintaining step is executed throughout both said mounting step, wherein said first cutting edge never contacts either said first fixture or said second fixture.

254. A method, as claimed in Claim 218, further comprising the steps
10 of:

maintaining a first cutting edge of said first blade in spaced relation to said first fixture throughout said mounting step; and

maintaining said first cutting edge of said first blade in spaced relation to said second fixture both throughout and after said separating step.

255. A method, as claimed in Claim 218, further comprising the steps
15 of:

seating said first blade on said second fixture after said separating step; and

maintaining a first cutting edge of said first blade in spaced relation to said second fixture throughout said separating step, from an end of said separating step to a start of
20 said seating step, and throughout an entirety of said seating step.

256. A method, as claimed in Claim 218, wherein:

said second positioning step comprises disposing an entirety of said first blade in spaced relation with said second fixture.

257. A method, as claimed in Claim 218, wherein:

25 said second positioning step comprises suspending said first blade above said second fixture.

258. A method, as claimed in Claim 257, wherein:

said wafer comprises a first cantilever, wherein said first blade is disposed on an end of said first cantilever, wherein said second positioning step comprises supporting at
30 least a portion of said first cantilever with said second fixture.

259. A method, as claimed in Claim 257, wherein:

said wafer further comprises a first blade support tab, wherein said first blade is disposed on an end of said first blade support tab, wherein said second positioning step

comprises supporting at least a portion of said first blade support tab with said second fixture.

260. A method, as claimed in Claim 218, wherein:

said separating step comprises fracturing said wafer.

5 261. A method, as claimed in Claim 218, wherein:

said separating step is executed at least substantially along a line that is at least substantially parallel with said first cutting edge.

262. A method, as claimed in Claim 218, wherein:

10 said wafer comprises a first score associated with said first blade, wherein said separating step comprises fracturing said wafer at least substantially along said first score.

263. A method, as claimed in Claim 262, wherein:

said second positioning step comprises supporting said wafer proximate to said first score, while an entirety of said first blade is disposed in spaced relation to said second fixture.

15 264. A method, as claimed in Claim 218, wherein:

said separating step comprises deflecting said first blade in a direction of said second fixture.

265. A method, as claimed in Claim 218, wherein:

said separating step is executed with a first handle mounted on said first blade.

20 266. A method, as claimed in Claim 265, wherein:

said separating step comprises applying a force on said first handle that is at least generally directed toward said first fixture.

267. A method, as claimed in Claim 218, wherein:

25 said separating step comprises applying a force directly on said first blade that is at least generally directed toward said first fixture.

268. A method, as claimed in Claim 218, wherein:

said separating step is completed before any portion of said first blade contacts said second fixture.

269. A method, as claimed in Claim 218, wherein:

30 said separating step comprises executing a first moving step, wherein said method further comprises the step of executing a second moving step, wherein said first moving step comprises moving a first cutting edge of said first blade at least generally toward said second fixture without having said first cutting edge actually contact said second fixture, and wherein said second moving step comprises moving said first cutting edge of said

first blade at least generally away from said second fixture before said first moving step causes said first cutting edge to contact said second fixture.

270. A method, as claimed in Claim 218, further comprising the steps of:

5 moving said first blade into contact with said second fixture after said separating step, and then pivoting said first blade to direct a first cutting edge of said first blade at least generally away from said second fixture.

271. A method, as claimed in Claim 218, further comprising the step of:
disposing a lower surface of said first blade against a first surface of said second
10 fixture after said separating step such that a rear edge of said first blade is disposed at a lower elevation relative to a first cutting edge of said first blade, wherein said first surface is both inclined and planar.

272. A method, as claimed in Claim 271, further comprising the step of:
retaining said first blade against said first surface.

15 273. A method, as claimed in Claim 272, wherein:
said retaining step comprises using a vacuum.

274. A method, as claimed in Claim 218, wherein:
said wafer comprises a plurality of said first blades, wherein said method further
comprises repeating said separating step for each of said plurality of said first blades, and
20 thereafter removing said wafer from said second fixture.

275. A method, as claimed in Claim 218, wherein said wafer comprises
a plurality of said first blades, wherein said method further comprises the steps of:

repeating said mounting step for each of said plurality of said first blades before
said removing step;
25 repeating said separating step for each of said plurality of said first blades; and
removing said wafer from said second fixture after every said first blade has been
separated from said wafer.

276. A cutting tool, comprising:
a blade body comprising first and second oppositely disposed major surfaces, a
30 first cutting edge surface disposed at an angle relative to at least said first major surface,
and a first cutting edge defined at least in part by said first cutting edge surface, wherein
said first major surface is defined by a first set of 3 Miller indices, and wherein at least
one individual Miller index of said first set has an absolute value greater than 3.

277. A cutting tool, as claimed in Claim 276, wherein:
said blade body is of a material selected from the group consisting of ceramic, silicon, and quartz.

5 278. A cutting tool, as claimed in Claim 276, wherein:
said blade body is a single crystal material.

279. A cutting tool, as claimed in Claim 276, wherein:
said second major surface is also defined by said first set of 3 Miller indices.

10 280. A cutting tool, as claimed in Claim 276, wherein:
said first cutting edge surface is aligned with a predetermined crystallographic
plane.

281. A cutting tool, as claimed in Claim 276, wherein:
said first cutting edge surface is an etched surface.

15 282. A cutting tool, as claimed in Claim 281, wherein:
said first cutting edge surface is aligned with a predetermined crystallographic
plane.

283. A cutting tool, as claimed in Claim 276, wherein:
said first cutting edge surface is oriented other than perpendicular to said first
major surface.

20 284. A cutting tool, as claimed in Claim 276, wherein:
said blade body further comprises a first registration surface spaced from said first
cutting edge and parallel with said first cutting edge surface.

285. A cutting tool, as claimed in Claim 284, wherein:
said first registration surface is aligned with a predetermined crystallographic
plane.

25 286. A cutting tool, as claimed in Claim 284, wherein:
said first registration surface is an etched surface.

287. A cutting tool, as claimed in Claim 286, wherein:
said first registration surface is aligned with a predetermined crystallographic
plane.

30 288. A cutting tool, as claimed in Claim 284, wherein:
said first cutting edge surface and said first registration surface are aligned with a
common, predetermined crystallographic plane.

289. A cutting tool, as claimed in Claim 284, wherein:

said first cutting edge surface and said first registration surface are each an etched surface.

290. A cutting tool, as claimed in Claim 289, wherein:

5 said first cutting edge surface and said first registration surface are aligned with a common, predetermined crystallographic plane.

291. A cutting tool, as claimed in Claim 284, wherein:

10 said first cutting edge surface extends from a first edge to said first cutting edge, wherein said first registration surface extends from a second edge to a third edge, wherein said first and second edges are disposed within a first reference plane, wherein said first cutting edge and said third edge are disposed within a second reference plane, and wherein said first and second reference planes are parallel.

292. A cutting tool, as claimed in Claim 284, further comprising:

15 a blade handle interconnected with said blade body and comprising a first registrant that interfaces with at least part of said first registration surface.

293. A cutting tool, as claimed in Claim 292, wherein:

20 an intersection between said first registration surface and said first major surface defines a first edge, wherein an intersection between said first registration surface and said second major surface defines a second edge, and wherein said blade holder interfaces with said first major surface.

294. A cutting tool, as claimed in Claim 293, wherein:

said first registrant interfaces with said first registration surface closer to said second edge than said first edge.

295. A cutting tool, as claimed in Claim 293, wherein:

25 said first registrant interfaces with said first registration surface along said second edge.

296. A cutting tool, as claimed in Claim 293, wherein:

said first registrant extends below said second edge.

297. A cutting tool, as claimed in Claim 284, wherein:

30 said blade body comprises a second registration surface spaced from said first cutting edge and parallel with said first cutting edge surface.

298. A cutting tool, as claimed in Claim 297, wherein:

said first and second registration surfaces are disposed within a common reference plane.

299. A cutting tool, as claimed in Claim 297, wherein:
said first and second registration surfaces are aligned with a common, predetermined crystallographic plane.
300. A cutting tool, as claimed in Claim 297, wherein:
5 said first and second registration surface are each an etched surface.
301. A cutting tool, as claimed in Claim 300, wherein:
said first and second registration surfaces are aligned with a common, predetermined crystallographic plane.
302. A cutting tool, as claimed in Claim 297, wherein:
10 said first cutting edge surface, said first registration surface, and said second registration surface are aligned with a common, predetermined crystallographic plane.
303. A cutting tool, as claimed in Claim 297, wherein:
said first cutting edge surface, said first registration surface, and said second registration surface are each an etched surface.
304. A cutting tool, as claimed in Claim 303, wherein:
15 said first cutting edge surface, said first registration surface, and said second registration surface are aligned with a common, predetermined crystallographic plane.
305. A cutting, tool, as claimed in Claim 297, further comprising:
a blade handle interconnected with said blade body and comprising first and
20 second registrants that interface with at least part of said first and second registration surfaces, respectively.
306. A cutting tool, as claimed in Claim 305, wherein:
said first and second registrants are positioned along a reference axis that is parallel with said first cutting edge.
307. A cutting tool, as claimed in Claim 305, wherein:
25 said first and second registrants are equidistant from said first cutting edge.
308. A cutting tool, as claimed in Claim 276, wherein:
said blade body further comprises a concave first registration cavity spaced from said first cutting edge and comprising first and second ends.
309. A cutting tool, as claimed in Claim 308, wherein:
30 said first registration cavity extends entirely through said blade body.

310. A cutting tool, as claimed in Claim 308, wherein:

said first end of said first registration cavity is perpendicular to said first major surface, and wherein said first registration surface is disposed at an angle other than perpendicular relative to said first major surface.

5 311. A cutting, tool, as claimed in Claim 308, further comprising:

a blade handle interconnected with said blade body and comprising a first registrant that interfaces with at least part of second end of said first registration cavity, wherein said first registrant is spaced from said first end of said first registration cavity.

312. A cutting tool, as claimed in Claim 308, wherein:

10 said blade body further comprises a concave second registration cavity spaced from said first cutting edge and comprising third and fourth ends.

313. A cutting, tool, as claimed in Claim 312, further comprising:

a blade handle interconnected with said blade body and comprising first and second registrants that interface with at least part of second end of said first registration cavity and at least part of said fourth end of said second registration cavity, wherein said first
15 registrant is spaced from said first end of said first registration cavity, and wherein said second registrant is spaced from said third end of said second registration cavity.

314. A method for fabricating a blade from a substrate, comprising the steps of:

20 executing a first etching step comprising etching said substrate to define a first cutting edge surface for a first blade; and

executing a second etching step comprising etching said substrate to define a first score, wherein said first blade may be separated from said substrate at least substantially along said first score.

25 315. A method, as claimed in Claim 314, wherein:

said substrate is ceramic.

316. A method, as claimed in Claim 314, wherein:

said substrate is silicon.

317. A method, as claimed in Claim 314, wherein:

30 said substrate is quartz.

318. A method, as claimed in Claim 314, wherein:

said substrate is a single crystal material.

319. A method, as claimed in Claim 314, wherein:

said first and second etching steps are simultaneously executed with a single etchant.

320. A method, as claimed in Claim 319, wherein:

5 said single etchant is an anisotropic etchant.

321. A method, as claimed in Claim 314, wherein:

said first and second etching steps are each a chemical etch.

322. A method, as claimed in Claim 314, further comprising the step of:

10 defining a first cutting edge for said first blade using said first etching step, wherein said first cutting edge is parallel with a length dimension of said first score.

323. A method, as claimed in Claim 314, further comprising the step of:

15 executing a third etching step comprising etching through said substrate to define a first portion of a perimeter of said first blade, and etching through said substrate to define a first blade support tab interconnecting said first blade with a remainder of said substrate, wherein said first score extends across at least a portion of said first blade support tab.

324. A method, as claimed in Claim 323, wherein:

20 said first, second, and third etching steps are simultaneously executed with a single etchant.

325. A method, as claimed in Claim 323, wherein:

said first score extends across only a portion of said first blade support tab.

326. A method, as claimed in Claim 323, wherein:

25 said first score comprises first and second ends, wherein said first and second ends are spaced inwardly from first and second edges, respectively, of said first blade support tab.

327. A method, as claimed in Claim 323, wherein:

30 said third etching step comprises etching through said substrate to define a pair of notches on a first perimeter wall of said first blade, wherein said first blade support tab extends between said pair of notches, and wherein said first score is located so that said pair of notches are disposed beyond said first score.

328. A method, as claimed in Claim 323, wherein:

said second etching step comprises locating said first score at a minimum width location along said first blade support tab.

329. A method, as claimed in Claim 314, wherein:

said second etching step comprises etching into said substrate a first amount that is within a range of about 2% to about 75% of a thickness of said substrate.

330. A method, as claimed in Claim 314, wherein:

5 said second etching step comprises etching into said substrate a first amount that is within a range of about 2% to about 5% of a thickness of said substrate.

331. A method, as claimed in Claim 314, wherein:

said second etching step comprises etching into said substrate a first amount that is within a range of about 10 microns to about 30 microns.

10 332. A method, as claimed in Claim 314, wherein:

said second etching step comprises etching through only a portion of a thickness of said substrate.

333. A method, as claimed in Claim 314, wherein:

15 said second etching step comprises etching said substrate to define first and second planar score surfaces that intersect along a first line.

334. A method, as claimed in Claim 332, wherein:

said first line is aligned with a crystallographic plane of said substrate.

335. A method, as claimed in Claim 314, wherein:

20 said second etching step comprises aligning said first score with a crystallographic plane of said substrate.

336. A method, as claimed in Claim 314, wherein:

said first score comprises a first score surface that is parallel with said first cutting edge surface.

337. A method, as claimed in Claim 314, further comprising the steps

25 of:

forming a first masking layer on said substrate; and

transferring a blade mask onto said first masking layer, wherein each of said first and second etching steps are executed through openings in said first masking layer in accordance with said blade mask.

30 338. A method, as claimed in Claim 337, wherein:

a first portion of said transferring step is selected from the group consisting of photomasking, masking, photolithography, and microphotolithography said first masking layer in accordance with said blade mask, and wherein a second portion of said transferring step is selected from the group consisting of wet chemical etching, plasma

etching, reactive ion etching, and ion beam milling said first masking layer in accordance with said blade mask.

339. A method for fabricating a blade from a substrate, comprising the steps of:

5 executing a first etch comprising etching through a substrate to define a first perimeter portion of a first blade, wherein said first perimeter portion extends between first and second ends such that said first blade remains part of said substrate between said first and second ends;

10 executing a second etch comprising etching through said substrate to define a first blade support tab, wherein a first free end of said first blade support tab merges into said first blade between said first and second ends; and

 executing a third etch comprising etching a first score across at least a portion of said first blade support tab.

15 340. A method, as claimed in Claim 339, wherein:
 said substrate is ceramic.

 341. A method, as claimed in Claim 339, wherein:
 said substrate is silicon.

 342. A method, as claimed in Claim 339, wherein:
 said substrate is quartz.

20 343. A method, as claimed in Claim 339, wherein:
 said substrate is a single crystal material.

 344. A method, as claimed in Claim 339, wherein:
 said first, second, and third etches are simultaneously executed with a single etchant.

25 345. A method, as claimed in Claim 344, wherein:
 said single etchant is an anisotropic etchant.

 346. A method, as claimed in Claim 339, wherein:
 said first, second, and third etches are each a chemical etch.

30 347. A method, as claimed in Claim 339, wherein:
 said first etch comprises defining a first cutting edge for said first blade, wherein said first cutting edge is parallel with a length dimension of said first score.

 348. A method, as claimed in Claim 339, wherein:
 said first score extends across only a portion of said first blade support tab.

349. A method, as claimed in Claim 339, wherein:

said first score comprises first and second ends, wherein each of said first and second ends are spaced inwardly from first and second side edges of said first blade support tab.

5 350. A method, as claimed in Claim 339, wherein:

said first etch comprises etching through said substrate to define a pair of notches on a first perimeter wall of said first blade, wherein said first blade support tab extends between said pair of notches, and wherein said first score is located so that said pair of notches are disposed beyond said first score.

10 351. A method, as claimed in Claim 339, wherein:

said third etch comprises etching into said substrate a first amount that is within a range of about 2% to about 75% of a thickness of said substrate.

352. A method, as claimed in Claim 339, wherein:

15 said third etch comprises etching into said substrate a first amount that is within a range of about 2% to about 5% of a thickness of said substrate.

353. A method, as claimed in Claim 339, wherein:

said third etch comprises etching into said substrate a first amount that is within a range of about 10 microns to about 30 microns.

354. A method, as claimed in Claim 339, wherein:

20 said third etch comprises etching through only a portion of a thickness of said substrate.

355. A method, as claimed in Claim 339, wherein:

said third etch comprises etching said substrate to define first and second planar score surfaces that intersect along a first line.

25 356. A method, as claimed in Claim 355, wherein:

said first line is aligned with a crystallographic plane of said substrate.

357. A method, as claimed in Claim 339, wherein:

said third etch comprises aligning said first score with a crystallographic plane of said substrate.

30 358. A method, as claimed in Claim 339, wherein:

said first score comprises a first score surface that is parallel with a first cutting edge surface of said first blade defined by said first etch.

359. A method, as claimed in Claim 339, wherein:

said third etch comprises locating said first score at a minimum width location along said first blade support tab.

5 of: 360. A method, as claimed in Claim 339, further comprising the steps

forming a first masking layer on said substrate; and

transferring a blade mask onto said first masking layer, wherein each of said first, second, and third etches are executed through openings in said first masking layer in accordance with said blade mask.

10 361. A method, as claimed in Claim 360, wherein:

a first portion of said transferring step is selected from the group consisting of photomasking, masking, photolithography, and microphotolithography said first masking layer in accordance with said blade mask, and wherein a second portion of said transferring step is selected from the group consisting of wet chemical etching, plasma etching, reactive ion etching, and ion beam milling said first masking layer in accordance with said blade mask.

362. A method for fabricating a blade from a substrate, comprising the steps of:

20 creating at least one opening that extends completely through said substrate, wherein said creating step comprises defining a first perimeter portion of a first blade, wherein said first perimeter portion extends between first and second ends such that said first blade remains part of said substrate between said first and second ends; and

defining a first score having first and second ends, wherein each of said first and second ends are spaced from any said opening from said creating step.

25 363. A method, as claimed in Claim 362, wherein:
said substrate is ceramic.

364. A method, as claimed in Claim 362, wherein:
said substrate is silicon.

30 365. A method, as claimed in Claim 362, wherein:
said substrate is quartz.

366. A method, as claimed in Claim 362, wherein:
said substrate is a single crystal material.

367. A method, as claimed in Claim 362, wherein:
said creating step comprises etching.

368. A method, as claimed in Claim 367, wherein:
said etching step is an anisotropic etch.

369. A method, as claimed in Claim 362, wherein:
said defining a first perimeter portion step comprises defining a first cutting edge,
5 wherein said defining a first score step comprises disposing said first score in parallel
relation with said first cutting edge.

370. A method, as claimed in Claim 362, wherein:
said defining a first perimeter portion step comprises defining a planar first cutting
edge surface, wherein said defining a first score step comprises defining a planar first
10 score surface, wherein said first cutting edge surface and said first score surface are
parallel.

371. A method, as claimed in Claim 362, wherein:
said creating step further comprising defining a first blade support tab that
interconnects said first blade with a remainder of said substrate, wherein said first score
15 extends across at least a portion of said first blade support tab.

372. A method, as claimed in Claim 371, wherein:
said first score extends across only a portion of said first blade support tab.

373. A method, as claimed in Claim 371, wherein:
said first and second ends of said first score are spaced inwardly from first and
20 second side edges, respectively, of said first blade support tab.

374. A method, as claimed in Claim 371, wherein:
said defining a first perimeter portion step comprises defining a pair of notches on
a first perimeter wall of said first blade, wherein said first blade support tab extends
between said pair of notches, wherein said first score is located so that said pair of
25 notches are disposed beyond said first score.

375. A method, as claimed in Claim 371, wherein:
said defining a first score step comprises locating said first score at a minimum
width location along said first blade support tab.

376. A method, as claimed in Claim 362, wherein:
30 said defining a first score step comprises etching.

377. A method, as claimed in Claim 362, wherein:
said defining a first score step comprises extending said first score to a depth
within said substrate that is within a range of about 2% to about 75% of a thickness of
said substrate.

378. A method, as claimed in Claim 362, wherein:

said defining a first score step comprises extending said first score to a depth within said substrate that is within a range of about 2% to about 5% of a thickness of said substrate.

5 379. A method, as claimed in Claim 362, wherein:

said defining a first score step comprises extending said first score to a depth within said substrate that is within a range of about 10 microns to about 30 microns.

380. A method, as claimed in Claim 362, wherein:

10 said defining a first score step comprises extending said first score through only a portion of a thickness of said substrate.

381. A method, as claimed in Claim 362, wherein:

said defining a first score step comprises defining first and second planar score surfaces that intersect along a first line.

382. A method, as claimed in Claim 381, wherein:

15 said first line is aligned with a crystallographic plane of said substrate.

383. A method, as claimed in Claim 362, wherein:

said defining a first score step comprises aligning said first score with a crystallographic plane of said substrate.

384. A method, as claimed in Claim 362, wherein:

20 said creating step and said defining a first score step each comprise etching said substrate.

385. A method, as claimed in Claim 384, further comprising the steps of:

forming a first masking layer on said substrate; and

25 transferring a blade mask onto said first masking layer, wherein said etching step is executed through openings in said first masking layer in accordance with said blade mask.

386. A method, as claimed in Claim 385, wherein:

30 a first portion of said transferring step is selected from the group consisting of photomasking, masking, photolithography, and microphotolithography said first masking layer in accordance with said blade mask, and wherein a second portion of said transferring step is selected from the group consisting of wet chemical etching, plasma etching, reactive ion etching, and ion beam milling said first masking layer in accordance with said blade mask.

387. A method for fabricating a blade from a substrate, comprising the steps of:

creating at least one opening that extends completely through said substrate, wherein said creating step comprises defining a first perimeter portion of a first blade,
5 wherein said first perimeter portion extends between first and second ends such that said first blade remains part of said substrate between said first and second ends; and

defining a first score on said substrate that is associated with said first blade, wherein said defining a first score step comprises using a same technique as said creating step, and wherein said first blade may be separated from a remainder of said substrate
10 using said first score.

388. A method for fabricating a blade from a substrate, comprising the steps of:

creating at least one opening that extends completely through said substrate, wherein said creating step comprises defining a first perimeter portion of a first blade,
15 wherein said first perimeter portion extends between first and second ends such that said first blade remains part of said substrate between said first and second ends; and

defining a first score on said substrate that is associated with said first blade, wherein said defining a first score step is executed during said creating step, and wherein said first blade may be separated from a remainder of said substrate using said first score.

20 389. A method for fabricating a blade from a substrate, comprising the steps of:

creating at least one opening that extends completely through said substrate, wherein said creating step comprises defining a first perimeter portion of a first blade, wherein said first perimeter portion extends between first and second ends such that said
25 first blade remains part of said substrate between said first and second ends, wherein said first perimeter portion comprises a first cutting edge and an oppositely disposed rear end; and

defining a first score on said substrate that is associated with said first blade, wherein said first score is located between a rearwardmost portion of said rear end and said first cutting edge, and wherein said first blade may be separated from a remainder of said substrate
30 using said first score.

390. A cutting blade, comprising:

a body, comprising:

a first cutting edge;

a first perimeter wall comprising a notch, wherein a first perimeter surface of said notch is of a first texture and a second perimeter surface of said notch is of a second texture that is different than said first texture.

391. A cutting blade, as claimed in Claim 390, wherein:

5 said body is formed from a material selected from the group consisting of single crystal silicon and single crystal quartz.

392. A cutting blade, as claimed in Claim 390, wherein:

 said body is formed from a single crystal material for which there is at least one crystal-plane selective etchant.

10 393. A cutting blade, as claimed in Claim 390, wherein:

 said first cutting edge defines a first end of said body, and wherein said first perimeter wall defines a second end of said first body that is opposite said first end.

394. A cutting blade, as claimed in Claim 390, wherein:

15 said first cutting edge and said first perimeter surface of said notch are at least generally parallel.

395. A cutting blade, as claimed in Claim 390, wherein:

 said first cutting edge and said second perimeter surface of said notch are parallel.

396. A cutting blade, as claimed in Claim 390, wherein:

20 said body comprises upper and lower surfaces, wherein each of said first and second perimeter surfaces of said notch are perpendicular to each of said upper and lower surfaces.

397. A cutting blade, as claimed in Claim 390, wherein:

 said first and second perimeter surfaces of said notch are each planar surfaces that are disposed within a common reference plane.

25 398. A cutting blade, as claimed in Claim 390, wherein:

 said first and second perimeter surfaces of said notch are each planar surfaces that are parallel to and offset from each other.

399. A cutting blade, as claimed in Claim 390, wherein:

30 said second perimeter surface is offset from said first perimeter surface, wherein said second perimeter surface is an etched surface, and wherein said first perimeter surface is defined other than by an etch.

400. A cutting blade, as claimed in Claim 390, wherein:

 said second perimeter surface of said notch is an etched surface, and wherein said first perimeter surface of said notch is a fractured surface.

401. A cutting blade, as claimed in Claim 390, wherein:

said body comprises upper and lower surfaces, wherein said first perimeter wall extends between said first and second primary surfaces, and wherein an entirety of a perimeter of said notch, including said second perimeter surface, is etched except for said
5 first perimeter surface.

402. A cutting blade, as claimed in Claim 390, wherein:

said body comprises upper and lower surfaces, wherein all surfaces of said body extending from said upper surface at least generally in a direction of said lower surface and vice versa, except for said first perimeter surface of said notch, are etched.

10 403. A cutting blade, as claimed in Claim 390, wherein:

said body comprises upper and lower surfaces, wherein all surfaces of said body except said upper surface, said lower surface, and said first perimeter surface are etched.

404. A cutting blade, as claimed in Claim 390, wherein:

said body comprises first and second primary surfaces, wherein said first
15 perimeter wall extends between said first and second primary surfaces, wherein said second perimeter surface of said notch extends from said first primary surface toward said second primary surface and terminates prior to reaching said second primary surface, wherein a first part of said first perimeter surface of said notch extends from a lowest extreme of said second perimeter surface of said notch to said second primary surface.

20 405. A cutting blade, as claimed in Claim 404, wherein:

a second part of said first perimeter surface of said notch extends from said first primary surface to said second primary surface, wherein a third part of said first perimeter surface of said notch also extends from said first primary surface to said second primary surface, and wherein said second perimeter surface is disposed between said second and
25 third parts of said first perimeter surface of said notch.

406. A cutting blade, as claimed in Claim 405, wherein:

said first perimeter surface of said notch is at least generally U-shaped in plan view.

407. A cutting blade, as claimed in Claim 390, wherein:

30 said second perimeter surface of said notch is a first score surface of a first score used to separate said first blade from a remainder of a wafer from which said first blade was fabricated.

408. A cutting blade, as claimed in Claim 407, wherein:

said body comprises upper and lower surfaces, wherein said first score surface is planar and perpendicular to each of said upper and lower surfaces.

409. A cutting blade, as claimed in Claim 390, wherein:

5 said first perimeter wall comprises first and second sections that are laterally spaced and disposed on opposite sides of said notch, wherein a perimeter of said notch comprises said first and second perimeter surfaces, a third perimeter surface, and a fourth perimeter surface, wherein said third perimeter surface intersects with said first section of said first perimeter wall, wherein said fourth perimeter surface intersects with said second
10 section of said first perimeter wall, and wherein an entirety of said first perimeter surface of said notch is recessed relative to said first and second sections of said first perimeter wall.

410. A cutting blade, as claimed in Claim 409, wherein:

15 said second perimeter surface of said notch is an etched surface, and wherein said first perimeter surface of said notch is a fractured surface.

411. A cutting blade, comprising:

a body, comprising:

upper and lower surfaces;

a first cutting edge;

20 a first perimeter wall extending between said upper and lower surfaces and comprising a notch, wherein an entirety of a perimeter of said notch is etched except for a first perimeter surface.

412. A cutting blade wafer, comprising:

a wafer comprising a frame;

25 a first cutting blade comprising a first cutting edge;

a first blade support tab interconnecting said frame of said wafer and said first cutting blade, wherein said first blade support tab comprises first and second sides that are laterally spaced;

30 a first space disposed between said first side of said first blade support tab and a first portion of said first cutting blade; and

a second space disposed between said second side of said first blade support tab and a second portion of said first cutting blade.

413. A cutting blade wafer, as claimed in Claim 412, wherein:

said wafer comprises upper and lower surfaces, wherein said cutting blade wafer comprises a first perimeter opening extending from said upper surface to said lower surface and that extends about an entirety of a perimeter of said first cutting blade except
5 for where said first cutting blade interfaces with said first blade support tab, wherein said first perimeter opening comprises said first and second spaces.

414. A cutting blade wafer, as claimed in Claim 412, further comprising:

a first score extending across at least a portion of said first blade support tab in a
10 direction progressing toward each of said first and second sides of said first blade support tab.

415. A cutting blade wafer, as claimed in Claim 414, wherein:

said first score extends across only a portion of said first blade support tab.

416. A cutting blade wafer, as claimed in Claim 414, wherein:

15 said first score comprises first and second ends, wherein said first and second ends are spaced inwardly from first and second sides, respectively, of said first blade support tab.

417. A cutting blade wafer, as claimed in Claim 414, wherein:

said first score has a depth that is within a range of about 2% to about 75% of a
20 thickness of said wafer.

418. A cutting blade wafer, as claimed in Claim 414, wherein:

said first score has a depth that is within a range of about 2% to about 5% of a thickness of said wafer.

419. A cutting blade wafer, as claimed in Claim 414, wherein:

25 said first score has a depth that is within a range of about 10 microns to about 30 microns.

420. A cutting blade wafer, as claimed in Claim 414, wherein:

said first score extends through only a portion of a thickness of said wafer.

421. A cutting blade wafer, as claimed in Claim 414, wherein:

30 said first score comprises first and second planar score surfaces that intersect along a first line.

422. A cutting blade wafer, as claimed in Claim 421, wherein:

said first line is aligned with a crystallographic plane of said wafer.

423. A cutting blade wafer, as claimed in Claim 414, wherein:

at least a portion of said first score is aligned with a crystallographic plane of said wafer.

424. A cutting blade wafer, as claimed in Claim 414, wherein:

5 said first cutting blade comprises a first, second, third, and fourth wall sections, wherein said first and second wall sections intersect, wherein said third and fourth wall sections intersect, wherein said second and fourth wall sections each define a portion of a boundary of said first and second spaces, respectively, wherein said first score is recessed relative to a reference plane that contacts at least a portion of each of said first and third
10 wall sections.

425. A cutting blade wafer, as claimed in Claim 424, wherein:

 said first cutting blade further comprises fifth and sixth wall sections, wherein said fifth wall section is located between said second wall section of said cutting blade and said first side of said blade support tab and thereby also defines a portion of said
15 boundary of said first space, wherein said sixth wall section is located between said fourth wall section of said cutting blade and said second side of said blade support tab and thereby also defines a portion of said boundary of said second space, and wherein said first score is recessed relative to said reference plane in a direction of said fifth and sixth wall sections.

20 426. A cutting blade wafer, as claimed in Claim 414, wherein:

 said first cutting blade comprises a first, second, third, and fourth wall sections, wherein said first and second wall sections intersect at a first location, wherein said third and fourth wall sections intersect at a second location, wherein said second and fourth wall sections each define a portion of a boundary of said first and second spaces,
25 respectively, and at least generally face said first and second sides, respectively, of said first blade support tab, wherein said first and third wall sections fail to define any portion of said first and second spaces, wherein said first score is offset from a reference plane that extends through said first and second locations, wherein said offset is in a direction of where said first blade support tab merges with said first cutting blade.

30 427. A microkeratome cutting tool, comprising:

 a blade comprising first and second oppositely disposed major surfaces, a first cutting edge surface disposed at an angle relative to each of and extending between said first and second major surfaces, and a first cutting edge defined by an intersection of said first cutting edge surface and said first major surface; and

a blade handle mounted on said blade and comprising a lower surface, wherein said lower surface of said blade handle and part of said first major surface face each other, and wherein said blade handle is spaced back from said first cutting edge.

428. A microkeratome cutting tool, as claimed in Claim 427 wherein:
5 said blade is a material selected from the group consisting of ceramic, silicon, and quartz.

429. A microkeratome cutting tool, as claimed in Claim 427, wherein:
said blade is a single crystal material.

430. A microkeratome cutting tool, as claimed in Claim 427, wherein:
10 said first and second major surfaces are planar and disposed in parallel relation.

431. A microkeratome cutting tool, as claimed in Claim 427, wherein:
at least one of said first and second major surfaces are defined by a first set of 3 Miller indices, and wherein at least one individual Miller index of said first set has an absolute value greater than 3.

432. A microkeratome cutting tool, as claimed in Claim 431, wherein:
15 each of said first and second major surfaces are defined by said first set of 3 Miller indices.

433. A microkeratome cutting tool, as claimed in Claim 427, wherein:
said first cutting edge surface is aligned with a predetermined crystallographic
20 plane.

434. A microkeratome cutting tool, as claimed in Claim 427, wherein:
said first cutting edge surface is an etched surface.

435. A microkeratome cutting tool, as claimed in Claim 434, wherein:
said first cutting edge surface is aligned with a predetermined crystallographic
25 plane.

436. A microkeratome cutting tool, as claimed in Claim 427, wherein:
said first cutting edge surface is oriented other than perpendicular to said first major surface.

437. A microkeratome cutting tool, as claimed in Claim 427, wherein:
30 an angle between said first cutting edge surface and said first major surface is acute.

438. A microkeratome cutting tool, as claimed in Claim 427, wherein:
said first cutting edge surface is planar.

439. A microkeratome cutting tool, as claimed in Claim 427, wherein:
said blade further comprises a first registration surface spaced from said first cutting edge, and wherein said blade handle comprises a first registrant that interfaces with at least part of said first registration surface.
- 5 440. A microkeratome cutting tool, as claimed in Claim 427, wherein:
said blade further comprises a first registration surface spaced from said first cutting edge and parallel with said first cutting edge surface, and wherein said blade handle comprises a first registrant that interfaces with at least part of said first registration surface.
- 10 441. A microkeratome cutting tool, as claimed in Claim 440, wherein:
said first cutting edge surface and said first registration surface are aligned with a common, predetermined crystallographic plane.
442. A microkeratome cutting tool, as claimed in Claim 440, wherein:
said first cutting edge surface and said first registration surface are each an etched
15 surface.
443. A microkeratome cutting tool, as claimed in Claim 442, wherein:
said first cutting edge surface and said first registration surface are aligned with a common, predetermined crystallographic plane.
444. A microkeratome cutting tool, as claimed in Claim 440, wherein:
20 said first cutting edge surface extends from said first cutting edge to a first edge at said second major surface, wherein said first registration surface extends from a second edge at said first major surface to a third edge at said second major surface, wherein said first cutting edge and said second edge are disposed within a first reference plane, wherein said first and third edges are disposed within a second reference plane, and
25 wherein said first and second reference planes are parallel.
445. A microkeratome cutting tool, as claimed in Claim 440, wherein:
said first registrant interfaces with said first registration surface only at an intersection between said first major surface and said first registration surface.
446. A microkeratome cutting tool, as claimed in Claim 440, wherein:
30 said blade comprises a second registration surface spaced from said first cutting edge and parallel with said first cutting edge surface, and wherein said blade handle further comprises a second registrant that interfaces with at least part of said second registration surface.

447. A microkeratome cutting tool, as claimed in Claim 446, wherein:
said first cutting edge surface, said first registration surface, and said second registration surface are aligned with a common, predetermined crystallographic plane.

448. A microkeratome cutting tool, as claimed in Claim 446, wherein:
5 said first cutting edge surface, said first registration surface, and said second registration surface are each an etched surface.

449. A microkeratome cutting tool, as claimed in Claim 448, wherein:
said first cutting edge surface, said first registration surface, and said second registration surface are aligned with a common, predetermined crystallographic plane.

10 450. A microkeratome cutting tool, as claimed in Claim 446, wherein:
said first and second registration surfaces are disposed within a common reference plane.

451. A microkeratome cutting tool, as claimed in Claim 446, wherein:
said first and second registrants are positioned along a reference axis that is
15 parallel with said first cutting edge.

452. A microkeratome cutting tool, as claimed in Claim 446, wherein:
said first and second registrants are equidistant from said first cutting edge.

453. A microkeratome cutting tool, as claimed in Claim 427, wherein:
said blade further comprises a concave first registration cavity on said first major
20 surface, spaced from said first cutting edge, and comprising first and second ends, and wherein said blade handle further comprises a first registrant extending within said first registration cavity.

454. A microkeratome cutting tool, as claimed in Claim 453, wherein:
said first registration cavity extends entirely through said blade from said first
25 major surface to said second major surface.

455. A microkeratome cutting tool, as claimed in Claim 453, wherein:
said first end of said first registration cavity is perpendicular to said first major surface, and wherein said second end is disposed at an angle other than perpendicular relative to said first major surface.

30 456. A microkeratome cutting tool, as claimed in Claim 453, wherein:
said first registrant that interfaces with at least part of second end of said first registration cavity, wherein said first registrant is spaced from said first end of said first registration cavity.

457. A microkeratome cutting, tool, as claimed in Claim 453, wherein:
said first registrant engages said blade only at an intersection between said second end of said first registration cavity and said first major surface.

458. A microkeratome cutting tool, as claimed in Claim 453, wherein:
5 said blade further comprises a concave second registration cavity on said first major surface, spaced from said first cutting edge, and comprising third and fourth ends, and wherein said blade handle further comprises a second registrant extending within said second registration cavity.

459. A microkeratome cutting tool, as claimed in Claim 458, wherein:
10 said first and second registrants are positioned along a reference axis that is parallel with said first cutting edge.

460. A microkeratome cutting tool, as claimed in Claim 458, wherein:
said first and second registrants are equidistant from said first cutting edge.

461. A microkeratome cutting tool, as claimed in Claim 458, wherein:
15 said first and second registration cavities each extend entirely through said blade from said first major surface to said second major surface.

462. A microkeratome cutting tool, as claimed in Claim 458, wherein:
said first end of said first registration cavity and said third end of said second registration cavity are each perpendicular to said first major surface, and wherein said
20 second end of said first registration cavity and said fourth end of said second registration cavity are each disposed at an angle other than perpendicular relative to said first major surface.

463. A microkeratome cutting, tool, as claimed in Claim 458, wherein:
said first registrant interfaces with at least part of said second end of said first
25 registration cavity, wherein said first registrant is spaced from said first end of said first registration cavity, wherein said second registrant interfaces with at least part of said fourth end of said second registration cavity, and wherein said second registrant is spaced from said third end of said second registration cavity.

464. A microkeratome cutting, tool, as claimed in Claim 458, wherein:
30 said first registrant engages said blade only at an intersection between said second end of said first registration cavity and said first major surface, and wherein said second registrant engages said blade only at an intersection between said fourth end of said second registration cavity and said first major surface.

465. A microkeratome cutting head assembly, comprising:

an eye flap receptacle; and

a blade comprising a first major surface, a second major surface that is disposed opposite of said first major surface, a first cutting edge surface that extends from said first major surface to said second major surface, and a first cutting edge defined by an intersection between said first major surface and said first cutting edge surface, wherein said first major surface is disposed above said second major surface.

466. A microkeratome cutting head assembly, as claimed in Claim 465, wherein:

said first cutting edge surface at least generally faces a patient's eye when being cut by said microkeratome cutting head assembly.

467. A microkeratome cutting head assembly, as claimed in Claim 465, wherein:

said first major surface is located generally between said second major surface and said eye flap receptacle; and

said second major surface is located generally between said first major surface and a patient's eye when being cut by said microkeratome cutting head assembly.

468. A microkeratome cutting head assembly, as claimed in Claim 465, further comprising:

a first blade support associated with said first major surface and comprising a first leading edge that is spaced back from said first cutting edge.

469. A microkeratome cutting head assembly, as claimed in Claim 468, wherein:

said first leading edge of said first blade support is disposed no more than about 1 millimeter from said first cutting edge, measured in a dimension that is parallel with said first major surface.

470. A microkeratome cutting head assembly, as claimed in Claim 469, wherein:

a blade angle measured between said first major surface and said first cutting edge surface is no more than about 35°.

471. A microkeratome cutting head assembly, as claimed in Claim 468, wherein:

said first blade support defines a portion of said eye flap receptacle.

472. A microkeratome cutting head assembly, as claimed in Claim 468, wherein:

said first blade support comprises means for directing a patient's eye flap being cut by said microkeratome cutting head assembly into said eye flap receptacle.

5 473. A microkeratome cutting head assembly, as claimed in Claim 468, wherein:

said first cutting edge surface intersects with said second major surface at a first edge, wherein a reference plane, that is both perpendicular to said first major surface and that contains said first edge, intersects said first major surface at a first location.

10 474. A microkeratome cutting head assembly, as claimed in Claim 473, wherein:

said first leading edge of said first blade support is located between said first cutting edge and said first location in a dimension that is parallel with said first major surface.

15 475. A microkeratome cutting head assembly, as claimed in Claim 473, wherein:

said first leading edge of said first blade support is disposed closer to said first cutting edge than said first location is to said first cutting edge in a dimension that is parallel with said first major surface.

20 476. A microkeratome cutting head assembly, as claimed in Claim 473, wherein:

said first cutting edge of said blade and said first edge of said blade are separated by a first distance measured along a first axis, wherein said first cutting edge of said blade and said first leading edge of said first blade support are separated by a second distance measured along a second axis that is parallel with said first axis, and wherein said second distance is less than said first distance.

477. A microkeratome cutting head assembly, as claimed in Claim 476, wherein:

said first and second axes are perpendicular to said first cutting edge.

30 478. A microkeratome cutting head assembly, as claimed in Claim 468, further comprising:

a second blade support that is associated with said second major surface of said blade.

479. A microkeratome cutting head assembly, as claimed in Claim 478, wherein:

5 said second blade support comprises a second leading edge that is spaced back from said first cutting edge, wherein said first leading edge of said first blade support is closer to said first cutting edge than said second leading edge of said second blade support is to said first cutting edge in a dimension that is parallel with said first major surface.

480. A microkeratome cutting head assembly, as claimed in Claim 465, wherein:

10 an underside of an eye flap being cut by said microkeratome cutting head assembly interfaces with part of said first major surface and not said first cutting edge surface.

481. A microkeratome cutting head assembly, as claimed in Claim 465, wherein:

15 a blade angle measured between said first major surface and said first cutting edge surface is no more than about 35°.

482. A microkeratome cutting head assembly, comprising:

an eye flap receptacle;

20 a blade comprising a first major surface, a second major surface that is disposed opposite of said first major surface, a first cutting edge, and a first cutting edge surface that extends from said first cutting edge to said second major surface; and

25 a first blade support associated with said first major surface and comprising a first leading edge that is spaced back from said first cutting edge, wherein said first cutting edge surface intersects with said second major surface at a first edge, wherein a first reference plane that is perpendicular to said first major surface and that contains said first edge intersects with a second reference plane that contains said first major surface at a first location, wherein said first leading edge is disposed somewhere between said first location and said first cutting edge in a dimension that is parallel with said first major surface.

30 483. A microkeratome cutting head assembly, as claimed in Claim 482, wherein:

said first cutting edge surface at least generally faces a patient's eye when being cut by said microkeratome cutting head assembly.

484. A microkeratome cutting head assembly, as claimed in Claim 482, wherein:

said first major surface is located generally between said second major surface and said eye flap receptacle; and

5 said second major surface is located generally between said first major surface and a patient's eye when being cut by said microkeratome cutting head assembly.

485. A microkeratome cutting head assembly, as claimed in Claim 482, wherein:

a blade angle associated with said first cutting edge is no more than about 35°.

10 486. A microkeratome cutting head assembly, as claimed in Claim 482, wherein:

said first cutting edge surface extends from said first major surface to said second major surface, and wherein said first cutting edge is defined by an intersection between said first major surface and said first cutting edge surface.

15 487. A microkeratome cutting head assembly, as claimed in Claim 482, wherein:

said first leading edge of said first blade support is disposed no more than about 1 millimeter from said first cutting edge, measured in a dimension that is parallel with said first major surface.

20 488. A microkeratome cutting head assembly, as claimed in Claim 487, wherein:

a blade angle associated with said first cutting edge is no more than about 35°.

489. A microkeratome cutting head assembly, as claimed in Claim 482, wherein:

25 said first blade support defines a portion of said eye flap receptacle.

490. A microkeratome cutting head assembly, as claimed in Claim 482, wherein:

said first blade support comprises means for directing a patient's eye flap being cut by said microkeratome cutting head assembly into said eye flap receptacle.

30 491. A microkeratome cutting head assembly, as claimed in Claim 482, wherein:

said first leading edge of said first blade support is disposed closer to said first cutting edge than said first location is to said first cutting edge in a dimension that is parallel with said first major surface.

492. A microkeratome cutting head assembly, as claimed in Claim 482, wherein:

5 said first cutting edge of said blade and said first edge of said blade are separated by a first distance measured along a first axis, wherein said first cutting edge of said blade and said first leading edge of said first blade support are separated by a second distance measured along a second axis that is parallel with said first axis, and wherein said second distance is less than said first distance.

493. A microkeratome cutting head assembly, as claimed in Claim 492, wherein:

10 said first and second axes are perpendicular to said first cutting edge.

494. A microkeratome cutting head assembly, as claimed in Claim 482, further comprising:

a second blade support that is associated with said second major surface of said blade.

15 495. A microkeratome cutting head assembly, as claimed in Claim 494, wherein:

20 said second blade support comprises a second leading edge that is spaced back from said first cutting edge, wherein said first leading edge of said first blade support is closer to said first cutting edge than said second leading edge of said second blade support is to said first cutting edge in a dimension that is parallel with said first major surface.

496. A microkeratome cutting head assembly, as claimed in Claim 482, wherein:

25 an underside of an eye flap being cut by said microkeratome cutting head assembly interfaces with part of said first major surface and not said first cutting edge surface.

497. A microkeratome cutting head assembly, comprising:

an eye flap receptacle;

30 a blade comprising a first major surface, a second major surface that is disposed opposite of said first major surface, and a first cutting edge; and

an upper blade support associated with said first major surface of said blade and comprising a first leading edge that is spaced back from said first cutting edge;

a lower blade support associated with said second major surface of said blade and comprising a second leading edge that is spaced back from said first cutting edge,

wherein said first leading edge of said upper blade support is closer to said first cutting edge of said blade than said second leading edge of said lower blade support.

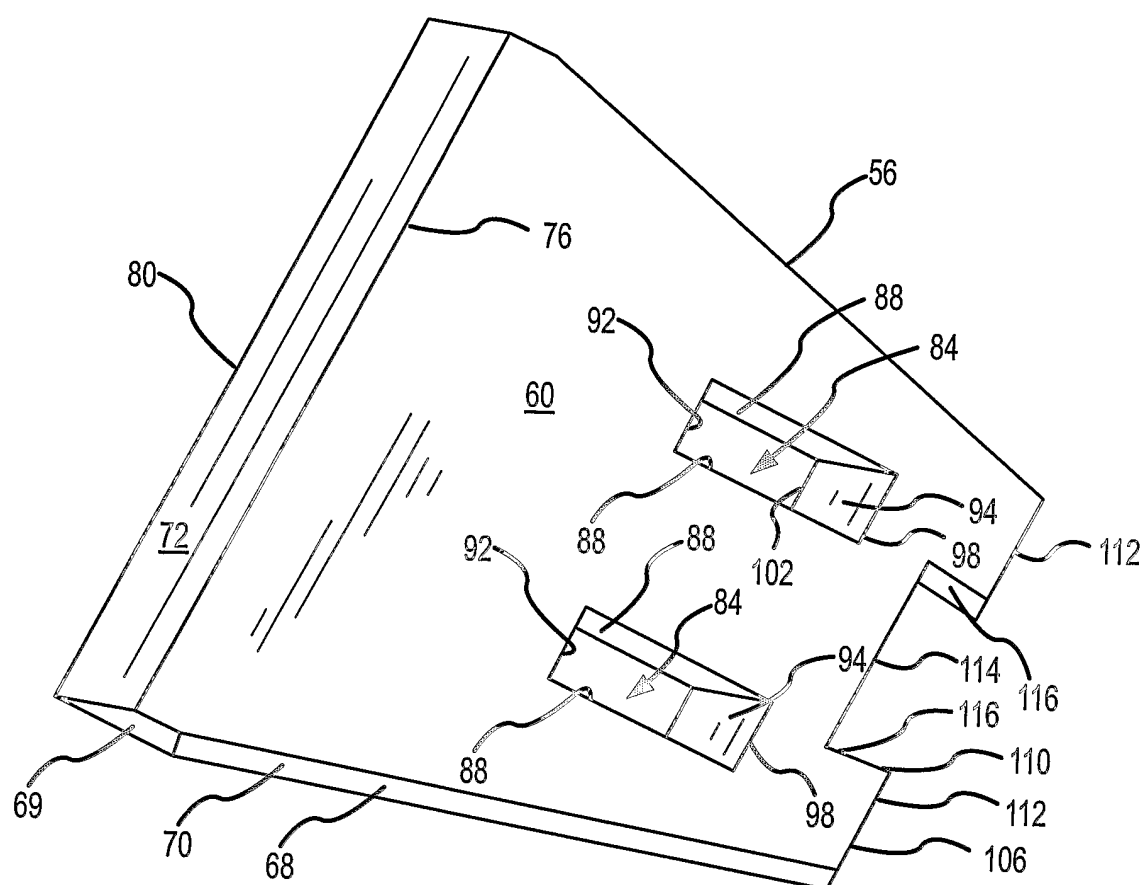


FIG.2A

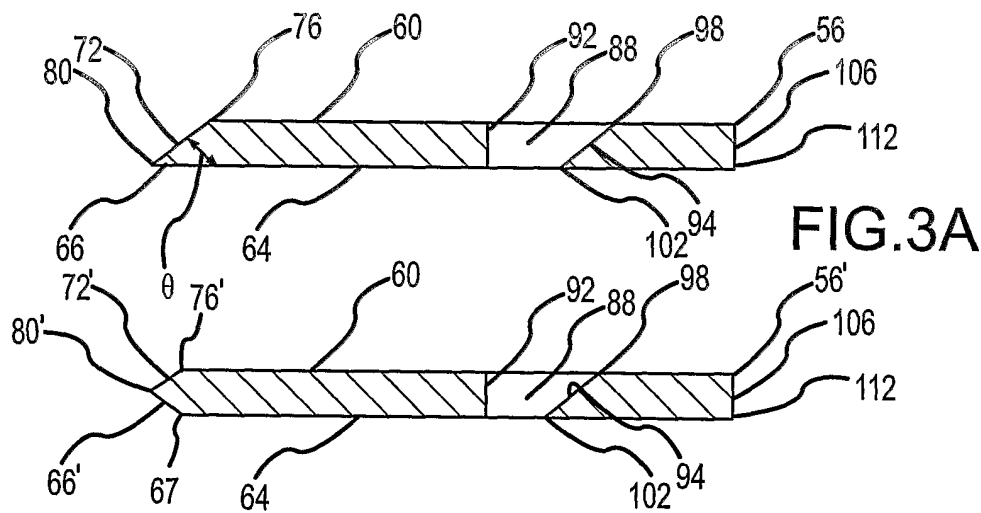
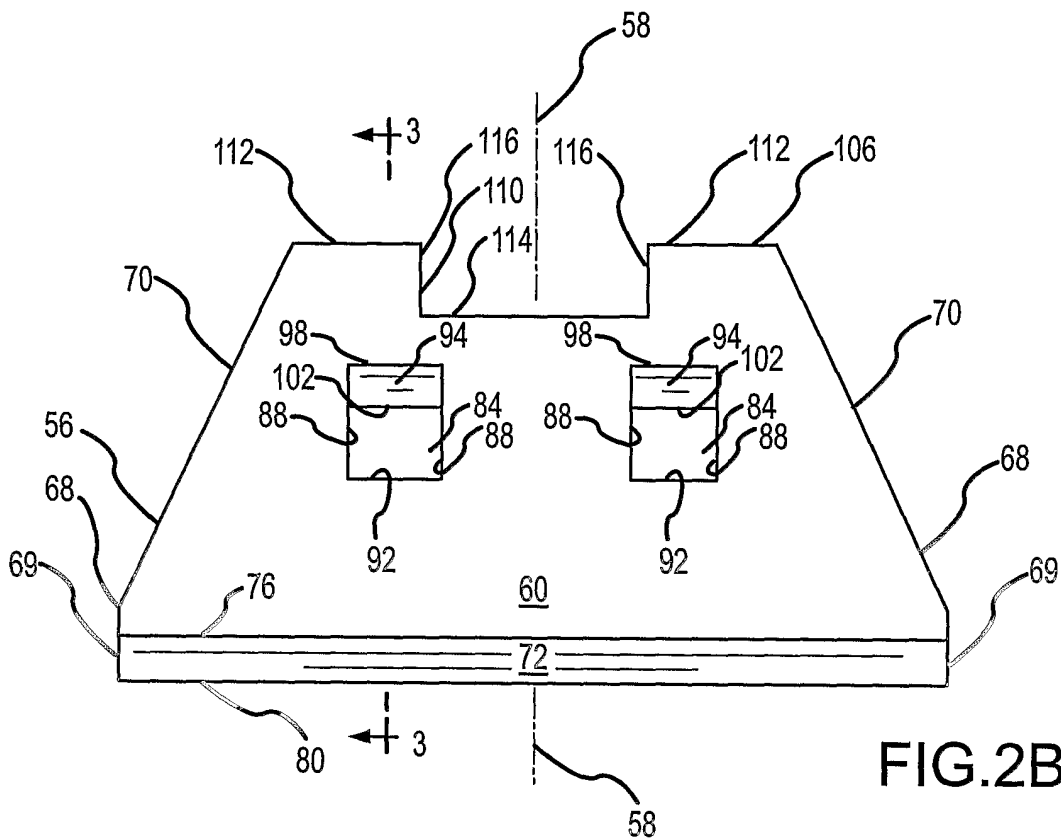


FIG. 3A

FIG. 3B

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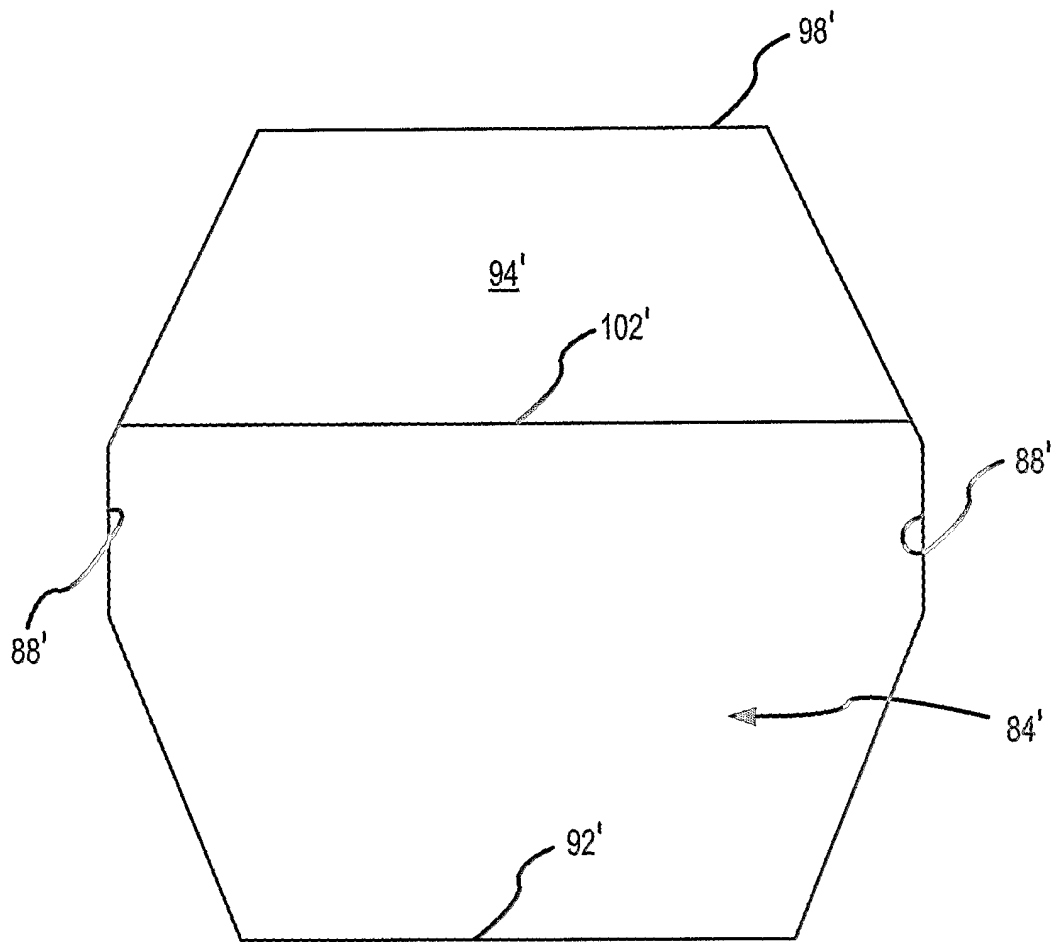


FIG. 2C

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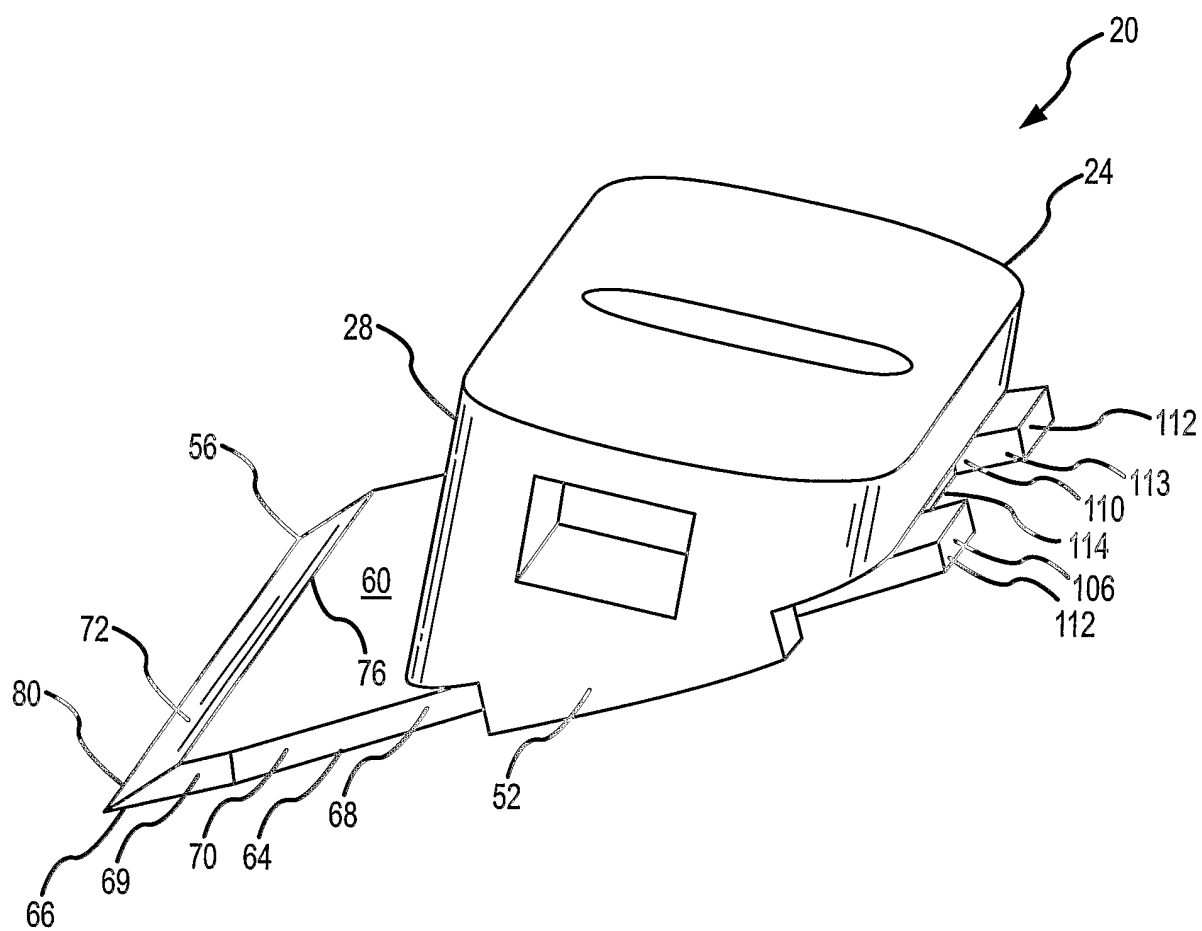


FIG.4

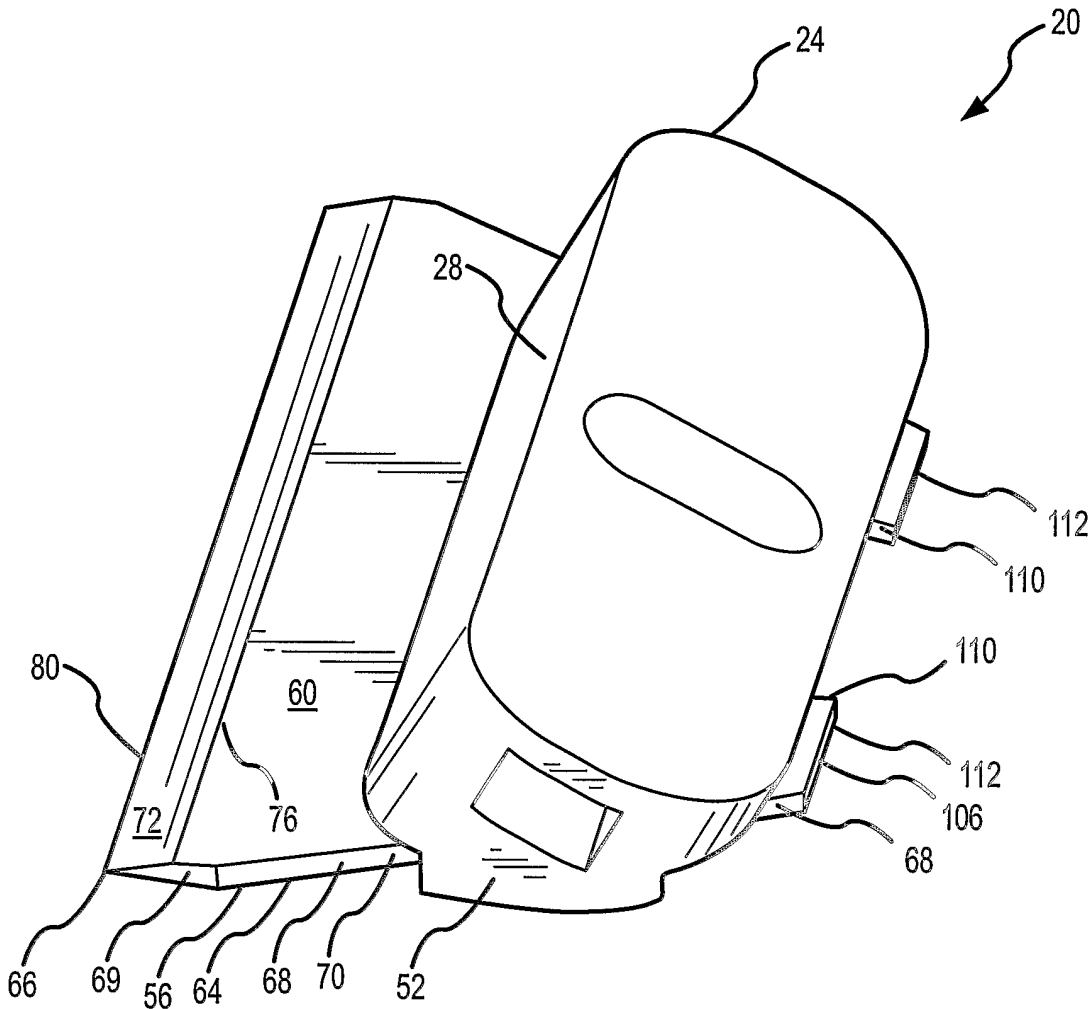


FIG.5

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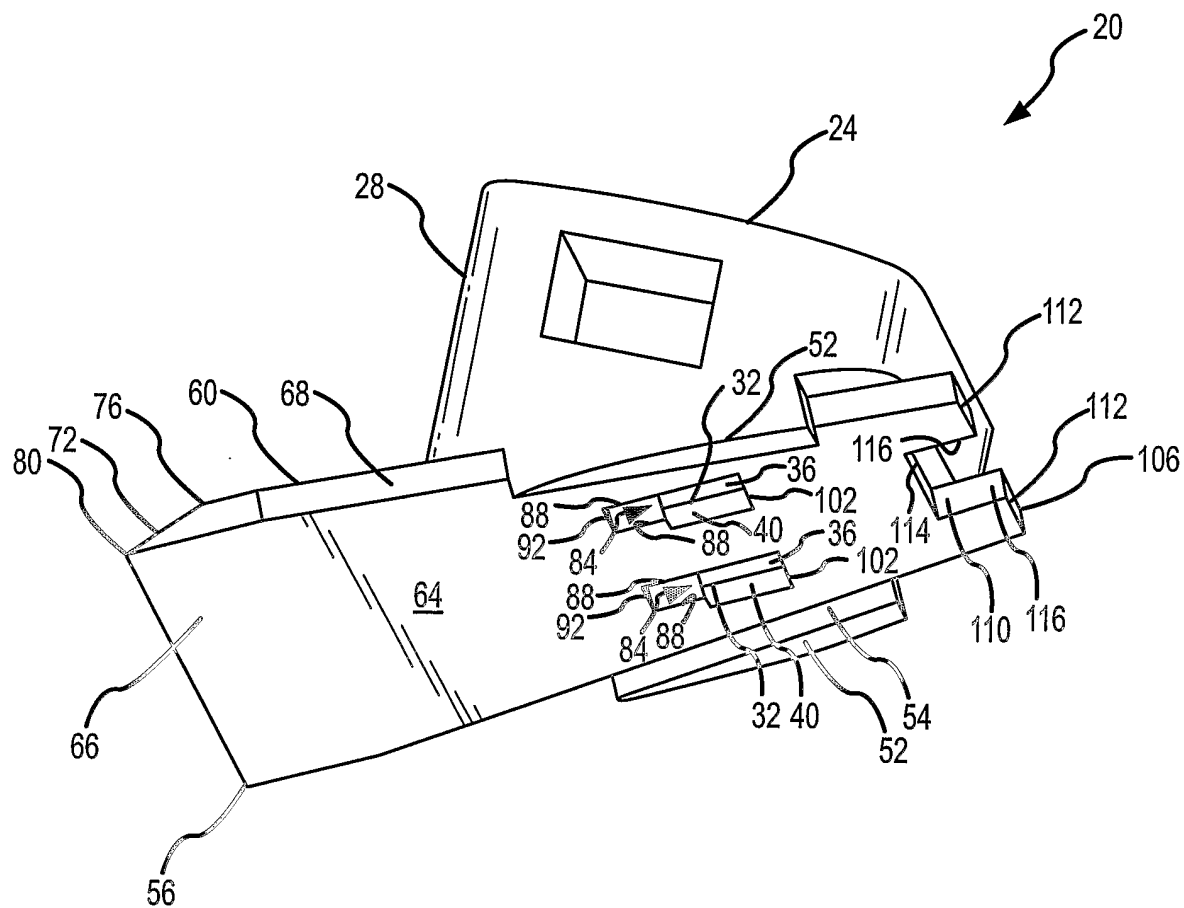


FIG. 6

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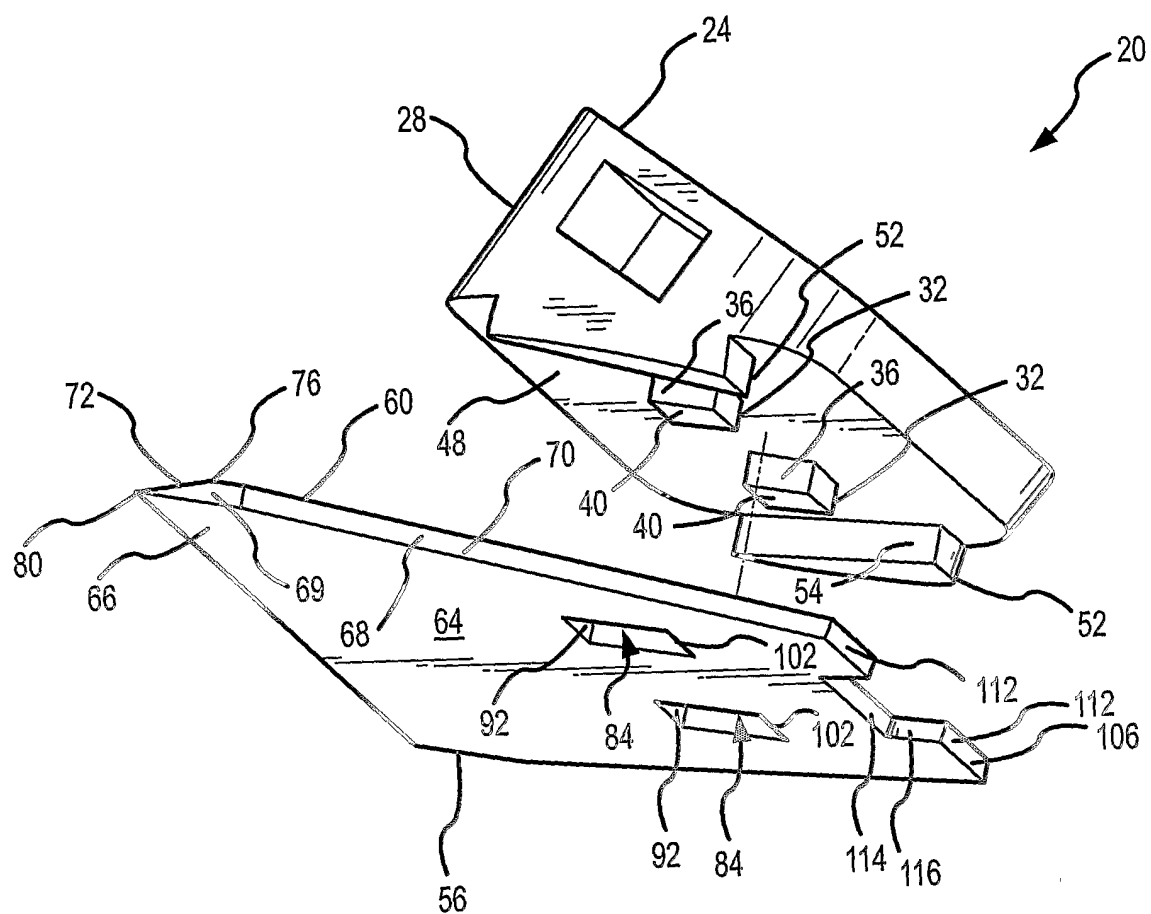


FIG.7

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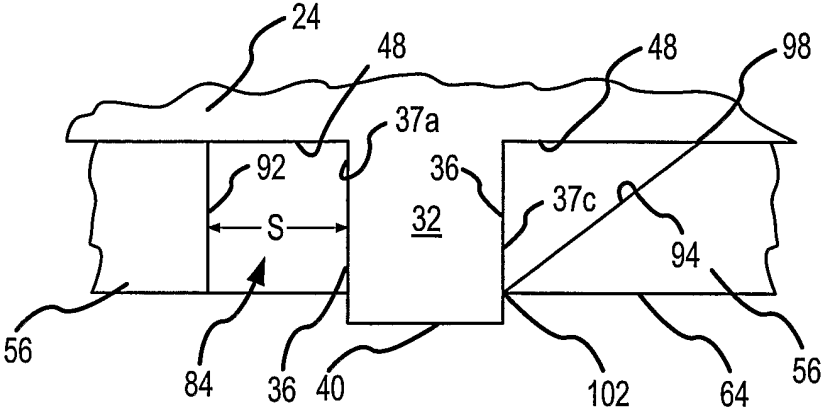


FIG. 8B

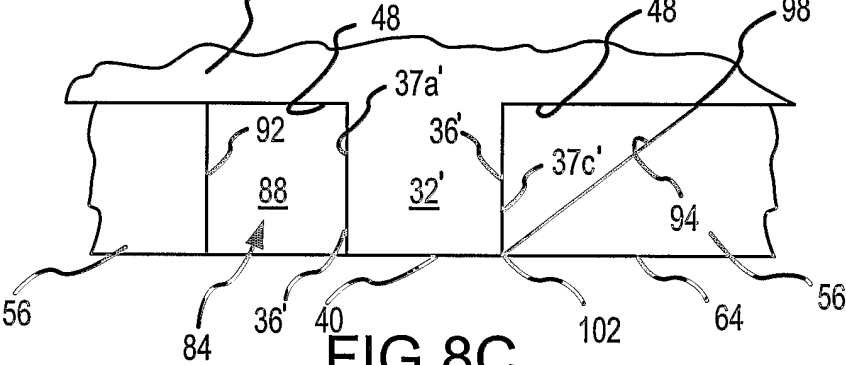


FIG. 8C

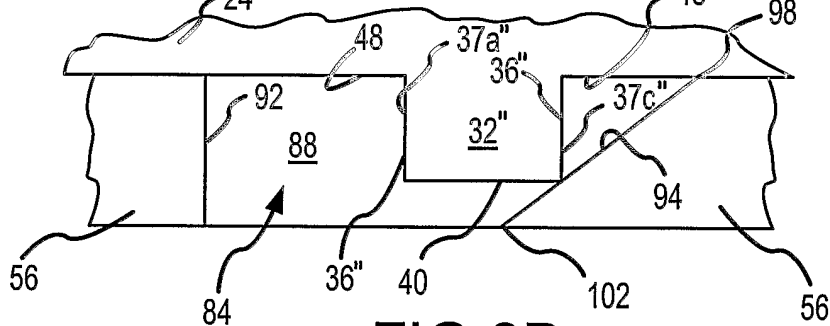


FIG. 8D

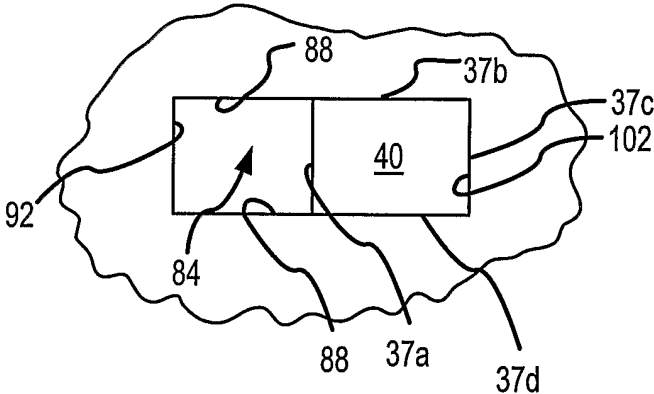


FIG. 8A

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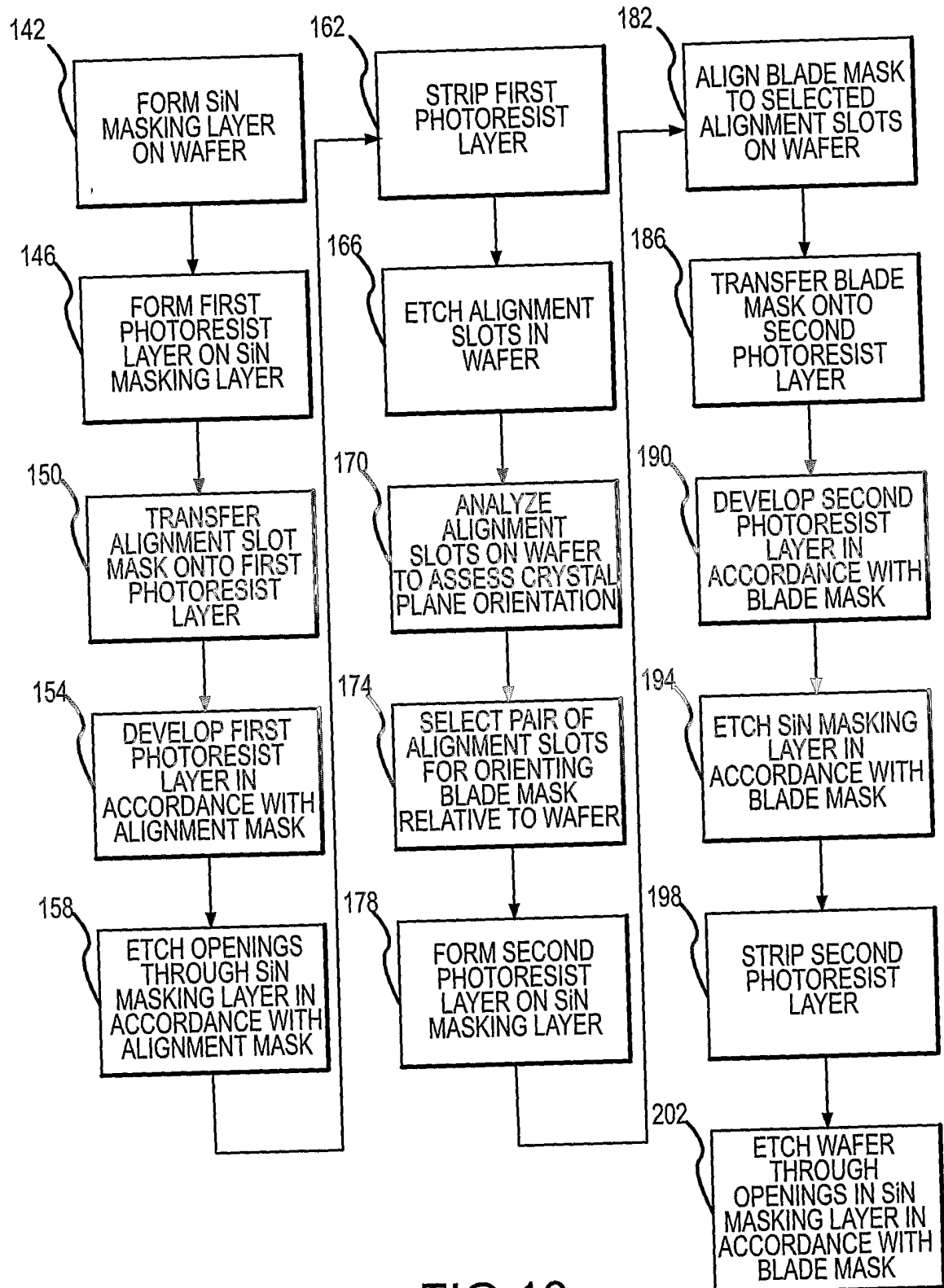


FIG.10

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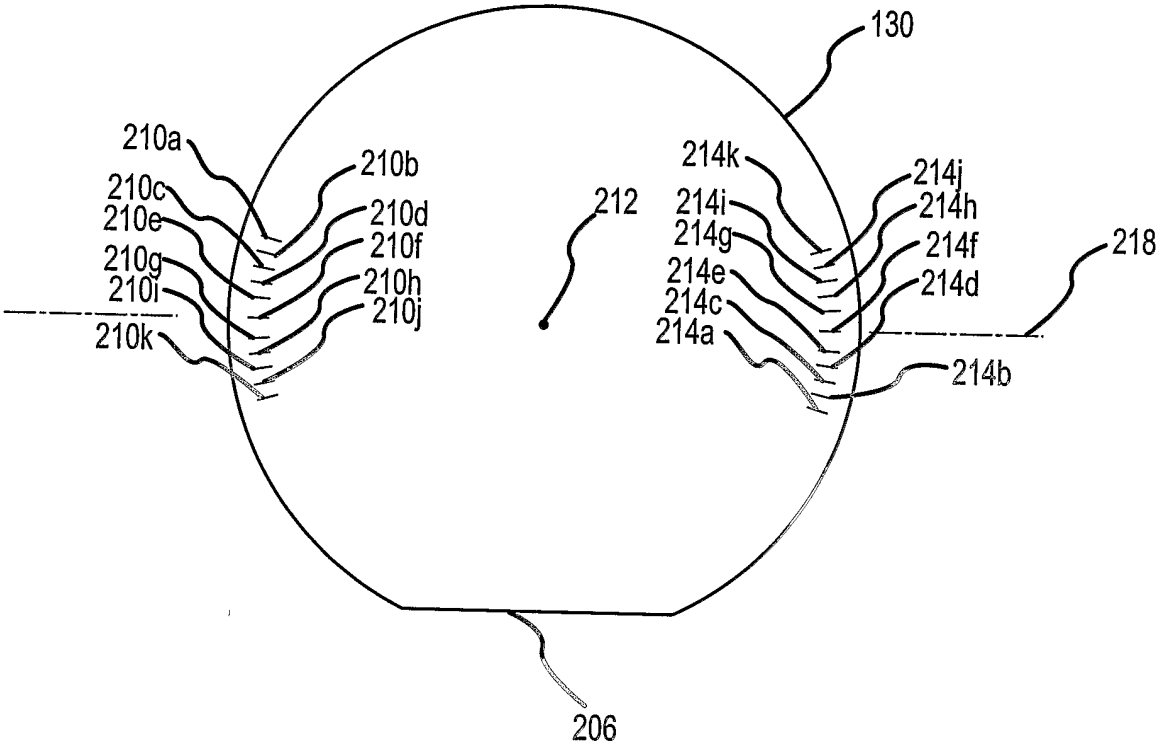


FIG. 11

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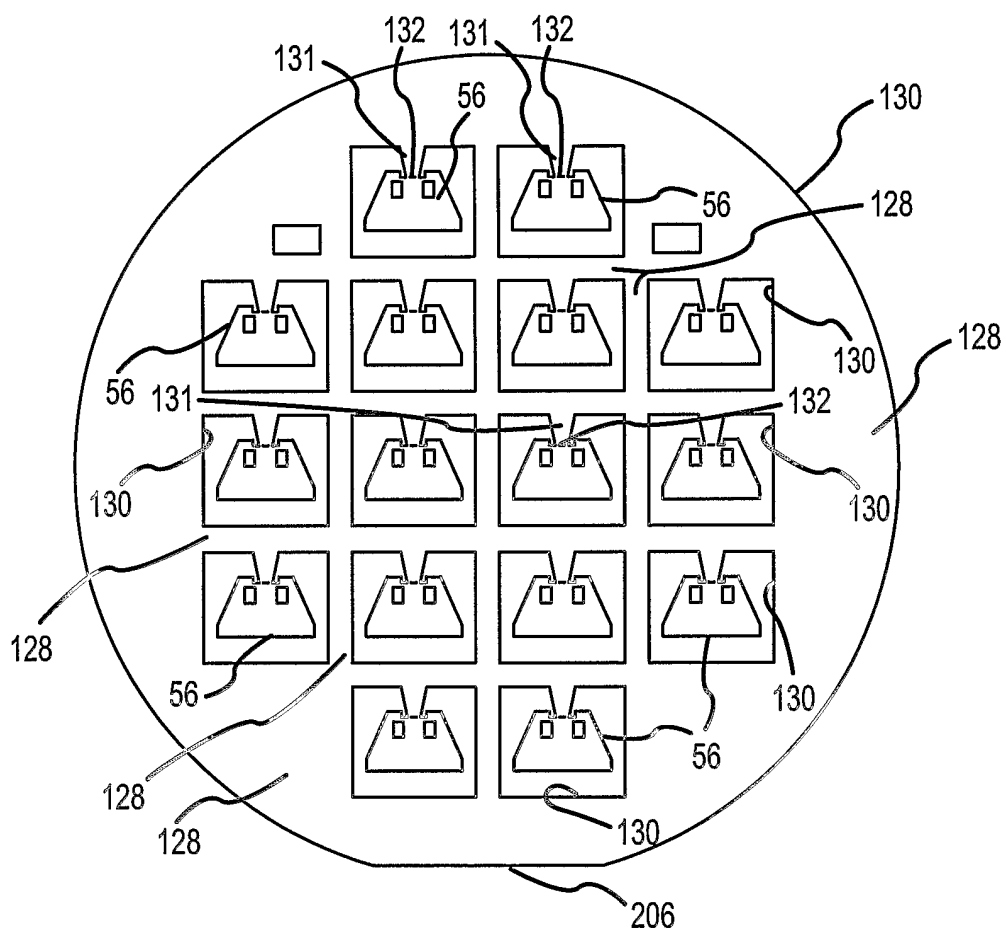


FIG. 12

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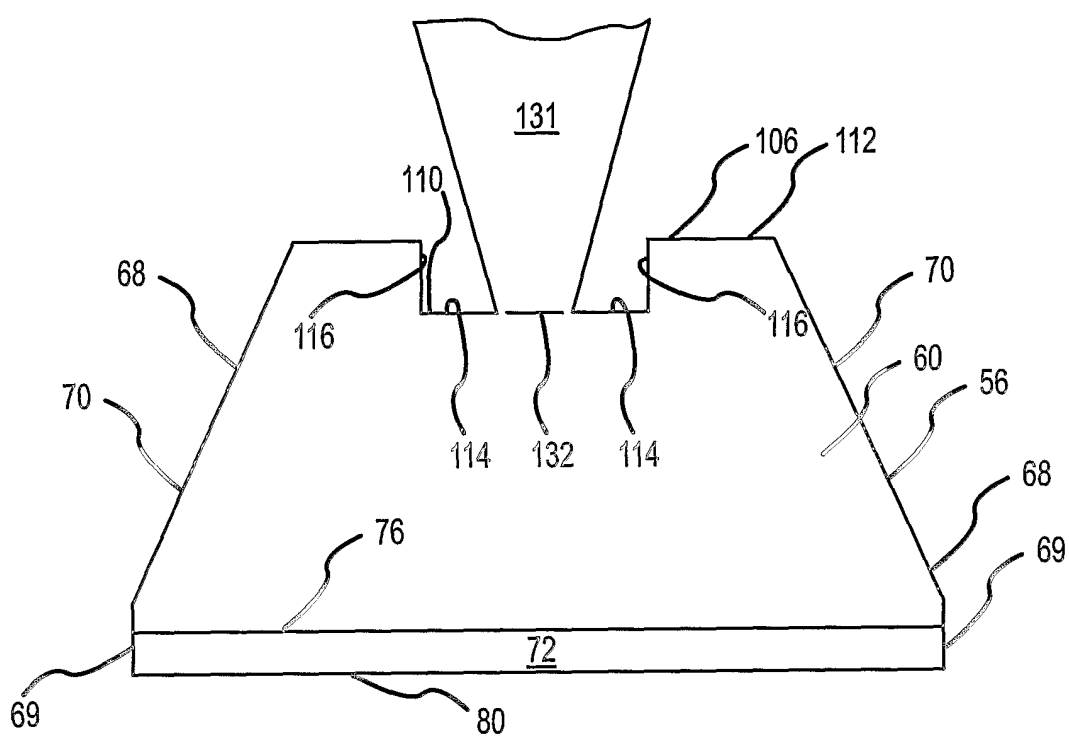


FIG. 13A

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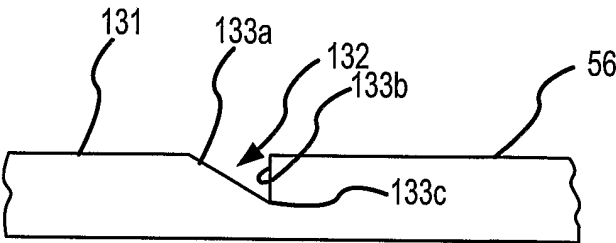


FIG.13B

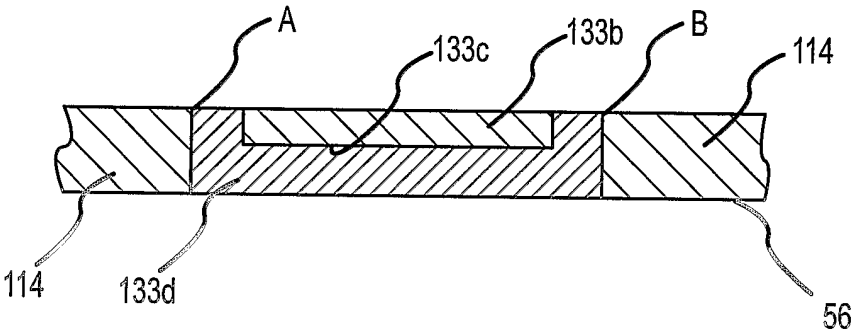


FIG.13C

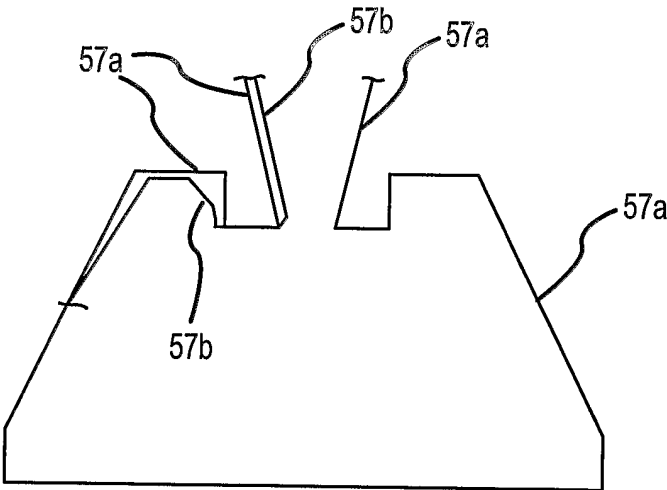


FIG.13D

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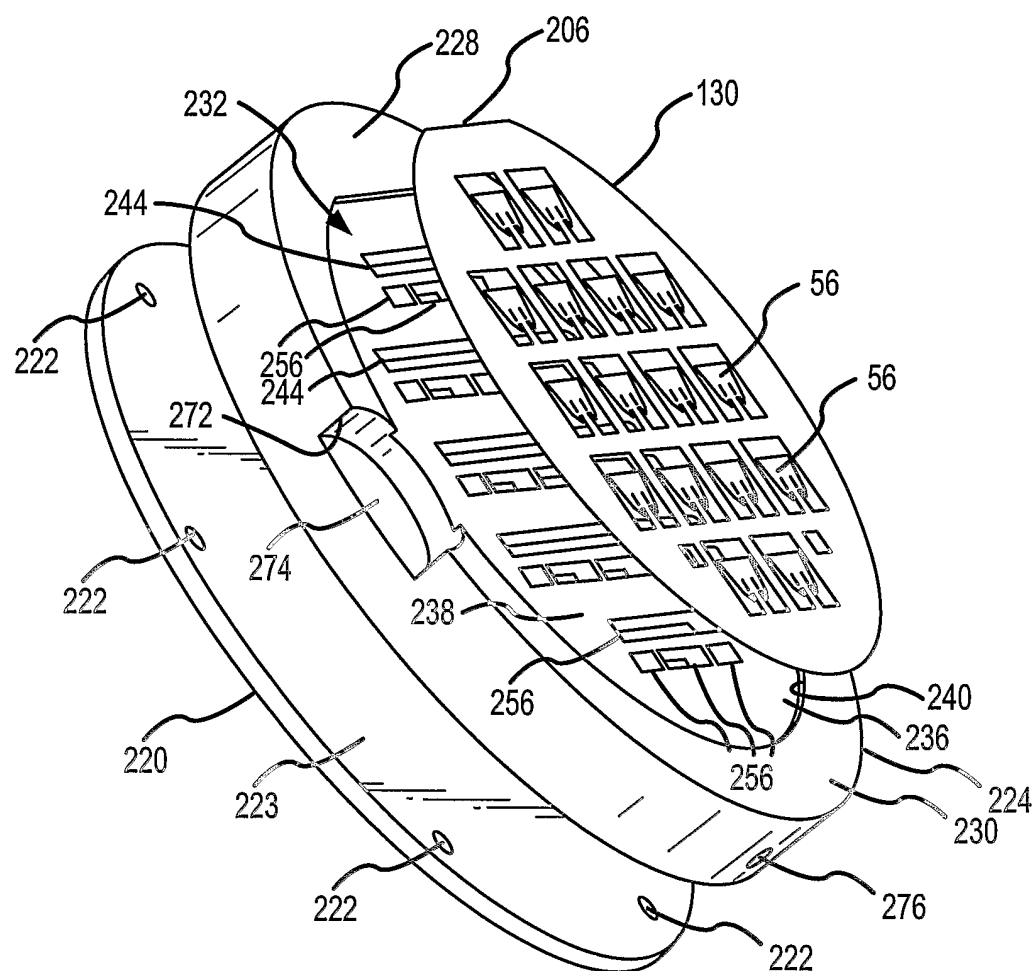


FIG. 15

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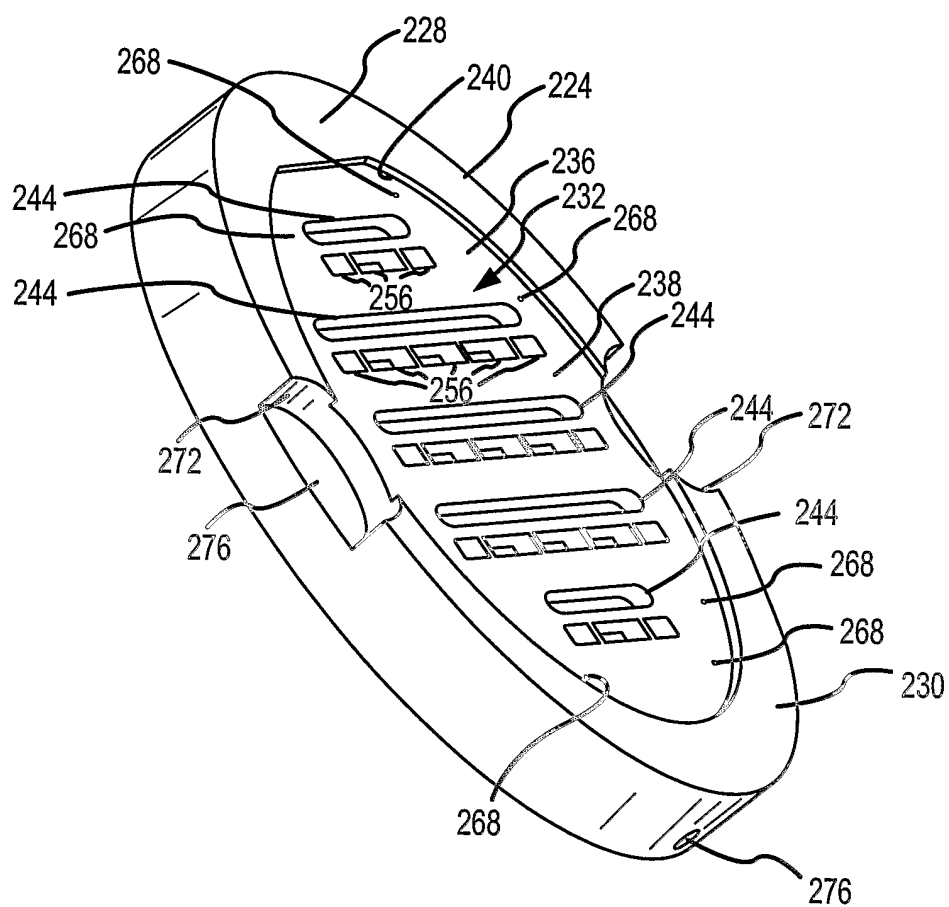


FIG.16

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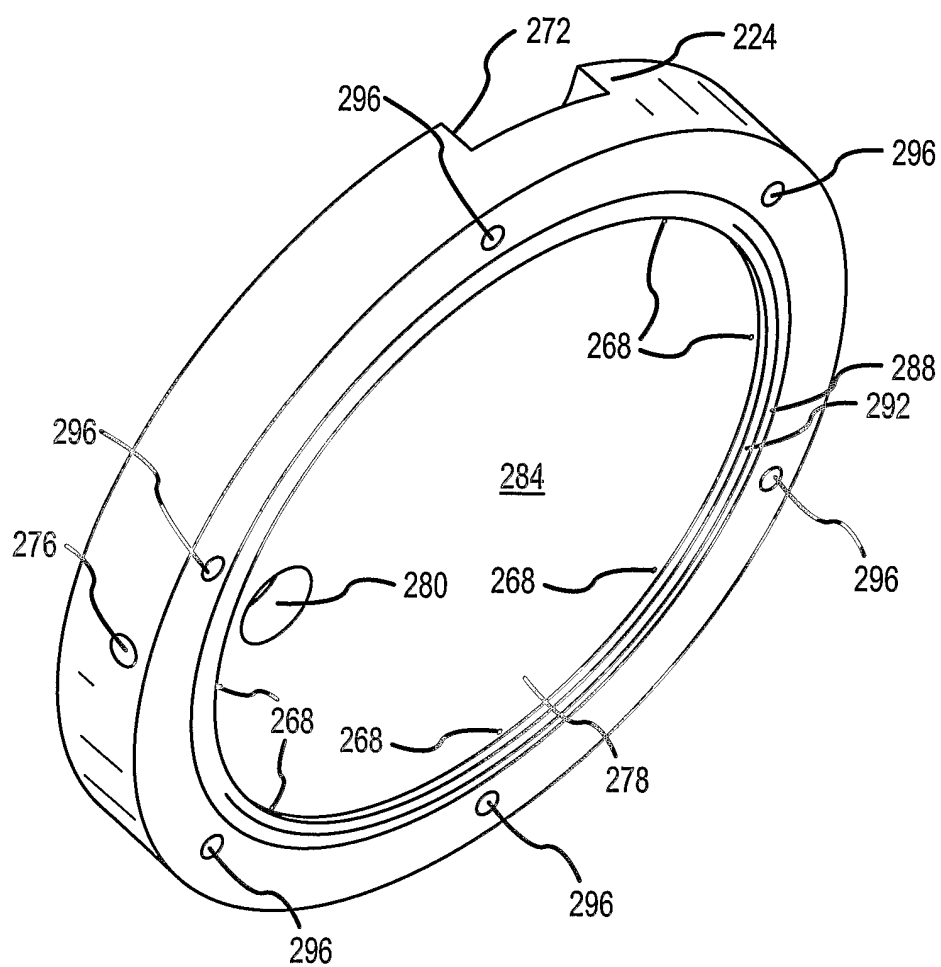


FIG.17

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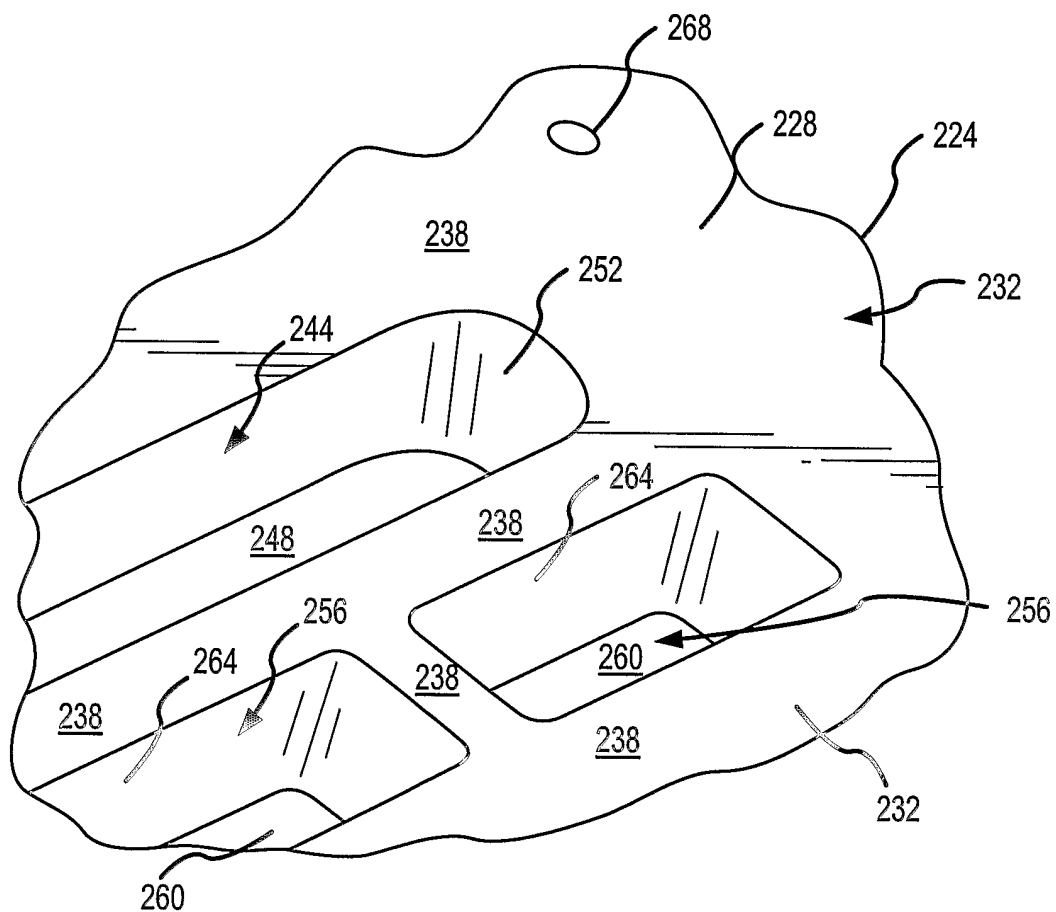


FIG.18

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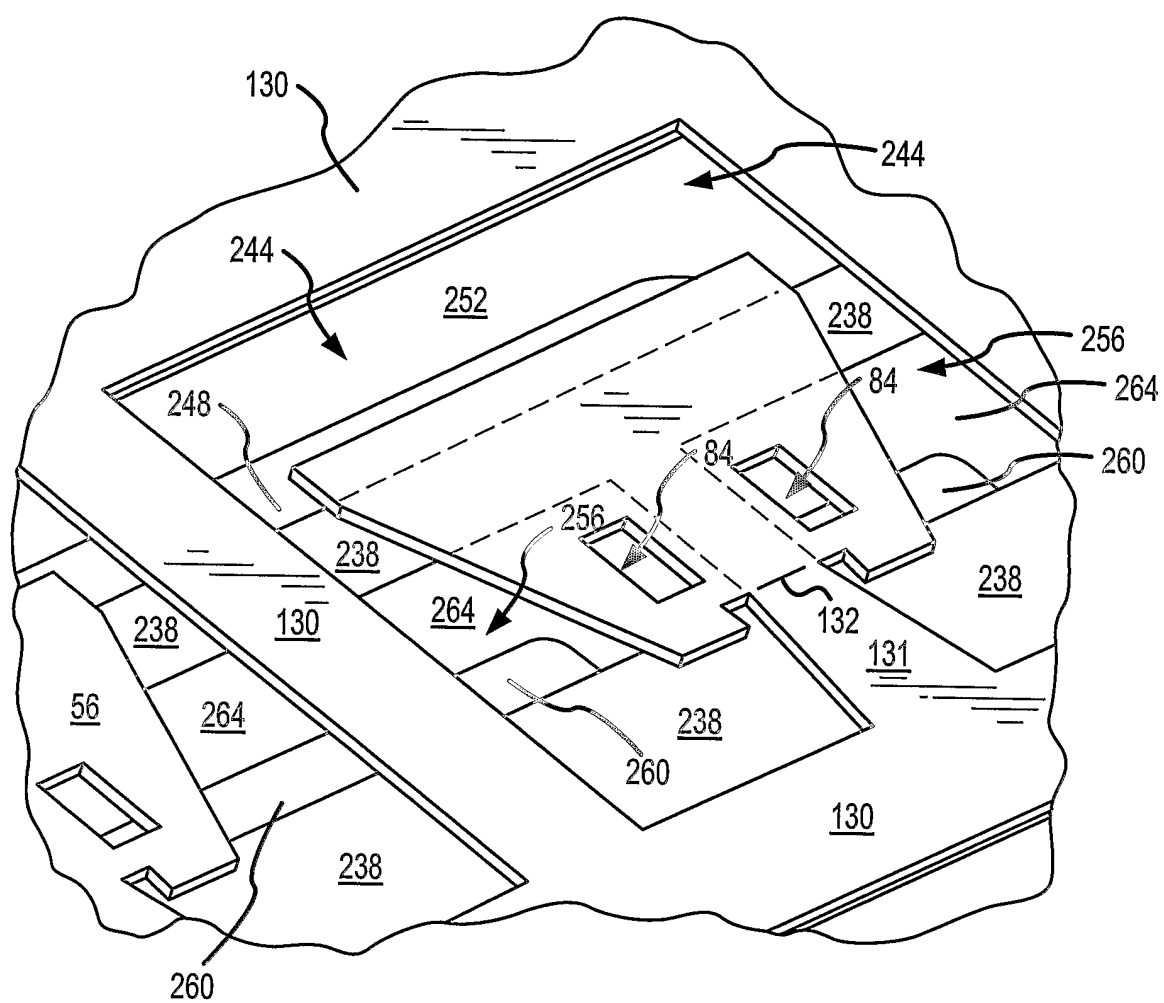


FIG.19

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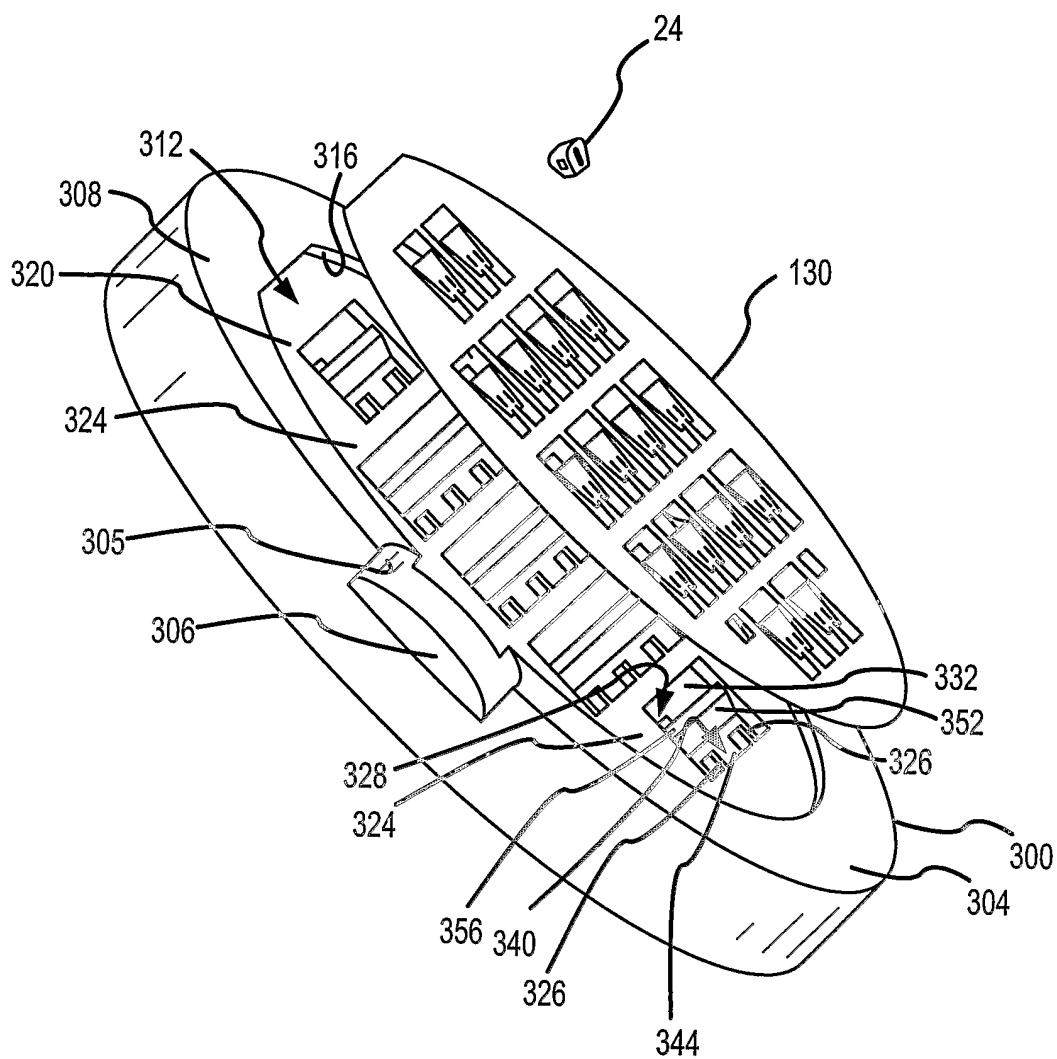


FIG. 21

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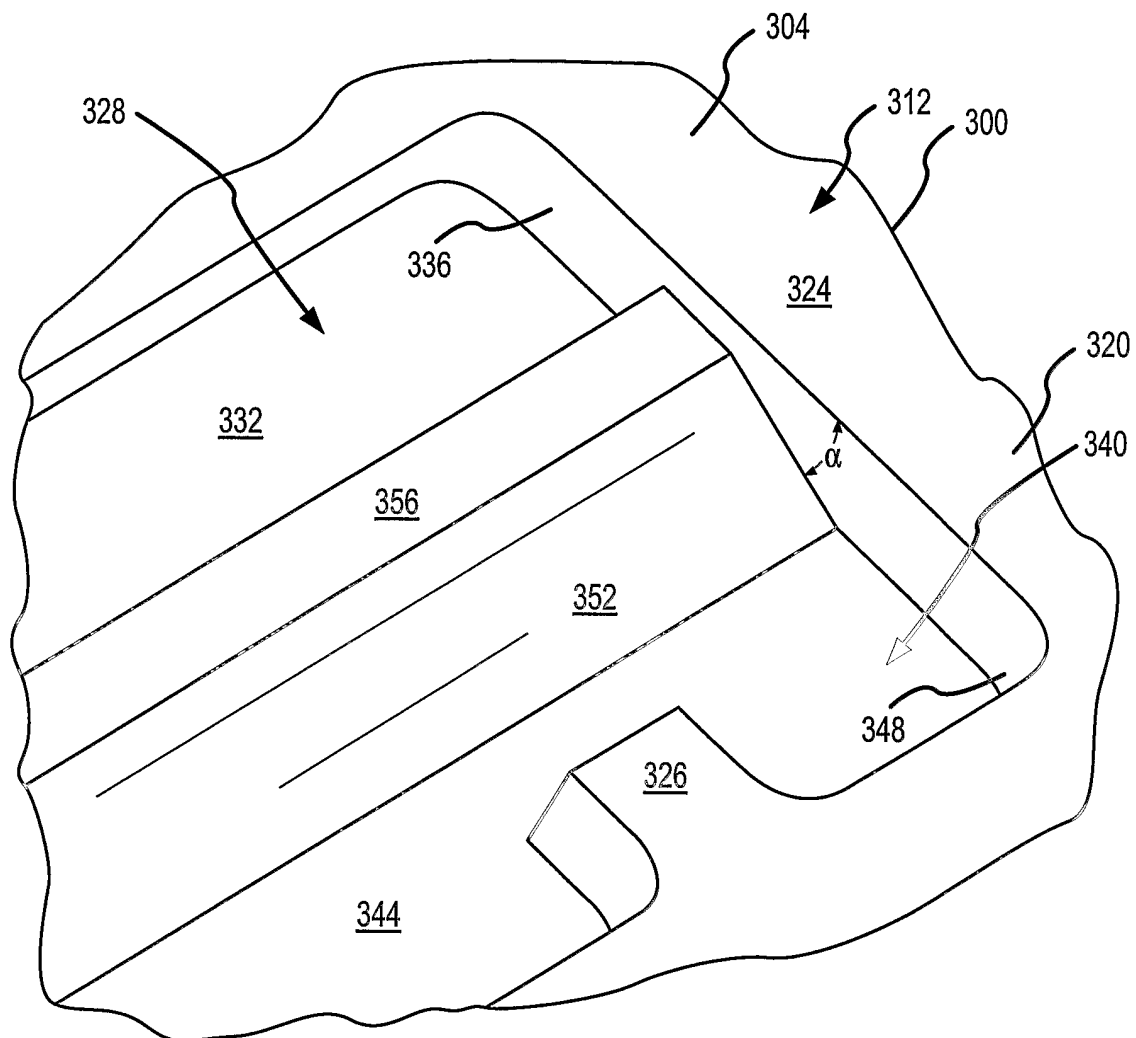


FIG. 22

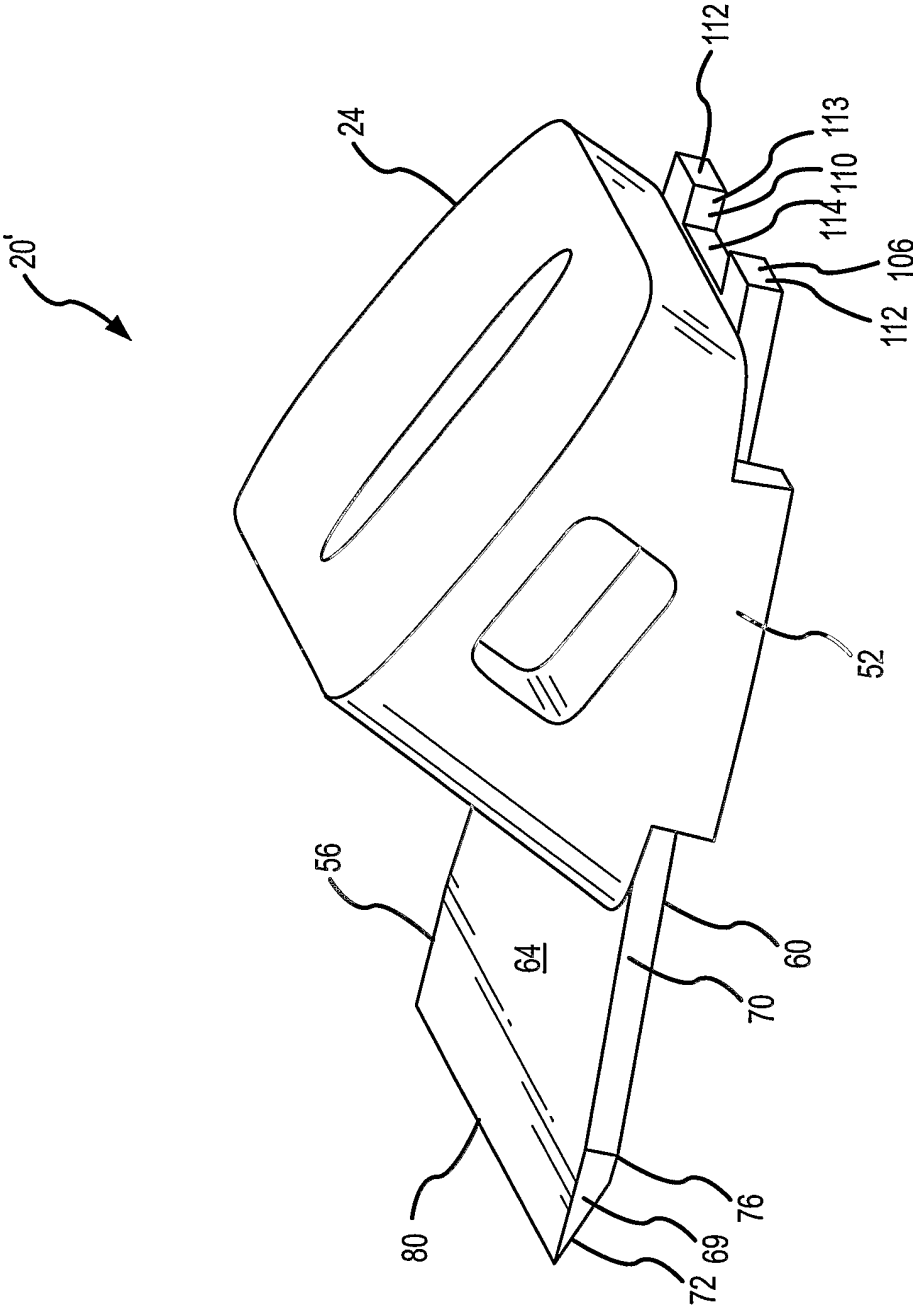


FIG. 24

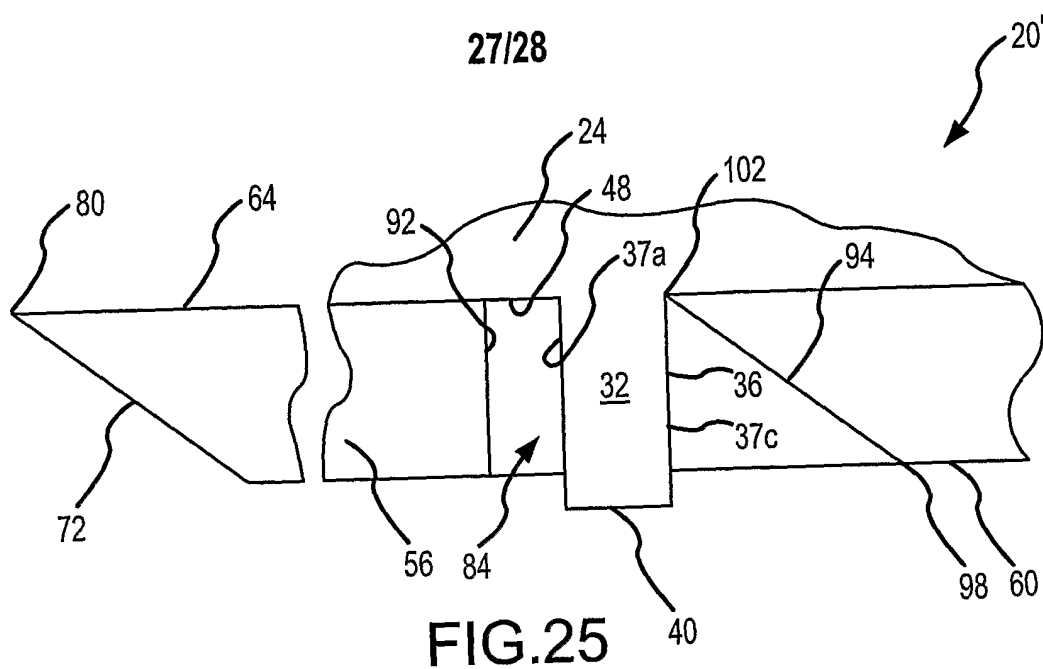


FIG.25

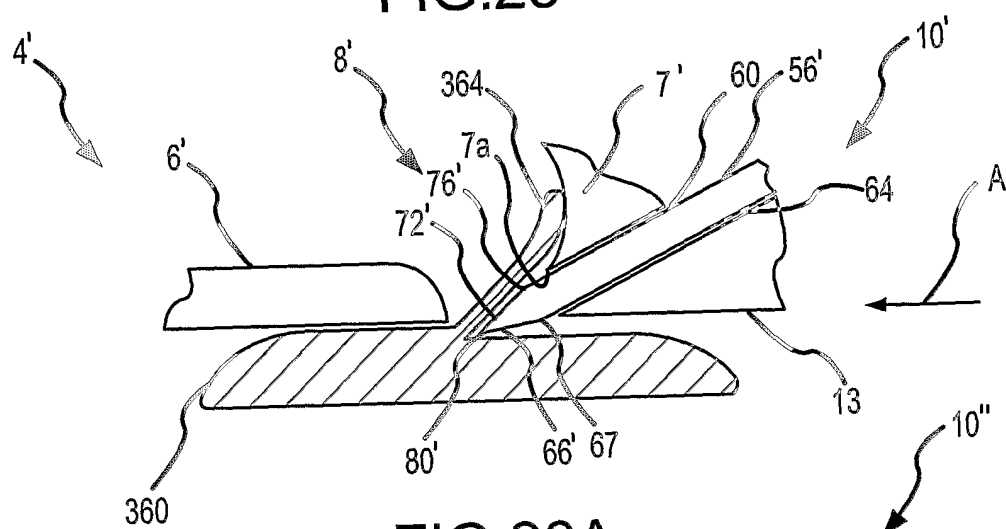


FIG. 26A

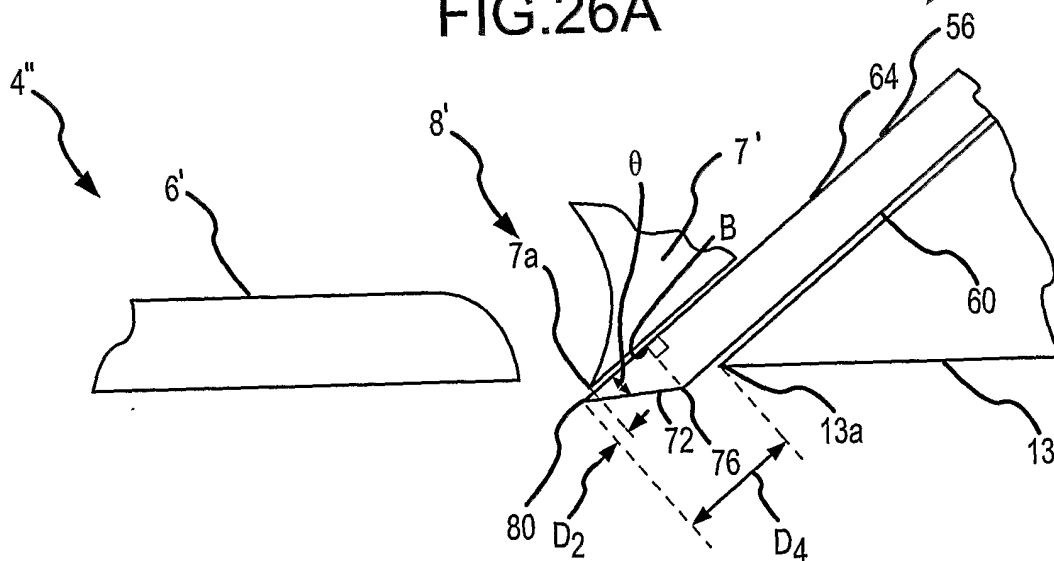


FIG. 26B

