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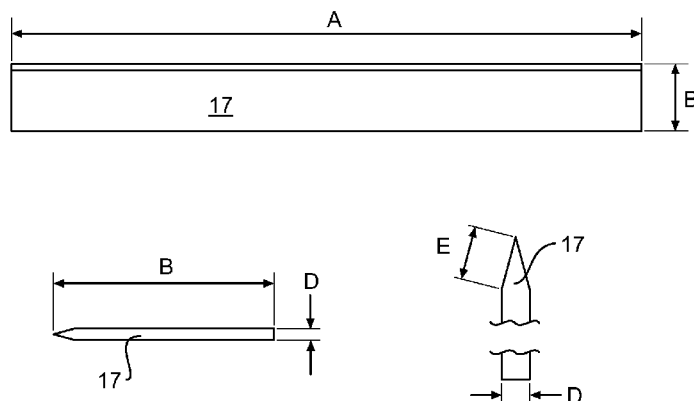


FIG. 1

(57) Abstract: Disclosed is a razor blade having a mineral blade with a mineral cutting edge, with the mineral cutting edge having a radius of less than about 20 nanometers and an angle of about 40-50 degrees and wherein the mineral blade is coated in an adhesion promoter and an outer layer and a method of making the razor blade. Also disclosed is a razor having a mineral blade, and a method of making the razor.

MINERAL BLADE AND RAZOR FOR USE WITH SAME

CROSS REFERENCE TO RELATED APPLICATIONS

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[0001] This application claims priority to U.S. Patent Application No. 61/494,722, filed June 8, 2011, which is herein incorporated by reference in its entirety.

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FIELD OF THE INVENTION

[0002] The present invention relates generally to a mineral blade and a non-disposable razor for use with same, and methods for making the mineral blade and the non-disposable razor.

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BACKGROUND

[0003] Handheld non-electric razors have been available for many years and may be found in a number of different shapes and sizes as well as in disposable and non-disposable formats. As disclosed herein, a razor is defined as a self-contained shaving unit having a least one razor blade, a cartridge, a head and a handle. The cartridge maintains the blade or blades in a pre-determined shaving position. The blade or blades may be formed of a suitable substrate material such as stainless steel and a cutting edge is formed with a wedge-shaped configuration with an ultimate tip having a radius of less than about 1,000 angstroms, usually about 200-300 angstroms. Hard coatings such as diamond, amorphous diamond, diamond-like carbon (DLC) material, nitrides, carbides, oxides or ceramics are often used to improve strength, corrosion resistance and shaving ability, maintaining needed strength while permitting inner edges with lower cutting forces to be used.

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[0004] Typical modern shaving razor blades incorporate a substrate of stainless steel, such as iron and chromium – containing martensitic stainless steel, together with a hard coating of chromium or chromium nitride overlying the stainless steel substrate at least along the cutting edge of the blade.

[0005] A coating of a fluoropolymer lubricant such as polytetrafluoroethylene (PTFE) overlies the hard coating. The hard coating is

normally applied by a process known as sputtering. Sputtering ordinarily is conducted under a controlled atmosphere, typically a noble gas at extremely low pressures. Following the sputtering process, the semi-finished blade or blades, with the hard coating, are removed from the controlled atmosphere.

- 5 The blades are coated with the lubricant by applying a dispersion of the fluorocarbonpolymer and a liquid solvent, evaporating off the solvent and then fusing the remaining lubricant by heating to above the melting point of the polymer.

- [0006]** One avenue of research in the razor art has been directed
10 toward the development of a hard coating which could be used as a substitute for stainless steel and chromium in the blade. Ordinary cutting tools become dull and unusable due to gradual abrasive wear of their cutting edges. In use, the ultimate tip of the edges having hard coatings and PTFE outer layers can become more rounded after repeated shaves such that there is an increase in
15 the tip radius and generally perceived decrease in shaving performance. Razors incorporating blades according to this general construction have been regarded previously as adequate in that they provide a good combination of shaving performance, durability and low cost. Nonetheless, there have been needs for still further improvements as these known blades have a relatively
20 short usable life span and become dull relatively quickly.

- [0007]** What is needed in the industry is a razor, and more particularly, a razor blade comprised of materials that allow the blade to maintain its sharp edge and performance over an extended number of shaves. In order to improve the chemical and mechanical properties of a substance, its hardness,
25 wear resistance, corrosion resistance, and fatigue resistance, the substrate, such as one used for the razor blade, have hard coatings applied to the substrate, particularly at the cutting edge. For razor blades these hard coatings serve two major roles. Namely, to strengthen the razor blade, which allows for slimmer profiles, and to provide a suitable interface with the
30 adhesion of a lubricant coating, such as PTFE. Generally, the thinner the razor blade becomes at its cutting edge the lower the cutting force and the better the razor blade's cutting attributes. The properties of the resulting razor blade greatly depend on the strength and the hardness of both the underlying substrate and the coating. Up until the development of embodiments of the

present invention, suitable blade substrates and coatings providing these advantages were not known in the art.

SUMMARY

5 **[0008]** Embodiments of the present invention are razor blades and a razor and methods of making them with novel and non-obvious features permitting extended use of the razor and blades and thus reducing waste.

10 **[0009]** An embodiment is a razor blade comprising a mineral substrate, an adhesion promoter first surface bound to the mineral substrate, and an outer layer bound to a second surface the adhesion promoter. The mineral substrate may be corundum, sapphire, ruby and diamond or a combination thereof. The adhesion promoter first surface comprises a substrate binding group and the second surface comprises an outer layer binding group. The adhesion promoter substrate binding group may comprise a silane and/or
15 phosphonate. The adhesion promoter outer layer binding group may comprise a halogen and/or an amine. The outer layer is a lubricious fluoropolymer, including, but not limited to, PTFE.

20 **[0010]** An embodiment is a razor blade comprising a mineral blade with a mineral cutting edge, the mineral cutting edge having a radius of less than about 20 nanometers and an angle of about 40-50 degrees, wherein the mineral blade is coated in about 20 nanometers of the adhesion promoter and at least about 400 nanometers of the outer layer. The mineral may be a corundum such as a single crystal sapphire, ruby, or diamond. The mineral blade may be about 0.2 millimeters thick, when used in conjunction with the
25 razor according to an embodiment of the present invention. Thickness as well as width of the blade may vary greatly depending upon the application, single blade, at least two blades, or use of the blade in a straight razor.

30 **[0011]** In one embodiment, the mineral blade may be annealed before coating with chromium nitride and the mineral cutting edge is sharpened by treating with at least one of plasma and laser. The chromium nitride coating may be applied by magnetron sputtering, and following the coating with chromium nitride the blade may be annealed in an argon atmosphere. A portion of the chromium nitride coating may be diffused into the mineral blade.

The PTFE may be spray applied and sintered in an inert atmosphere onto the surface of the chromium nitride coated mineral blade.

[0012] An embodiment is a razor comprising at least one mineral blade further comprising a head having a first surface and a second surface, a
5 cartridge having a cartridge top having a first surface and a second surface and a cartridge bottom having a first surface and a second surface, wherein the blade is disposed between the second surface of the cartridge top and the first surface of the cartridge bottom, wherein the first surface of the cartridge top is removably attached to the second surface of the head, and a handle,
10 wherein the head is movably attached by a pivot pin to a first end of the handle. The first surface of the cartridge top is removably attached to the second surface of the head using at least one magnet.

[0013] The handle may be comprised of a left piece having an internal and an external surface, a right piece having an internal and an external
15 surface, and a center piece, wherein the center piece is disposed between the internal surface of the left piece and the internal surface of the right piece. The cartridge may be comprised of a cartridge top having a first surface and a second surface, a cartridge bottom having a first surface and a second surface, wherein the blade is disposed between the second surface of the
20 cartridge top and the first surface of the cartridge bottom, wherein the cartridge top is attached to the cartridge bottom using at least two micro-screws, and wherein at least one cavity is disposed in the first surface of the cartridge top, wherein the cavity is adapted to receive at least one magnet. The magnet may be a rare earth magnet and may be, but is not limited to, a
25 nickel-plated rare earth magnet. At least one first magnet may be disposed on the second surface of the head and at least one second magnet of opposite polar orientation from the first magnet may be disposed on the first surface of the cartridge top. The center piece may be comprised of iridium, and the razor may comprise at least one mineral blade. The mineral blade
30 may comprise corundum, sapphire, ruby, diamond, or any combination thereof.

[0014] Additional advantages of an embodiment of the invention will be set forth in part in the description that follows, and in part will be obvious from the description, or may be learned by practice of the invention. The

advantages of the invention will be realized and attained by means of the elements and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

5 **[0015]** The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and with the description, serve to explain the principles of the invention. Where appropriate, the same reference numerals refer to the same or similar elements.

10 **[0016]** Figure 1 is an elevation view of a razor blade according to an embodiment of the present invention.

[0017] Figure 2 is an elevation view of a razor blade according to an embodiment of the present invention.

15 **[0018]** Figure 3 is an elevation view of a razor blade according to an embodiment of the present invention.

[0019] Figure 4 is an elevation view of a razor blade according to an embodiment of the present invention.

[0020] Figure 5 is an exploded view of a razor according to an embodiment of the present invention.

20 **[0021]** Figure 6 is an elevation view of razor blades as fixed in a cartridge according to an embodiment of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

25 **[0022]** Reference now will be made in detail to the device and methods consistent with implementations of the present invention, examples of which are illustrated in the accompanying drawings. The appended claims define the scope of the invention, and the following description does not limit that scope.

30 **[0023]** As shown in Fig. 1-4, blade **10** is comprised of substrate **17** then coated with adhesion promoter **18** and subsequently coated with outer layer **19**. As shown in Fig. 1, substrate **17** may comprise mineral, corundum, alpha- Al_2O_3 , aluminum oxide, alumina, diamond, ruby, or sapphire or any other suitable mineral. Substrate **17** may comprise minerals containing chemical dopants or other impurities, as in the case of corundum and ruby. Substrate

17 may be monocrystalline as cut from from a boule or polycrystalline, as would result from sintering and fusing aluminum oxide under pressure. For purposes of example only, in one embodiment substrate **17** may comprise a sapphire, which may be, but is not limited to, a single crystal sapphire **2**

5 having length **A** of about 38 mm, and width **B** may be about 4mm. Thickness **D** may be about 0.2 mm. Many other measurements having width **B** greater than about 4mm, and thickness **D** greater than about 0.2mm are possible depending on whether the razor is mounted as a single-blade or a double blade razor, or even mounted as a straight razor.

10 **[0024]** As shown in Fig. 1 and 2, the C (0001) crystal face is disposed on the **B** x **D** face, and is mechanically and chemically sharpened on both sides to produce angle **G** of about 30 degrees. After mechanical and chemical sharpening, the crystal substrate **17** is then annealed to relieve stresses in the crystal. At this stage, the edge radius **F** is roughly about
15 100nm. Length **E** is driven by the thickness **D** tolerance combined with the angle **G** tolerance. Length **E** may be about 0.30mm to about 0.50mm. In one embodiment length **E** is approximately 0.39mm.

[0025] As shown in FIG. 3, substrate **17** may be further sharpened by plasma and/or laser to produce an even sharper cutting edge **I** of less than
20 about 20nm edge radius. In one embodiment plasm sharpening may be accomplished by placing blade **10** in a vacuum chamber and then treating them with oxygen or chlorine gas that has been excited to a plasma state. In one embodiment a laser may be used to sharpen blade **10**. In addition, a combination of plasma and laser sharpening may be used. This final
25 sharpening step also increases the final angle **H** to about 40-50 degrees for the final edge **J** of about 1-1.5um to increase the durability of the edge. At this stage sharpening of substrate **17** is complete.

[0026] As shown in FIG. 4, sharpened substrate **17** is treated with bifunctional adhesion promoter **18**. Adhesion promoter **18** comprises a
30 substrate binding group that binds to substrate **17** and an exposed functional group that mediates interaction with outer layer **19**. Adhesion promoter **18** may comprise either silane or phosphonate substrate binding chemistry to bind to substrate **17**. In the case of silane chemistry, the silane group can be mono-, di- or trialkoxy substituted. A monoalkoxy substituted silane will create

an adhesion promoter 4 monolayer about three to about eight layers thick. Monoalkoxy substitution is preferred. At substrate **17** surface while di- or tri-alkoxy substituted silanes will create adhesion promoter **18** multilayer from about three to about eight layers thick. Monoalkoxy substitution is preferred.

5 The silane alkoxy groups can be methoxy, ethoxy, propoxy, isopropoxy or any alkoxy groups based on any higher alcohol, but methoxy and ethoxy are preferred. In the case of phosphonate substrate binding group, an unsubstituted phosphonic acid group can be used or phosphonate mono- or di-substituted with any alkoxy group as described in the above paragraph.

10 Again, methoxy or ethoxy groups are preferred.

[0027] Adhesion promoter **18** exposed functional group is attached to the substrate binding group by an aromatic and/or alkane spacer. In the case of an alkane, it can be of any length but for purposes of stability, a propyl group is preferred. The exposed functional group can be either a halogen or
15 an amine. In the case of a halogen, a chloro-group is preferred. In the case of amine, it can be a primary or secondary amine or any combination of amines linked by an alkane spacer or spacers. Adhesion promoter **18** is then cured according to its substrate binding group's chemistry. Curing processes are known to ones of ordinary skill in the art and the conditions need not be
20 repeated here. In the case or silane curing chemistry, the treatment may comprise a about 5 to about 10 minute curing at about 110 degrees C. In the case of phosphonate chemistry, curing consists immersing in solution for about 24 hours then dried, procedures that are known to one of ordinary skill in the art.

25 **[0028]** The subsequent application of outer layer **19**, which may be, but is not limited to, a polyamide-imide/fluoropolymer (PAI) layer may be accomplished with the PAI applied as a primer or co-sprayed as a mix of commercially available PAI resin and commercially available fluoropolymer dispersion or suspended micropowder. The PAI layer may comprise PAI
30 available from a number of commercial sources. The solvent can be water or organic solvent. The fluoropolymer is preferably polytetrafluoroethylene (PTFE) but any acceptably lubricious fluoropolymer can be substituted. Finally, the coated blade undergoes a curing heat treatment. Curing of the outer layer coating is accomplished first by drying at 95 degrees C for 10

minutes and then with a bake at 420 degrees C for 10 minutes. The curing process: 1) evaporates the solvent; 2) converts the polyamic acid in PAI resin to its final polyamide-imide form, giving the PAI its toughness; and 3) sintering of PTFE to create adhesion with the PAI resin as well as create a continuous outer layer of fluoropolymer film.

[0029] In a first embodiment adhesion promoter **18** may be an alkene or alkyne adhesion promoter and outer layer **19** may be PTFE deposited via initiated Chemical Vapor Deposition (iCVD). Substrate **17** is first coated with bifunctional adhesion promoter **18**. The exposed functional group is preferably an alkene or alkyne. Any group containing a carbon-carbon multiple bond is acceptable. Some examples are vinyl, allyl, propenyl, and vinylbenzyl. A vinyl or allyl group is preferred. Adhesion promoter **18** layer is then cured according to its substrate binding group's chemistry, as discussed above.

[0030] The subsequent application of outer layer **19** of PTFE is accomplished through initiated chemical vapor deposition (iCVD). Briefly, this involves the pyrolysis of a fluorinated gaseous compound that yields a difluorocarbene radical. The difluorocarbene radical polymerizes into PTFE at the surface of substrate **17** as disclosed in US patent 6,153,269, which is hereby incorporated by reference in its entirety.

[0031] In a second embodiment adhesion promoter **18** is a fluoroalkane and outer layer **19** is iCVD PTFE or sintered PTFE. Substrate **17** is first coated with bifunctional adhesion promoter **18**. The exposed functional group comprises an alkane spacer attached to an unbranched fluoroalkane chain. The spacer can be methylene, ethylene, propylene or longer but ethylene is preferred. The fluoroalkane chain can be any length but is preferably between four and twelve CF₂ units in length. Adhesion promoter **18** layer is then cured according to its substrate binding group's chemistry, as discussed above. Curing, for the purposes of the present application, can be implied to be a part of the coating process. The subsequent application of outer layer **19** comprising a fluoropolymer is then accomplished either by conventional spray-sinter methods or by iCVD as described above.

[0032] In a third embodiment bare corundum substrate **17**, including, but not limited to, sapphire is coated with outer layer **19** which may be iCVD PTFE. Untreated substrate **17** is treated with iCVD procedure to apply outer layer **19** of PTFE material and then heat-sintered as described previously.

5 **[0033]** In a fourth embodiment, after sharpening, substrate **17** is coated in about 5nm to about 50nm, and in one embodiment about 20nm of adhesion promoter **18**, which is, but not limited to, chromium nitride, applied via magnetron sputtering. After this coating is applied, substrate **17** and adhesion promoter **18** are then annealed in an argon atmosphere so as to diffuse the
10 lower portion of the metallic coating into substrate **17**. Finally, outer layer **19** of PTFE is spray-applied via atomizer and sintered in an inert atmosphere onto the surface. In one embodiment, final sintered PTFE coating is at least about 100nm to about 1500nm and in one embodiment at least about 400nm thick.

15 **[0034]** As shown in FIG. 5, blade **10** comprising substrate **17**, adhesion promoter **18** and outer layer **19** may be used in conjunction with razor **40** according to one embodiment of the present invention. Razor **40** is comprised of three main sub-assemblies: handle **20**, head **1**, and cartridge **30**. Handle **20** may comprise three separate pieces: first or left handle **3**,
20 center piece **4**, and second or right handle **2**. They are assembled by at least two sets of sexed bolts **12** and **13**. Sexed bolt **12** is sized appropriately for placement through structural thru-holes **19** disposed near a first end **26** of handle **20** located proximal to head **1**. Sexed bolt **13** is sized appropriately for placement through structural thru-holes **19** disposed near a second end **18** of
25 handle **20** located distal from head **1**. Sexed bolts **12**, **13** may be comprised of stainless steel or any other suitable material such as, but not limited to, titanium, gold, platinum, and iridium or any combination thereof. Head **1** is attached to first **3** and second **2** handle pieces by pivot pins **7**. When sexed bolts **12**, **13** are in place, securing first handle **3**, second handle **2** and center
30 piece **4** together, head **1** will not be removable from handle **20**. The connection between head **1** and handle **20** comprises two pivot pins **7**. Near first end **26** of both first **3** and second **2** handle pieces small cavity **22** is disposed and/or milled out to receive torsion spring **8**, **9** and pivot pins **7**.

[0035] Cartridge **30** comprises two frame pieces, cartridge top **5** and cartridge bottom **6**, that may be secured together by at least one micro screw **16**. Micro screw **16** may be comprised of stainless steel or any other suitable material, including, but not limited to, titanium, platinum, gold and iridium or any combination thereof. Disposed between a second or underside surface of cartridge top **5** and a first or top surface of cartridge bottom **6** is at least one blade **10**, prepared as described above. In one embodiment at least two blades **10'** and **10''** may also include a small piece of shock absorbent material **31** disposed between the at least two blades **10**. Shock absorbent material **31** may comprise rubber or any other suitable material. The rubber may be, but is not limited to, synthetic rubber, natural rubber, and/or a foam rubber.

[0036] Cartridge **30** removably attaches to head **1** by a system of at least one magnet **14**, **15**. Magnets **14**, **15** may be rare earth magnets, or any other suitable magnet. Magnet **14** is disposed and affixed to a second surface or underside of head **1**. Magnet **15** is disposed and affixed to a first surface or top surface of cartridge top **5**. Magnets **14** and **15** are disposed in cavities **24** found in head **1** and cartridge top **5**. The geometry of cartridge **30** and head **1** are complimentary, so that as magnets **14**, **15** attract one another and pull together, the top or upper surface of cartridge **30** and the second or underside surface of head **1** mate in such a way to prevent cartridge **30** from shearing off from head **1** during use. Cartridge **30** must be removed from head **1** by overcoming the attractive force of magnets **14**, **15** and pulling cartridge **30** away in a direction perpendicular to the longitudinal axis of head **1**.

[0037] First **3** and second **2** handle pieces are mirror structures of each other. They may be milled/machined from 316 stainless steel or any other suitable material such as, but not limited to, titanium, gold, platinum, and iridium or any combination thereof and may be machine polished to a satin finish. Two sets of structural thru-holes **19**, one disposed near first end **26** and the other disposed near second end **18** of handle **20**, serve as the location for sexed bolts **12**, **13** and female screw **11** for assembly of handle **20**. Female screw **11** may be a removable thread-locker screw. To reduce weight and improve balance of handle **20** there may be a large tear-shaped

opening disposed along a portion of the length of handle **20** between the two structural holes **19**.

[0038] Center piece **4** may be flat, and machined/milled from high purity iridium, or any other suitable material, such as, but not limited to, stainless steel, titanium, gold, and platinum or any combination thereof. Iridium is very strong, rare, and difficult to work with. Center piece **4** may be polished to a bright/near-mirror finish. Center piece **4** has at least one, and in one embodiment, two structural thru-holes **19**, one disposed near first end **26** and the other disposed near second end **18** of handle **20**, which align with thru-holes **19** disposed on left **3** and right **2** handle pieces when handle **20** is assembled, to complete thru-holes **19** for the sexed bolts **12**, **13** and female screw **11**. Center piece **4** may have at least one, and in one embodiment four, complex openings, that may be generally ovoid or tear-shaped, to reduce the weight and/or improve the balance of handle **20**. The outer edges of these openings may generally follow the contour of the openings disposed on the left **3** and right **2** handle pieces.

[0039] The profile of center piece **4** may be larger and/or wider than the profile of left **3** and right **2** handle pieces, so that when handle **20** is assembled, center piece **4** may protrude beyond at least one of the top, bottom, and/or posterior surfaces of handle pieces **3** and **2**. To enhance the comfort of handle **20**, an outer surface of center piece **4** may have filleted edges and/or a slight bulge.

[0040] Head **1** comprises a single piece of machined/milled 316 stainless steel, or any other suitable material, such as, but not limited to, titanium, gold, platinum, and iridium or any combination thereof, that may be machine polished to a satin finish to match left **3** and right **2** handle pieces. Head **1** may be generally rectangular in shape and possess at least one large, generally rectangular opening through the middle. On its underside, head **1** may have at least one cavity **24** into which magnet **14** is affixed with adhesive or by any other suitable manner. Magnet **14** may be comprised of nickel-plated rare earth magnets or any other suitable magnet.

[0041] Cartridge **30** sub-assembly comprises at least one blade **10** described above, although it's possible blade **10** may be comprised of diamond or any other suitable material. Blade **10** is sandwiched between

cartridge top **5** and cartridge bottom **6**, which may be machined from 316 stainless steel or any other suitable material such as, but not limited to, titanium, gold, platinum, and iridium or any combination thereof and may be mechanically polished to satin finish, matching left **3** and right **2** handle pieces and/or head **1**. Cartridge bottom **6** has at least one large generally rectangular opening in the center. Cartridge top **5** has a similar opening, plus at least one, and in one embodiment, two transverse struts **32** which match the angle of left **3** and right **2** handle pieces, and which provide support for the back surface of blade **10**.

[0042] Cartridge bottom **6** may have at least two tapped holes **29** adapted to receive microscrews **16**. Cartridge top **5** may have at least two thru-holes **28**, or the same number of tapped holes **29** disposed in cartridge bottom **6**, adapted for the insertion of microscrews **16**. Cartridge bottom **6** and top **5** are attached to each other via microscrews **16**. Microscrews **16** may be comprised of stainless steel or any other suitable material such as, but not limited to, titanium, gold, platinum and iridium or any combination thereof, the shafts of which pass through hole **28** in cartridge top **5** and are secured and screw into matching and/or aligning tapped holes **29** in cartridge bottom **6** from above, thereby securing cartridge top **5** to cartridge bottom **6** and securing blade **10** in assembled cartridge **30**.

[0043] In addition, cartridge top **5** may have at least one well **24** to receive rare earth magnet **15** in the opposite polar orientation to magnet **14** disposed in well **24** on head **1**, allowing cartridge assembly **30** to attach to head **1**. To prevent cartridge **30** from shearing off from head **1** during shaving or incidental contact, head **1** and cartridge **30** may have several interlocking surfaces oriented perpendicular to the face plane, horizontally, vertically, and/or both.

EXAMPLE

[0044] The following values are exemplary only, and are based on an embodiment of the present invention having two blades **10**. As shown in FIG. 6, blades **10** comprised of first blade **10'** and second blade **10''** are held in cartridge **30** so that they are oriented at angle **N** of about 18 degrees to about 20 degrees, and in one embodiment about 19 degrees from the front face **36**

of cartridge **30**. First blade **10'** is located at a distance **R** of about 0.83mm to about 0.94mm and in one embodiment about 0.889mm from the trailing edge of guard bar **34**, and is exposed at a distance **S** of approximately 0.6mm (when viewed along the face plane). Second blade **10''** is located at a distance **Q** of about 1.6mm to about 1.8mm and in one embodiment about 1.7mm from first blade **10'**, at the same exposure. The [leading edge of top bar **36**] is located at a distance **P** of about 3.4mm to about 3.6mm and in one embodiment about 3.515mm from the tip of second blade **10''**, and at a distance **O** of about 0.13mm to about 0.24mm and in one embodiment about 0.186mm back from the plane created by the two blade **10** edges.

[0045] Referring back to FIG. 5, one pivot pin **7** is inserted into clockwise wound torsion spring **8**. A first leg of torsion spring **8** is inserted into a slot (not shown) on pivot pin **7**. Spring **8** and pivot pin **7** subassembly is then inserted into cavity **22** disposed on or near first end **26** of left handle piece **3** and rotated so that a second leg of torsion spring **8** is inserted into a milled hole (not shown) at the base of cavity **22**. Left handle piece **3** is then mated to head **1** by inserting pivot pin **7** into hole **23** in head **1**. A second pivot pin **7**, counter-clockwise wound torsion spring **9**, and right handle piece **2** are assembled in the same manner, respectively. Center piece **4** is then placed between right **2** and left **3** handle pieces and sexed bolts **12**, **13** are then inserted in the front and rear thru-holes **19**, and secured with removable female screws **11**. Head **1** and handle **20** are thereby connected, with sprung pivoting pins **7** between head **1** and handle **20**.

[0046] Cartridge **30** attaches to head **1** via magnets **14**, **15** attached to cartridge **30** and head **1**. At least one magnet **14** may be disposed on each of head **1** and a matching number of magnets **15** on a first or top surface of cartridge top **5**. As head **1** and cartridge **30** are brought together, the attraction of magnets **14**, **15** will cause them to align and pull together. As head **1** and cartridge **30** come together, interlocking surfaces on the two will prevent cartridge **30** from shearing away from head **1** during normal usage.

[0047] In an embodiment, Applicant's solid white sapphire blades are hypoallergenic, substantially impervious to oxidation and corrosion, and may be an order of magnitude more durable than any other known shaving blade.

[0048] In an embodiment, Applicant's substrate **17** are sapphire blades that may be sharpened with high-energy, ionized particles creating a tip less than about 100 atoms in width, or roughly 5000 times smaller than the width of a hair.

5 **[0049]** In an embodiment, Applicant's custom hexagonal screws may be precision machined from pure platinum.

[0050] Numerous characteristics and advantages have been set forth in the foregoing description, together with details of structure and function. The novel features are pointed out in the appended claims. The disclosure,
10 however, is illustrative only, and changes, may be made in detail, especially in matters of shape, size, and arrangement of parts, within the principle of the invention, to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

WHAT IS CLAIMED IS:

1. A razor blade comprising:
a mineral substrate;
5 an adhesion promoter having a first surface bound to the mineral substrate; and
the adhesion promoter having a second surface bound to an outer layer.
- 10 2. The razor blade according to Claim 1, wherein the mineral is diamond.
3. The razor blade according to Claim 1, wherein the mineral is corundum.
- 15 4. The razor blade according to Claim 2, wherein the corundum is sapphire.
5. The razor blade according to Claim 1, wherein the adhesion promoter first surface comprises a substrate binding group and the adhesion promoter
20 second surface comprises an outer layer binding group.
6. The razor blade according to Claim 5, wherein the adhesion promoter substrate binding group comprises a silane.
- 25 7. The razor blade according to Claim 5, wherein the adhesion promoter substrate binding group comprises a phosphonate.
8. The razor blade according to Claim 5, wherein the adhesion promoter outer layer binding group comprises a halogen.
- 30 9. The razor blade according to Claim 5, wherein the adhesion promoter outer layer binding group comprises an amine.

10. The razor blade according to Claim 1, wherein the outer layer is a lubricious fluoropolymer.

11. A razor blade comprising:

- 5 a mineral blade having a mineral cutting edge;
the mineral cutting edge having a radius of less than about 20 nanometers and an angle of about 40-50 degrees;
wherein the corundum blade is coated in about 20 nanometers of adhesion promoter and at least about 400 nanometers of outer layer.

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12. A razor comprising at least one blade according to Claim 1, further comprising:

- a head having a first surface and a second surface;
a cartridge having a cartridge top having a first surface and a second
15 surface and a cartridge bottom having a first surface and a second surface;
wherein the blade is disposed between the second surface of the cartridge top and the first surface of the cartridge bottom;
wherein the first surface of the cartridge top is removably attached to the second surface of the head; and
20 a handle, wherein the head is movably attached by a pivot pin to a first end of the handle.

13. The razor according to Claim 11, wherein the first surface of the cartridge top is removably attached to the second surface of the head using at
25 least one magnet.

14. The razor according to Claim 11, wherein the handle is comprised of a left piece having an internal and an external surface, a right piece having an internal and an external surface, and a center piece, wherein the center piece
30 is disposed between the internal surface of the left piece and the internal surface of the right piece.

15. The razor according to Claim 11, wherein the cartridge is comprised of:
a cartridge top having a first surface and a second surface;

a cartridge bottom having a first surface and a second surface;
wherein the blade is disposed between the second surface of the
cartridge top and the first surface of the cartridge bottom;
wherein the cartridge top is attached to the cartridge bottom using at
5 least one micro-screw; and
wherein at least one cavity is disposed in the first surface of the
cartridge top, wherein the cavity is adapted to receive at least one magnet.

10 16. The razor according to Claim 13, wherein the magnet is a rare earth
magnet.

17. The razor according to Claim 13, wherein the magnet is a nickel-plated
rare earth magnet.

15 18. The razor according to Claim 13, wherein at least one first magnet is
disposed on the head and at least one second magnet of opposite polar
orientation from the first magnet is disposed on the first surface of the
cartridge top.

20 19. The razor according to Claim 14, wherein the center piece is comprised
of at least one of iridium, platinum, titanium and gold or a combination thereof.

20. The razor according to Claim 11, wherein the razor comprises at least
two mineral blades.

25 21. A method for sharpening blades comprising the use of plasma
sharpening.

22. A method for sharpening blades comprising the use of a laser.

30 23. A razor comprising:
a handle;
a head attached to the handle; and
a cartridge containing a blade;

wherein the cartridge is removably attached to the head by at least one magnet.

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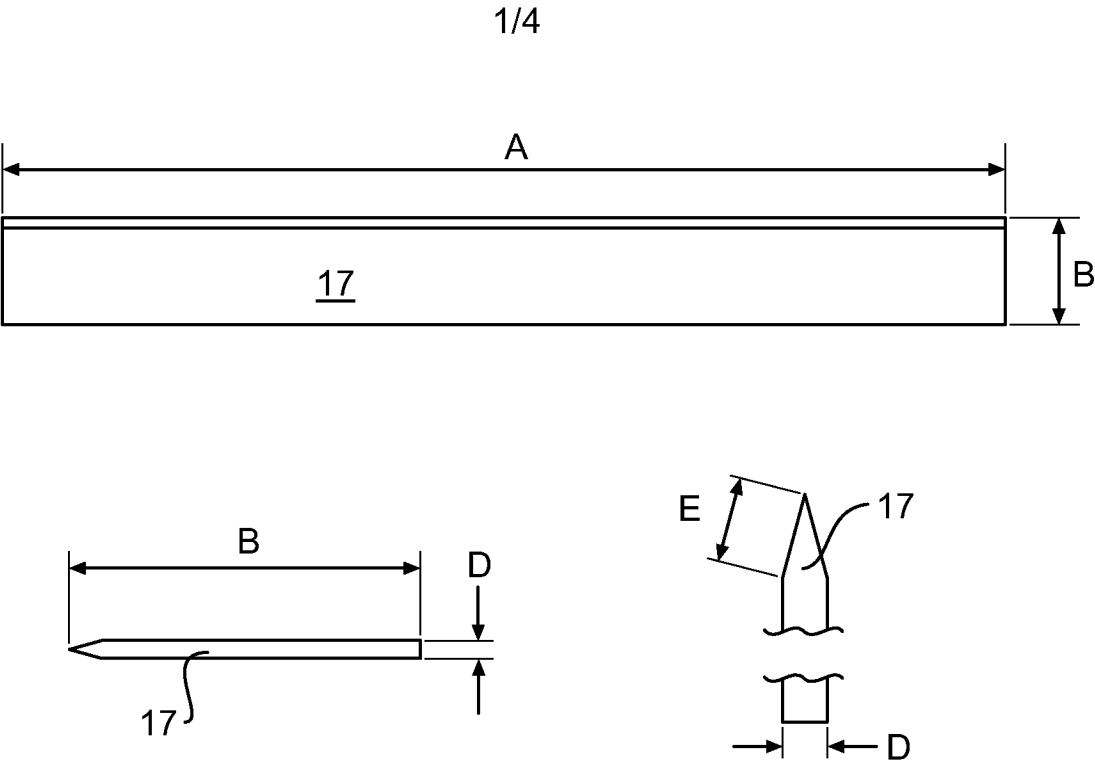


FIG. 1

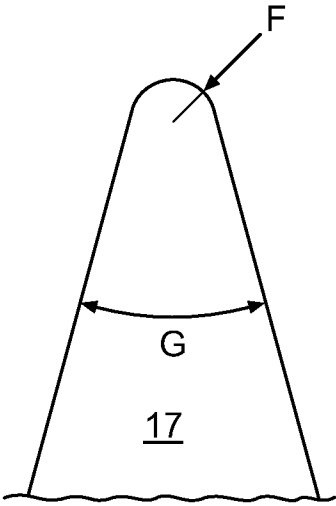


FIG. 2

2/4

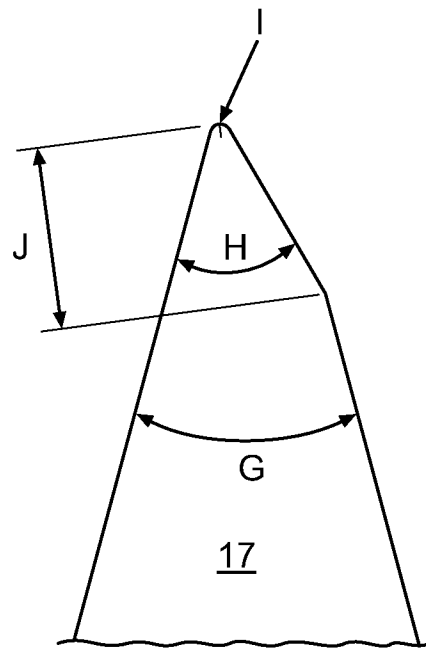


FIG. 3

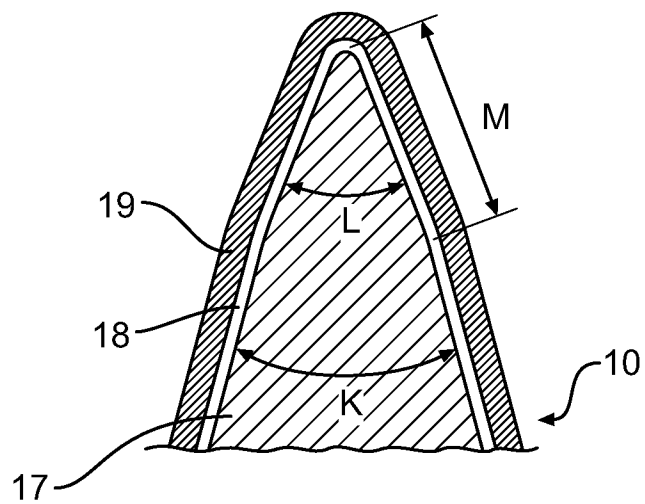


FIG. 4

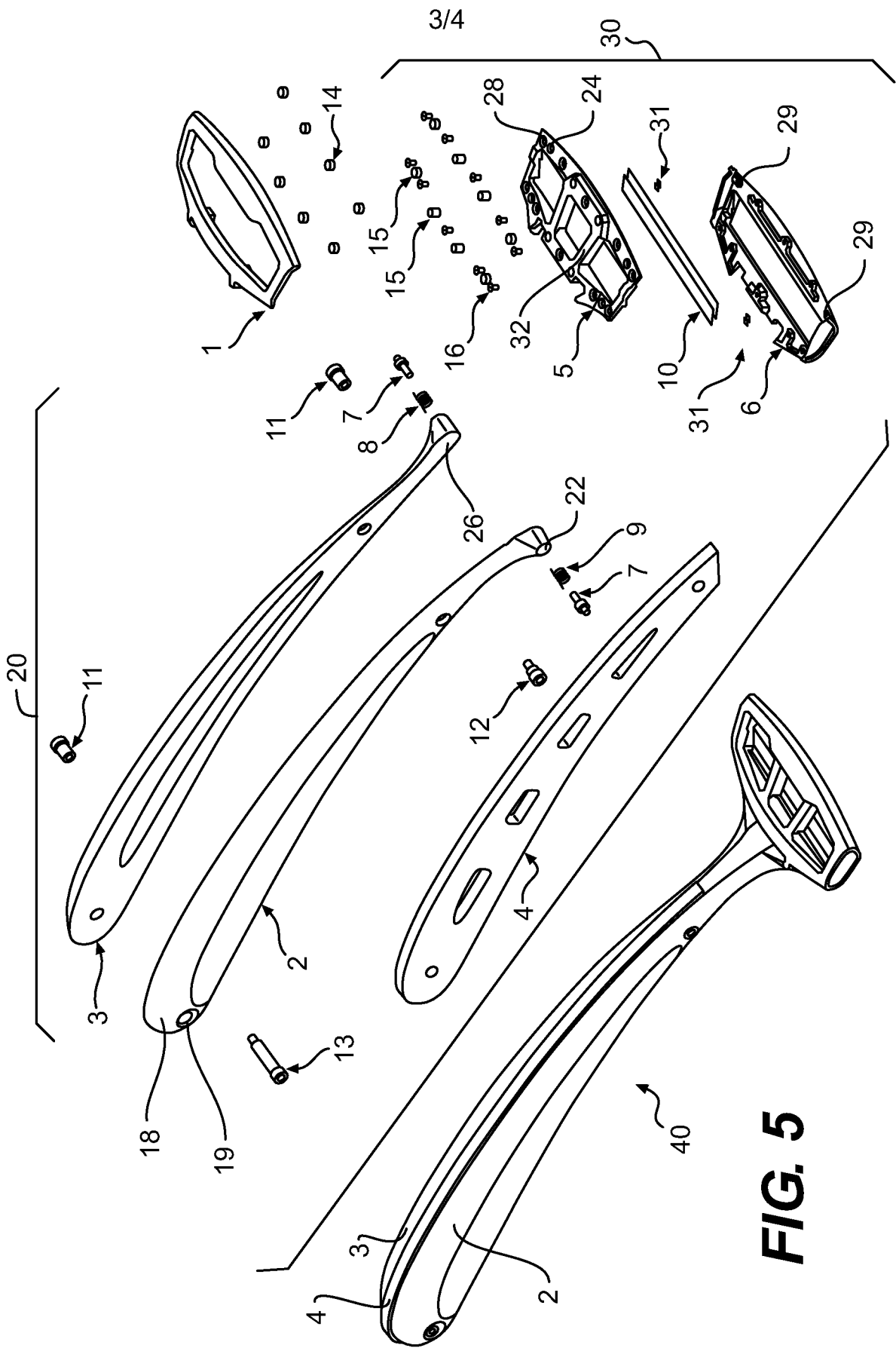


FIG. 5

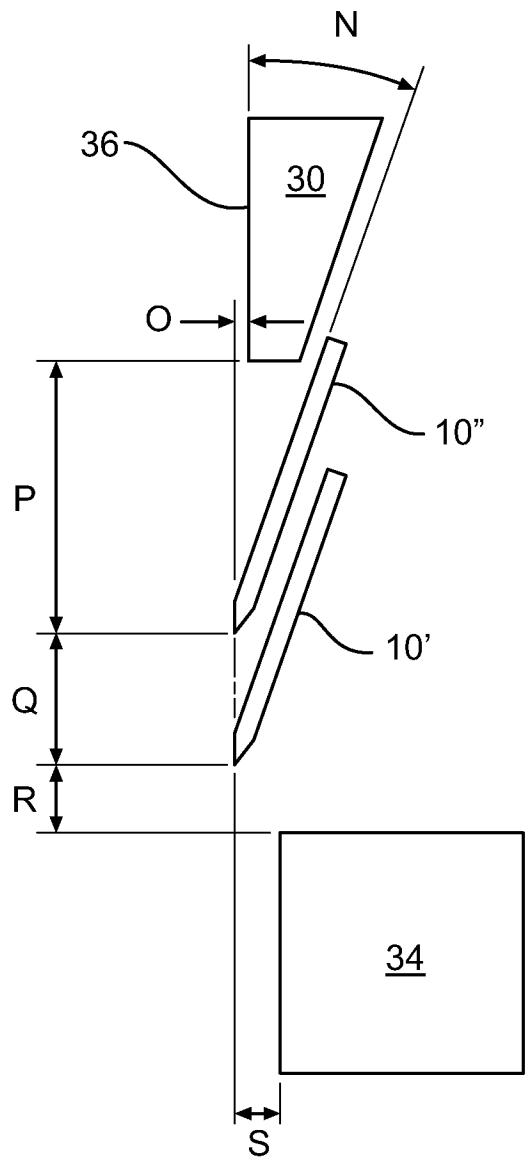


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2012/041654

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B62B 21/52, 21/60 (2012.01)

USPC - 30/346.54, 526

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - B26B 21/08, 21/10, 21/14, 21/18, 21/22, 21/24, 21/52, 21/54, 21/56, 21/58, 21/60; H01F 7/02 (2012.01)

USPC - 30/32, 34.05, 36, 40, 50, 51, 60, 74, 346.5, 346.51, 346.53, 346.54, 346.55, 346.58, 526, 527, 531; 204/192.15, 192.3

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
206/350, 352, 354, 818; 264/247, 259; 335/306; 427/299, 333; 428/411.1; 438/20; 445/50, 51

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

Patbase, Google Patents, Google.com

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/0024222 A1 (AKARI et al) 04 February 2010 (04.02.2010) entire document	1, 5, 10
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Y		2-4, 6-9, 11-20
X	"Industrial Diamond Cuts Through the Competition". MCCLARENCE, E. 10 September 2010 (10.09.2010). [retrieved on 2012-09-26]. Retrieved from the Internet:<URL: http://www.abrasiveshub.com/img/PG000534.pdf >. 2 pages.	21
X	US 5,983,756 A (ORLOFF) 16 November 1999 (16.11.1999) entire document	22
Y	US 4,581,969 (KIM) 15 April 1986 (15.04.1986) entire document	2
Y	US 3,894,337 A (JONES) 15 July 1975 (15.07.1975) entire document	3, 4, 11
Y	US 2009/0274634 A1 (COLLINS et al) 05 November 2009 (05.11.2009) entire document	6-9
Y	US 7,913,393 B2 (ROYLE et al) 29 March 2011 (29.03.2011) entire document	12-20, 23
Y	US 1,299,098 A (AMES) 01 April 1919 (01.04.1919) entire document	13, 16-18, 23
Y	US 2004/0216311 A1 (FOLLO) 04 November 2004 (04.11.2004) entire document	14, 19
Y	US 2,043,998 A (HADJOPOULOS) 16 June 1936 (16.06.1936) entire document	15
Y	US 7,337,903 B2 (LAURI) 04 March 2008 (04.03.2008) entire document	15, 16
Y	US 5,286,366 A (MITSUJI) 15 February 1994 (15.02.1994) entire document	17

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

28 September 2012

Date of mailing of the international search report

19 OCT 2012

Name and mailing address of the ISA/US

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P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2012/041654

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

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

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

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

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

See extra sheet.

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

Remark on Protest

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

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2012/041654

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees need to be paid.

Group I, claims 1-10 and 12, are drawn to a razor blade having a mineral substrate and adhesion promoters.

Group II, claims 11 and 13-20, are drawn to a razor blade having a mineral blade with a defined radius and cut angle.

Group III, claims 21 and 22, are drawn to methods for sharpening blades.

Group IV, claim 23, is drawn to a razor having a handle, head, and cartridge.

The inventions listed in Groups I through IV do not relate to a single general inventive concept under PCT Rule 13.1, because under PCT

Rule 13.2 they lack the same or corresponding special technical features for the following reasons:

The special technical features of Group I, a razor blade comprising: a mineral substrate, an adhesion promoter having a first surface bound to the mineral substrate, and the adhesion promoter having a second surface bound to an outer layer, are not present in Groups II-IV; the special technical features of Group II, a razor blade comprising a mineral blade having a mineral cutting edge, the mineral cutting edge having a radius of less than about 20 nanometers and an angle of about 40-50 degrees, wherein the corundum blade is coated in about 20 nanometers of adhesion promoter and at least about 400 nanometers of outer layer, are not present in Groups I, III, and IV; the special technical features of Group III, methods for sharpening blades including use of energy sources such as laser or plasma energy, are not present in Groups I, II, and IV; and the special technical features of Group IV, a razor comprising a handle, a head attached to the handle, and a cartridge containing a blade, wherein the cartridge is removably attached to the head by at least one magnet, are not present in Groups II-IV.

Groups I through IV share the technical features of a razor blade including a mineral substrate cutting edge and including an adhesion promoter. However, these shared technical features do not represent a contribution over the prior art. Specifically, US 2005/0268470 A1 to Skrobis et al. teaches colored razor blades (Abstract) including a mineral substrate cutting edge (Paras. [0048] through [0051] Suitable hard coating materials include carbon-containing materials (e.g., diamond, amorphous diamond or DLC); see also claims 29 and 30) and including an adhesion promoter (Para. [0035] oxide coating may be deposited on top of a thin adhesion-promoting layer of a non-oxidized metal, e.g., chromium, titanium, or other non-oxidized metals. This adhesion-promoting layer may be applied to the sheet of soft blade steel, e.g., by physical vapor deposition (PVD), and can have thickness of between 50 and 250 angstroms. If desired, the coating may be pre-applied by a supplier, prior to the other processing steps shown in FIG. 3. The oxide coating can be deposited by a number of techniques, including evaporation (a PVD technique), sputtering (PVD), arc sources (PVD), plasma enhanced chemical vapor deposition (PECVD), and other techniques such as sol-gel processing, and thermal growth of films).

Since none of the special technical features of the Group I through IV inventions are found in more than one of the inventions, unity is lacking.