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Registered U.S. Patent Attorneys

# #8

# Example Provisional Patent Application (PPA)

In due course, this Provisional patent application (PPA) was re-written and filed as a utility (non-provisional) patent application in the U.S. Patent Office. The patent was eventually granted as **US Patent No. 10,039,621**

*The following example is provided for educational purposes only in connection with* **ELG's Practical Guide to PROVISIONAL PATENT APPLICATIONS for the Cost-Conscious Inventor**.

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# BURNISHING OSTEOTOME

## CROSS REFERENCE TO RELATED APPLICATIONS

**[0001]** Upon future conversion to a non-provisional application, this application MAY claim priority to United States Serial Number 13/608,307 filed September 10, 1012, which is a continuation-in-part of United States Serial Number 13/427,391 filed March 30, 1012, which claims priority to Provisional Patent Application No. 61/466,579 filed March 23, 2011, the entire disclosures of each are hereby incorporated by reference and relied upon.

## BACKGROUND OF THE INVENTION

### Field of the Invention

**[0002]** The invention relates to an osteotome for expanding an initial osteotomy to receive a bone implant. With only minor modifications, the improved tool can be used to prepare a suitable anchoring sight for fasteners and anchoring devices in cellular materials like polymer foam and expanded metal.

### Related Art

**[0003]** An implant is a medical device manufactured to replace a missing biological structure, support a damaged biological structure, or enhance an existing biological structure. Bone implants are implants of the type placed into the bone of a patient. Bone implants may be found throughout the human skeletal system, including dental implants in a jaw bone to replace a lost or damaged tooth, joint implants to replace a damaged joints such as hips and knees, and reinforcement implants installed to repair fractures and remediate other deficiencies, to name but a few. The placement of an implant often requires a preparation into the bone using either hand osteotomes or precision drills with highly regulated speed to prevent burning or pressure necrosis of the bone. After a variable amount of time to allow the bone to grow on to the surface of the implant (or in some cases to a fixture portion of an implant), sufficient healing will enable a patient to start rehabilitation therapy or return to normal use or perhaps the placement of a restoration or other attachment feature.

**[0004]** The present invention is directed toward the preparation of a bone implant in cases where expansion of an initial osteotomy is required. The osteotome technique has become widely utilized in situations requiring preparation of an osteotomy site by expansion of a pilot hole. By nature, the osteotome technique is a traumatic procedure. The instruments are advanced with the impact of a surgical mallet, which compacts and expands the bone in the process of preparing osteotomy sites that will allow implant placement. Treatment of a mandibular site, for example, is often limited due to no accessibility specially in posterior region and due to the increased density and reduced plasticity exhibited by the bone in this region. Other non-dental bone implant sites may have similar challenging density and plasticity characteristics. Additionally, since the osteotome is inserted by hammering, the explosive nature of the percussive force provides limited control over the expansion process, which often leads to unintentional displacement or fracture of the labial plate of bone in dental applications. Many patients do not tolerate the osteotome technique well, frequently complaining about the impact from the surgical mallet. In addition, reports have documented the development of a variety of complications that result from the percussive trauma in dental applications, including vertigo and the eyes may show nystagmus (i.e., constant involuntary cyclical movement of the eyeball in any direction).

**[0005]** A technique has been developed for dental applications that allow the atraumatic preparation of implant sites by eliminating the use of a surgical mallet. This procedure is based on the use of a ridge expansion system that includes a bur kit and instruments known as motor-driven bone expanders, such as those marketed by Meisinger split control bone management system (Neuss, Germany). First a pilot hole is drilled at the implant site, then a series of progressively larger expander screw taps are introduced into the bone by hand or with motor-driven rotation in extremely low rotational speed as well as low rotational torque, which decreases surgical trauma while providing superior control (as compared with hammer taps) over the expansion site. The thread pattern of the expander screw taps has been designed to drive the expander deeper into the osteotomy and allow only the taper nature of the expander to impact the bone latterly. This method does not allow the surgeon the flexibility to drive the expander outside the designed feeding rate of the expander threads, also removing the expanders by reverse rotation to disengage the osteotomy has created more potential of bony wall fracture. There are several reports in the literature that have pointed out this potential problem. Also this method of expansion operated within the bone elasticity, so if the force was not enough to deform the bone by widening it, it returned to its original shape, so this method will call for the use of a conventional drill to create the last osteotomy after "expansion" immediately before placing the bone implant. In case the surgeon has not utilized the final drilling method prior to implant placement to reduce bone removal, he must apply large force (higher speed and higher rotational torque), to guarantee the needed deformation to produce the needed diameter to match the implant diameter. This widespread modification in the recorded usage has created always fracture of the osteotomy outer wall. Meisinger developed a tapered drill that has non-cutting 3 fluted twist in a reverse geometry and was called "Expander Burr" to help overcome the above issue. In dentistry, the term “bur” (or variously “burr”) is often synonymous with “cutter.” See ANITUA, *Ridge Expansion With Motorized Expander Drills*, Implant Dialogue, Page 9, Figs. 25-30.

**[0006]** Another bur tool is marketed under the brand name ANKYLOS by Friadent GmbH. A photograph of the ANKYLOS bone condenser/expander bur is shown in Figure 1. According to company-specified procedures, this bur tool is to be used also at extremely low speed rotation as well as low rotational torque as a last step in only a “cylindrical” (i.e., non-tapered) osteotomy that has been prepared by several progressively larger regular drill bits. Note in Figure 1 the smooth pilot tip of the ANKYLOS expander bur; this is designed as a non-cutting tip. ANKYLOS literature states that its expander bur can be rotated in a backward direction to achieve bone compaction. However, because of its non-cutting pilot tip, the ANKYLOS expander bur cannot be used in a multi-stage expansion operation and has to be always preceded with multiple step regular cutting drills. This means that a substantial amount of bone material must be excavated with drills before the ANKYLOS expander bur can be used, resulting in only a very small amount of expansion via compaction. It also means that the ANKYLOS expander bur is incapable of being used to enlarge the base of an osteotomy – it can only expand above the base of the osteotomy and also designed to shape that upper region of the osteotomy to receive a proprietary tapered implant made by the same company. The ANKYLOS condenser/expander bur is only designed to be used as the final step in its implant system. See ANKYLOS Surgical Manual, Dentsply Friadent, (www.dentsply-friadent.com), Friadent GmbH · P.O. Box 71 01 11 · 68221 Mannheim/Germany, Order no. 6-252054/004 (1211/5.0/GVD), Pages 24-25.

**[0007]** Burnishing is plastic deformation due to sliding contact. Burnishing occurs when the contact force between tool and working surface (bone in this case) exceeds the material yield strength. Burnishing will enhance the burnished material hardness, and create compressive residuals stresses. Burnishing also will help to close surface porosity, improve size, shape, and surface finish. Bone is flexible -- able to widen with compression, and lengthen with tension. Bone burnishing as used herein refers to bone plastic deformation without reaching its fracture or failure point. Bone burnishing is bone plastic deformation due to rolling and sliding contact with an osteotome. Generally speaking, regular twist drills or straight fluted drills have 2-3 flutes to guide them through the hole, whereas burnishing drills have 4 or more flutes.

**[0008]** There is a need in the art for an improved osteotome for surgical applications that provides greater surgical control, is capable of being used alternately for burnishing and cutting, minimizes loss of bone material, better prepares the implant site for stability and restoration, is less costly, less likely to introduce error, accelerates the surgical procedure, reduces patient discomfort and accelerates post-operative healing time. There is a need in the non-surgical arts for an improved tool to prepare a suitable anchoring sight for fasteners and anchoring devices in cellular materials like polymer foam and metal foam.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0009]** Referring to the Figures 2-8, a burnishing osteotome according to the present invention is generally shown at 30. The osteotome 30 comprises a longitudinally extending shank 32. The shank 32 has a coupling 34 at one end thereof to attach to a rotary input such as from a surgical motor having speed and torque controls. The osteotome 30 also includes a working end 36. The working end 36 extends longitudinally from the shank 32 opposite the coupling 34. As perhaps best shown in Figure 5, the working end 36 has a taper along at least a portion of its length. A leading distal tip 38 of the working end 36 defines a minimal outer diameter, and an upper end 40 defines a maximum outer diameter of the tapered portion. For dental applications as one example, dimensions of prototype osteotomes according to the present invention are provided in Figures 5-8. Of course, for non-dental applications involving larger bone osteotomy sites, the dimensional scale of the osteotome 30 may be adjusted accordingly.

**[0010]** According to the embodiment of the invention shown in Figures 2-20, the working end 36 includes at least one, but more preferably a plurality of helical grooves or flutes 42. The plurality of flutes 42 may comprise at least three flutes 42. Preferably, the flutes 42 are equally circumferentially spaced from one another so that if for example there are four flutes 42 they are arranged 90° apart; six flutes 42 would be arranged 60° apart; eight flutes 42 would be arranged 45° apart; ten flutes 42 would be arranged 36° apart; and so on. The number of flutes 42 may be dictated for primarily practical reasons by the size of the osteotome 30, such that very small diameter osteotomes 30 have the fewest number of flutes 42 and progressively larger osteotomes 30 have progressively more flutes 42.

**[0011]** A burnishing edge 44 is formed between adjacent flutes 42. As shown in Figure 15, the burnishing edge 44 is that specific portion of the crest portion which lies along the major diameter of the tapered working end 36 (i.e., the swept arc of the burnishing edge 44). The burnishing edge 44 is preferably established by a zero rake angle formation on one side with no margin and falling away on the other side with a primary taper clearance. In use, when the tool 30 is rotated in a burnishing (i.e., non-cutting) direction, the surgeon applies downward pressure applied to keep the burnishing edge 44 in contact with the bone surface of the osteotomy being expanded. The rubbing action of burnishing edge 44 against bone creates friction and heat, but this can be controlled by the surgeon by altering, on-the-fly, the rotation speed and/or pressure and/or irrigation flow. The surgeon may at any instant during the surgical procedure lift the burnishing edges 44 away from contact with the surface of the bone to allow air cooling and/or irrigation. This can be done in a controlled "bouncing" fashion where pressure is applied in short bursts with the surgeon continuously monitoring progress and making fine corrections and adjustments.

**[0012]** Figures 9-12 illustrate the surgical use of the osteotome 30 in an exemplary dental application. Because the osteotomy tool 30 is tapered, the harder the surgeon pushes down, the more pressure is exerted laterally. This gives the surgeon complete control of the expansion rate irrespective to a large degree on the rotation speed of the osteotome 30. Thus, the burnishing effect's intensity depends on the amount of surgeon-applied force exerted on the osteotome 30. The more force exerted, the quicker expansion will occur. A progression of surgical steps are used to expand an initial osteotomy (i.e., an initial drilled pilot hole) to receive a bone implant (not shown). Typically as a first step an initial osteotomy site is prepared by exposing bone, and then drilling a pilot hole into the bone with a pilot drill (not shown). This is shown in Figure 12, and may be accomplished with a typical prior art surgical pilot drill turned in a standard clockwise direction. The pilot hole in this instance comprises the initial osteotomy.

**[0013]** A first osteotome 30 (Figure 5) according to the present invention is operatively connected to a surgical motor (not shown) though its coupling 34 feature. Then the working end 36 of the first osteotome 30 is inserted into an initial osteotomy. The interior surface of the initial osteotomy is surrounded by bone. If the diameter of the pilot drill is, for example 1.5mm, then preferably the major diameter of the working end 36 of the first osteotome 30 adjacent the leading distal tip 38 is also 1.5mm so that it follows easily the pilot hole. Because of the widening taper, the major diameter of the working end 36 adjacent the upper end 40 is larger than the initial osteotomy. This may be, for example, 2.5mm. At these exemplary dimensions, a first osteotome 30 having four equally spaced flutes 42/burnishing edges 44 of helical twist (right hand spiral assuming the burnishing direction is counter-clockwise) has been found to provide satisfactory results. More or fewer flutes 42/burnishing edges 44 are certainly possible.

**[0014]** Depth markings in the form of laser-etched stripes may be applied to the working end 36 to indicate customary depths (as measured from the distal tip 38) of, for example, 7mm, 10mm, 13mm and 15mm. Although the surgeon may vary the rotational speed of the osteotome 30 according to the dictates of the situation in their judgment, experimental results indicate that rotation speeds between about 200-1200 RPM and torque settings between about 15-50 Ncm provide satisfactory results. More preferably rotation speeds between about 600-1000 RPM and torque settings between about 20-45 Ncm provide satisfactory results. And still more preferably, rotation speeds in the range of 800-900 RPM and torque settings of about 35 Ncm provide satisfactory results.

**[0015]** The burnishing procedure may include the controlled practice of bouncing the burnishing edges 44 into and out of contact with the interior surface of the osteotomy while continuously rotating the osteotome 30. If the surgeon warrants, the osteotome 30 may be rotated in the opposite direction (e.g., clockwise in these examples) and utilize the osteotome 30 to enlarge the osteotomy by cutting or excavating bone material from the osteotomy rather than via compression and plastic deformation. This technique of reversing rotation of the osteotome

30 as an intentional step during the surgical expansion procedure is described more fully in co-pending United States Serial Number 13/608,307. Those of skill in the art will recognize the substantial improvement in convenience and efficiency the present invention affords by allowing a surgeon to concurrently prepare a plurality of osteotomy sites coupled with the ability to expand one site by burnishing and another site by cutting without removing the osteotome 30 from the drill motor.

**[0016]** When the desired depth (approximately 7-20 mm) of the working end 36 has been advanced into the osteotomy, the resultant effect is an incremental expansion of the osteotomy to the dimensions of the working end 36 with little to no removal of bone material 46. The first osteotome 30 is then removed from the osteotomy to reveal a first enlarged osteotomy. The first enlarged osteotomy is fully prepared and ready to receive an implant if, in this example with the given dimensions, its fixture portion is sized at about a 3.0mm diameter. If the fixture portion of the implant is larger than about 3.0mm (continuing with this dental-specific example for purposes of illustration), then the first enlarged osteotomy must be enlarged still further. This is accomplished by repeating the inserting and enlarging steps with progressively larger tapered osteotomes 30 (Figures 6-8), as needed, until an osteotomy of predetermined size is achieved.

**[0017]** Bone material surrounding the osteotomy is progressively densified when one or more osteotomes 30 of progressively larger diameter (figures 5-8) are used to enlarge the osteotomy via the present burnishing technique. Bränemark classification of bone includes: Type I homogeneous compact bone; Type II bone having a thick cortical layer and a dense core; Type III bone having a thin cortical layer and a trabecular core of good strength; and Type IV bone having a thin cortical layer and a cancellous core of poor strength. A dense crestal cortex is generally favored for initial fixation of an implant. Often the implant can be placed to take advantage of one or both of the buccal and lingual cortical plates. Placing implants in Type III and IV bone is more challenging than in Types I and II. Moreover, the quality of bone can be extremely variable in a single location. It is likely that at some osteotomy sites the bone may contain voids, fatty marrow, and fibrous inclusion. When the surgeon encounters softer bone texture, the ability to drill accurately diminishes with the loss of tactile sensitivity. Also, inadvertent over-penetration and over-preparation of soft bone is common. Other factors, such as torqueing of the hand piece and reproducing a consistent angle of penetration, become more demanding as bone density decreases.

**[0018]** Use of the present invention to expand an osteotomy by burnishing helps to maintain all of the existing bone material by pushing the bone aside with minimal trauma while developing an accurately shaped osteotomy. Naturally, the condensing and compacting cellular structures of the bone increases as progressively larger osteotomes 30 are introduced. In addition, the osseous layer around the osteotomy is compacted, which will form a denser bone interface with the implant and thus improved retention. A particularly relevant benefit when there is a marginal quantity of bone to start with.

**[0019]** Turning now to Figures 16-20, detailed illustrations are provided to describe the novel grinding and bone chip repatriation action that occurs through use of this invention. In each progressive expansion of the osteotomy via burnishing (i.e., after the initial expansion which follows the pilot hole), the osteotome 30 does grind bone material that is encountered in the axial direction by the two leading faces 46. (The leading faces 46 are highlighted in Figures 14, 16A and 17A.) These chisel-like features of the osteotome 30 grind the bone material into a powdery consistency to make way for the downwardly advancing osteotome 30. When turned in a burnishing (non-cutting) direction, the leading faces 46 present a "negative rake" cutting angle which generates resistance to advancement (i.e., does not "pull" the osteotome 30 downwardly), and therefore offers the surgeon better control/stability.

**[0020]** When the osteotome is first presented to a previously expanded osteotomy, the diameter of the two leading faces 46 are generally equal to the opening of osteotomy, such that no bone material is initially encountered in the axial direction by the two leading faces 46. Thus, at the opening of the osteotomy no bone material is ground or "cut" by the two leading faces 46. However, as the osteotome 30 is moved deeper into the osteotomy, more and more bone material encountered in the axial direction by the two leading faces 46. This can be seen by comparison of the two cross-sections of Figure 16A (at opening of osteotomy) versus Figure 17A (near bottom of osteotomy). Figure 18 illustrates, in exaggerated fashion, that enlargement by a progressively larger osteotome 30 results in bone material that is both burnished and ground away. These actions occur in respective "zones" – a burnings zone and a grinding zone. The interface between the two zones is cylindrical and corresponds with the track of the outermost edge of the leading face. As a result, osteotomy expansion at the top or opening occurs 100% by the above-described burnishing technique, and osteotomy expansion at the bottom occurs 100% by grinding. There is therefore a linear transition from bushing to grinding, which has the beneficial effect of concentrating expansion forces near the top of the osteotomy with little to no expansion forces at the bottom of the osteotomy. This results is less lateral fracture of the bone.

**[0021]** The osteotome 30 is designed to repatriate the bone chips resulting from grinding into the porous side walls of the osteotomy. By "repatriate" it is meant that instead of being excavated and removed, the bone chips derived from the grinding zone are restored to the patient's bone by forcing the bone chips into the porous gaps in the surrounding bone material. This repatriation of bone chips further densifies and strengthens the surrounding bone wall to receive an implant. The process also helps accelerate healing.

**[0022]** As shown in Figure 20, the flute 42 immediately behind each leading face 46 is a chip repatriation flute 42A. That is, during the expansion process, bone chips from the grinding zone collect in front of each leading face 46. The chip build-up flows up the respective chip repatriation flutes 42A where the respective immediately adjacent burnishing edges 44 wipe the bone chips against the osteotomy wall and, like plaster in lath, pack the bone chips into any available pore. It is possible that the bone chips also create something of a hydrodynamic film that cushions the frictional interface between rotating tool 30 and bone. Because of the particular helical angle, the bone chips that flow up the two chip repatriation flute 42As 42 are continuously wiped downward, rather than being lifted up and out of the osteotomy as would be the case with a twist drill. This helps minimize loss of bone material and improve overall functionality of the invention.

**[0023]** Enhanced surgical control of the osteotome 30 is achieved by a combination of several design features. These include the "negative rake" cutting angle of the leading faces 46 in combination with a "no margin" burnishing edge 44 and a relatively large number of flutes 42. These and other attributes work in concert to offer the surgeon better control/stability during both burnings and cutting modes of operation.

**[0024]** Although the techniques of the present invention are preferably carried out in the context of a rotary osteotome, substantially equivalent results can be achieved using non-rotary techniques as well. These non-rotary techniques may include, as but one example of possibly many, the use of ultrasonic impulses like those currently marketed by Mectron S.p.A., via Loreto 15/A, 16042 Carasco (Ge), Italia, www.mectron.com. The implementation of piezoelectric surgery practices is still relatively new and its full effectiveness has yet to be understood. Applying the concepts of piezoelectric surgery practices to the present invention may be accomplished with a progressive set of tools 30' as shown in Figures 21-23. In these examples, the osteotomes 30' are un-fluted. A leading face 46' is formed by a multi-faceted diamond tip. As the tool 30' is advanced in the osteotomy, ultrasonic vibrations create a grinding zone at the leading face 46', with the bone chips collecting and then being repatriated into the walls of the osteotomy by the smooth tapered side walls. The region immediately above the leading face 42' may serve a function similar to the chip repatriation flute 42A' and the smooth sides of the tool 30' serve a function similar to the burnishing edges 44'.

**[0025]** Those of skill in the art will readily appreciate that the present invention can be used in non-dental surgical procedures, such as those applied by orthopedic surgeons and perhaps any other procedure requiring creation or enlargement of an osteotomy site with the beneficial bone densification attributes of the present invention. Figure 24 provides a suggestion of the numerous possible applications of this technology.

**[0026]** In addition to surgical applications in bone, it is also contemplated that the present invention could be applied, with little or no modification, to other cellular structures like polymeric and metallic foam to name but a few. An exemplary block of non-bone foam material is shown in Figure 25. Foam materials have numerous and rapidly expanding industrial and commercial uses. Such uses often require the use of fasteners and anchoring features. It is contemplated that the present drilling and burnishing tool and techniques can be used with the appropriate rotational speed and torque to prepare a hole for an anchor or fastening element in foam materials to achieve similar beneficial properties.

**[0027]** The foregoing invention has been described in accordance with the relevant legal standards, thus the description is exemplary rather than limiting in nature. Variations and modifications to the disclosed embodiment may become apparent to those skilled in the art and fall within the scope of the invention.

What is claimed is:

1. A surgical method for expanding an initial osteotomy to receive a bone implant, substantially as shown and described.

2. A surgical tool for expanding an initial osteotomy to receive a bone implant, substantially as shown and described.

3. A method for preparing a hole in cellular material to receive an anchor, substantially as shown and described.

4. A tool for preparing a hole in cellular material to receive an anchor, substantially as shown and described.

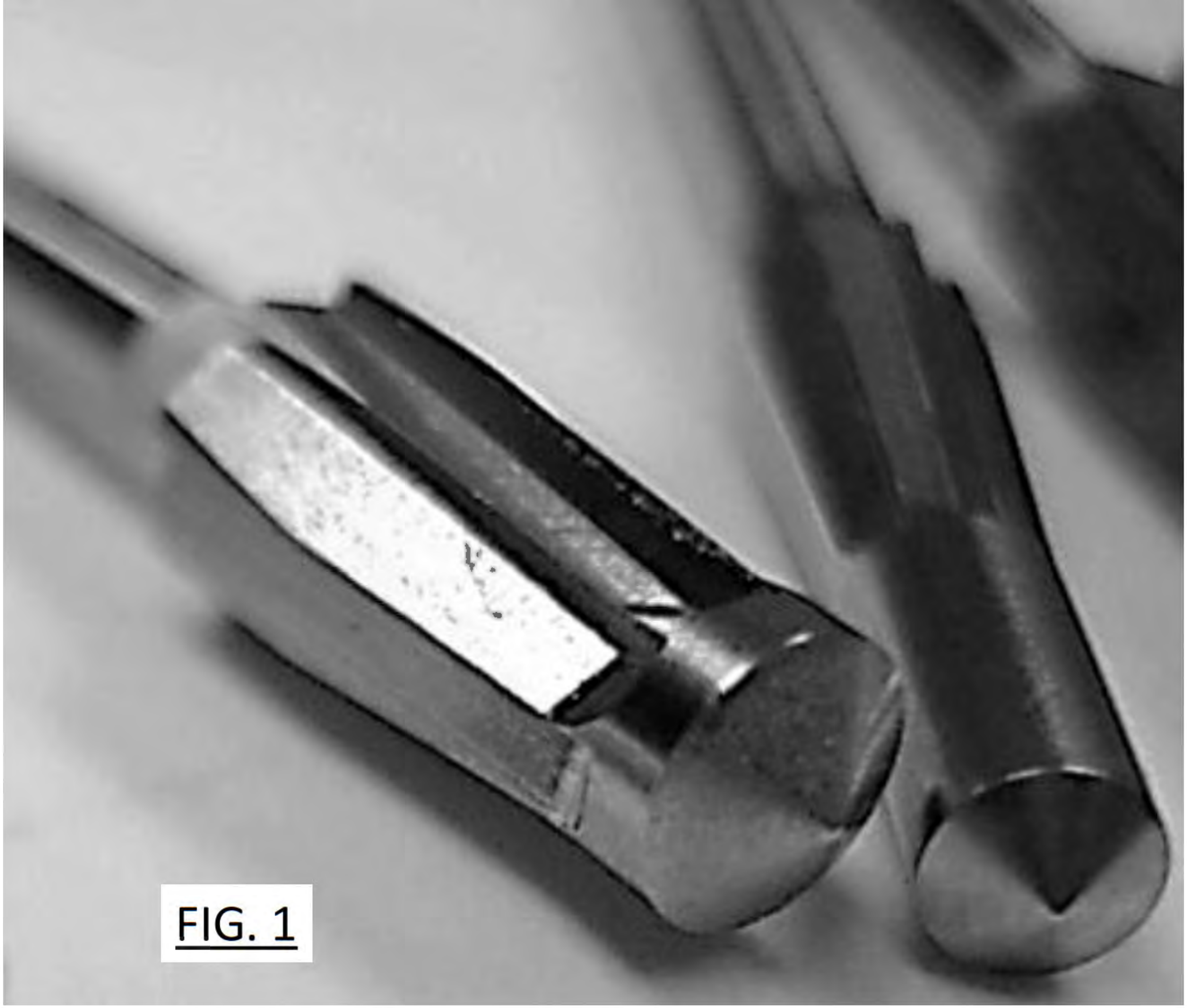


FIG. 1

PRIOR ART

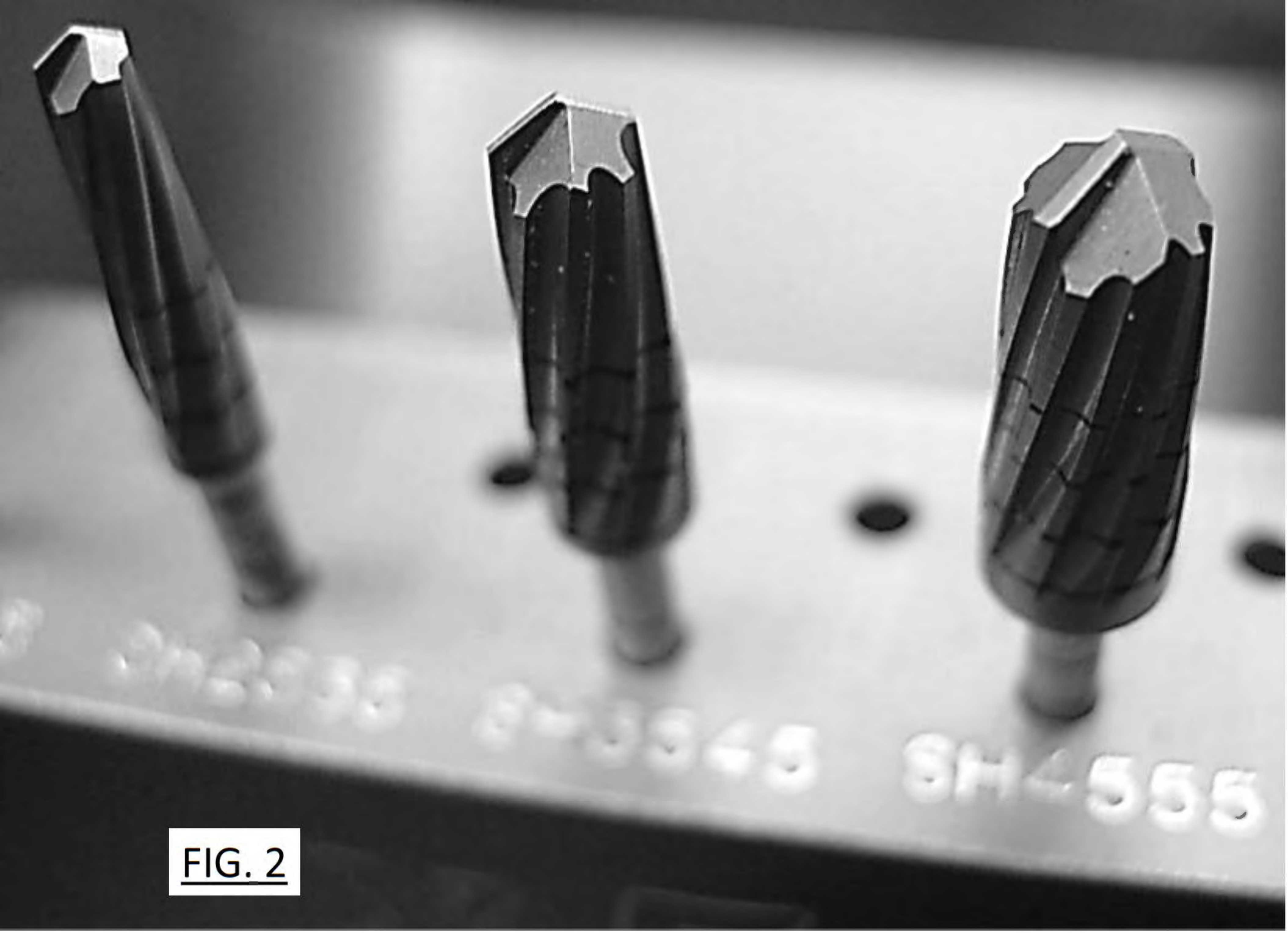


FIG. 2

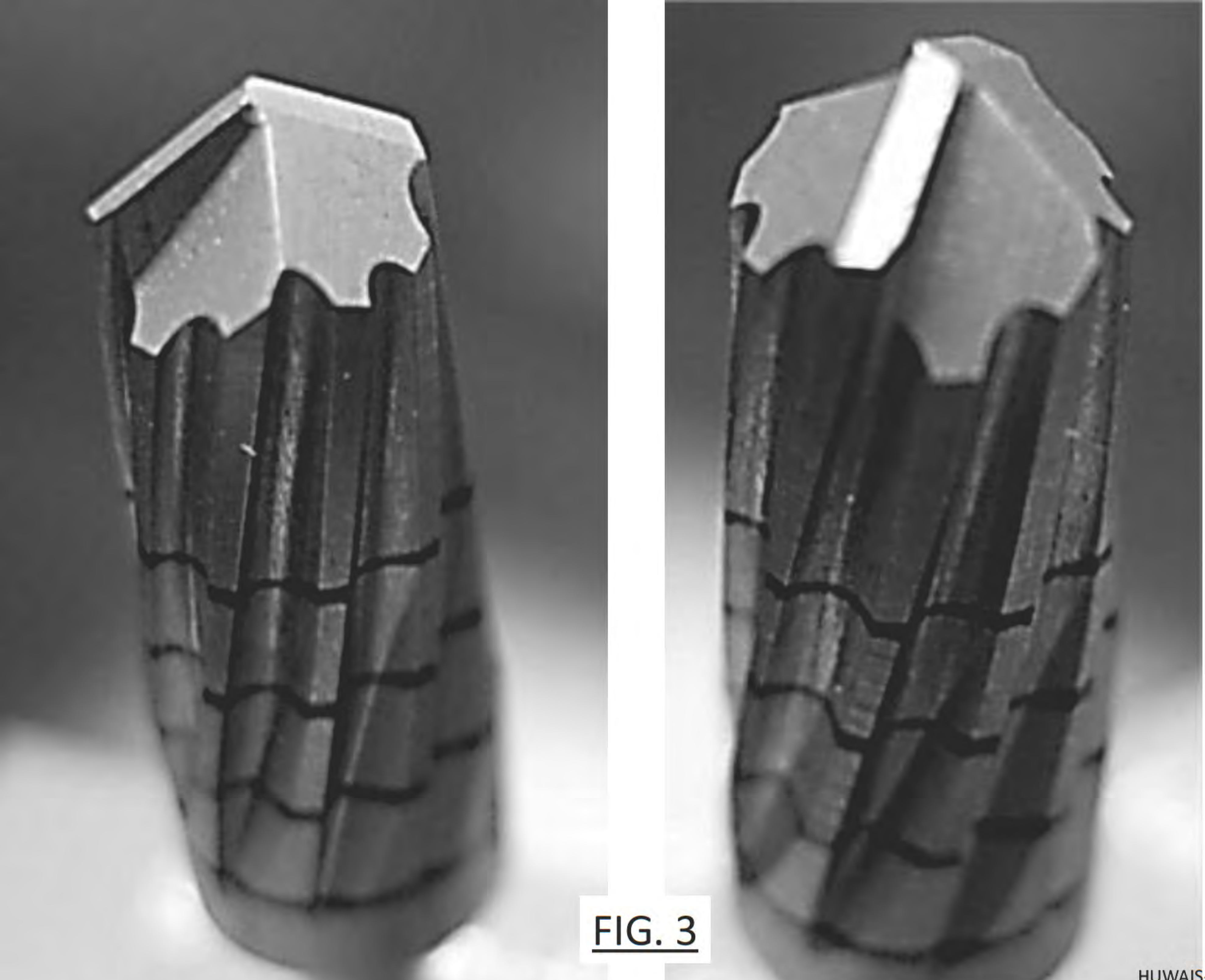


FIG. 3

HUWAIS-P0003P

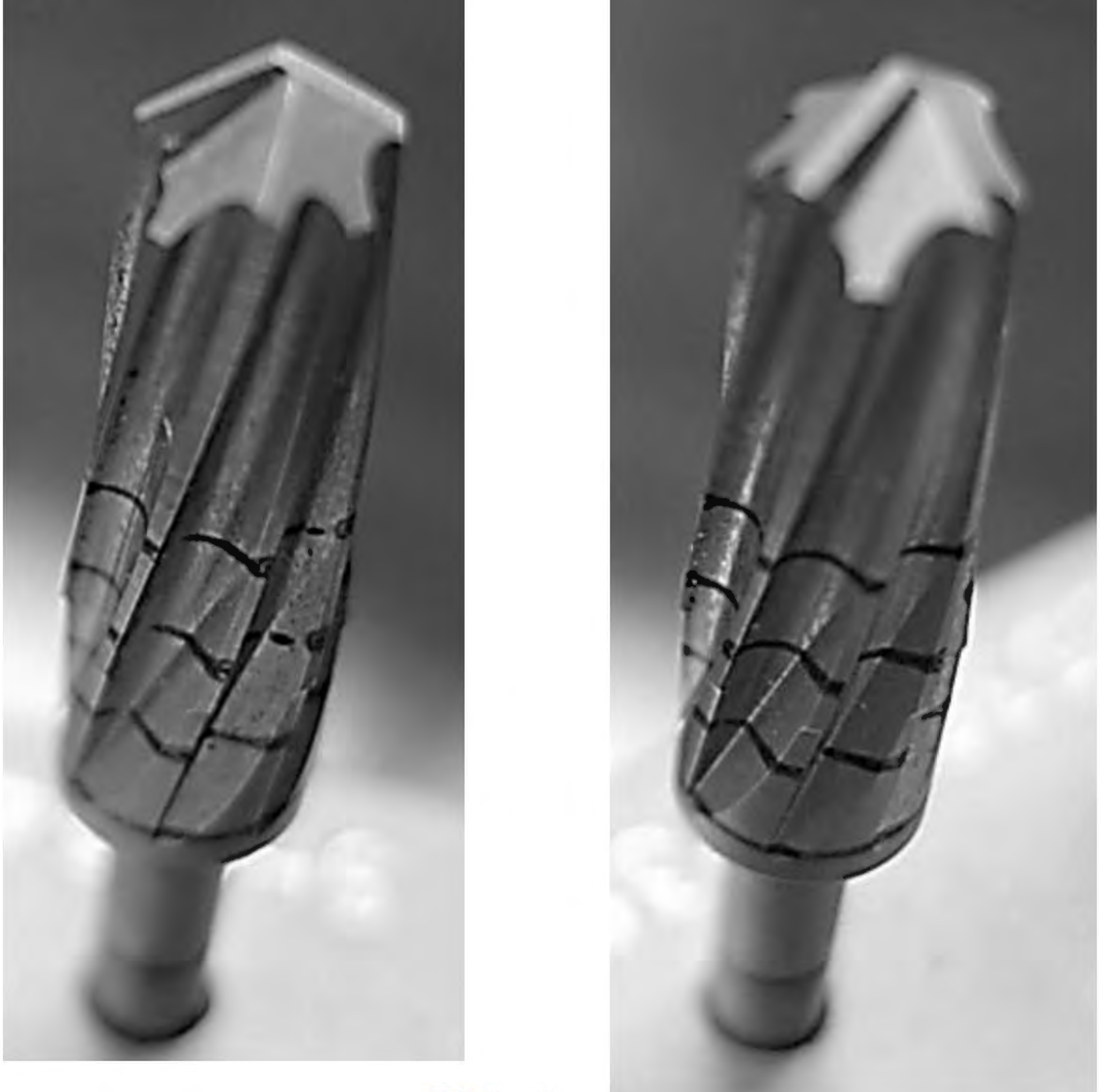
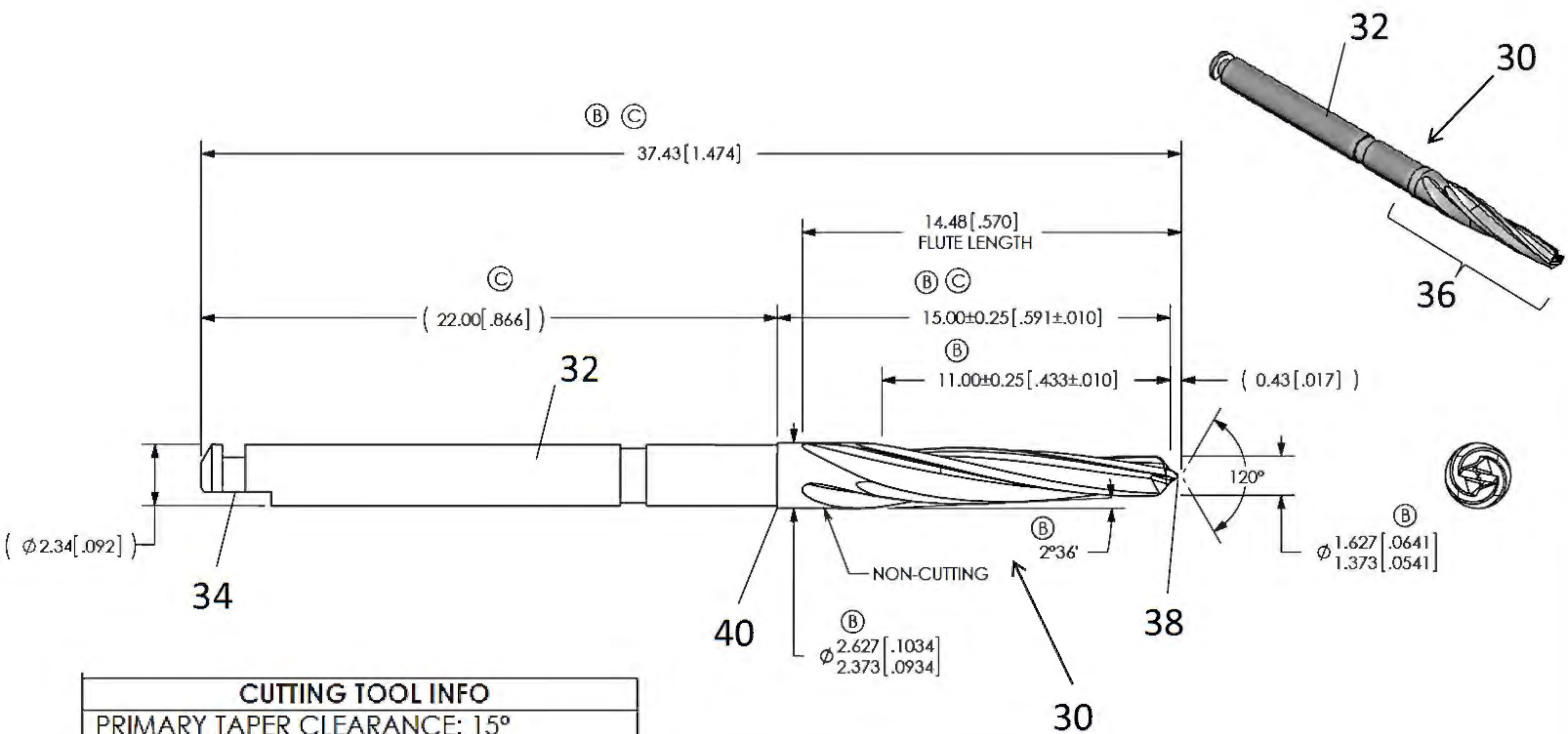


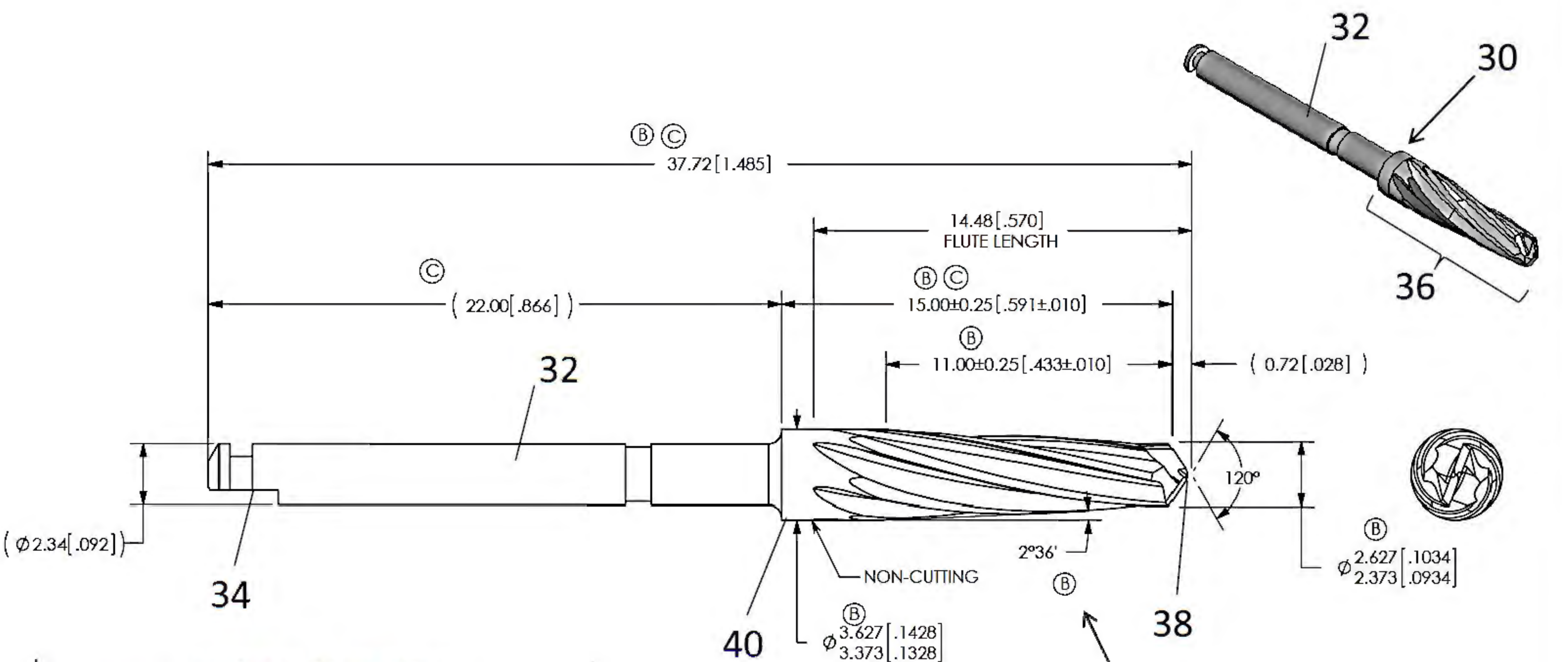
FIG. 4




| CUTTING TOOL INFO |
|---|
| PRIMARY TAPER CLEARANCE: 15° |
| PRIMARY POINT: 20° |
| SECONDARY POINT: 45° |
| FLUTE RAKE ANGLE: 0° |
| FLUTES: 4 (A) |
| HELIX: 15° RHS-RHC |
| POINT TYPE: CUSTOMER SPECIFIC |
| BTPI: N/A |
| MATERIAL: 440C STAINLESS STEEL |
| COOLANT THRU: N/A |
| COATING: N/A |

| NOTE |
|---|
| 58 - 62 Rc |

FIG. 5




| CUTTING TOOL INFO |
|---|
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| PRIMARY POINT: 20° |
| SECONDARY POINT: 45° |
| FLUTE RAKE ANGLE: 0° |
| FLUTES: 6 Ⓐ |
| HELIX: 15° RHS-RHC |
| POINT TYPE: CUSTOMER SPECIFIC |
| BTPI: N/A |
| MATERIAL: 440C STAINLESS STEEL |
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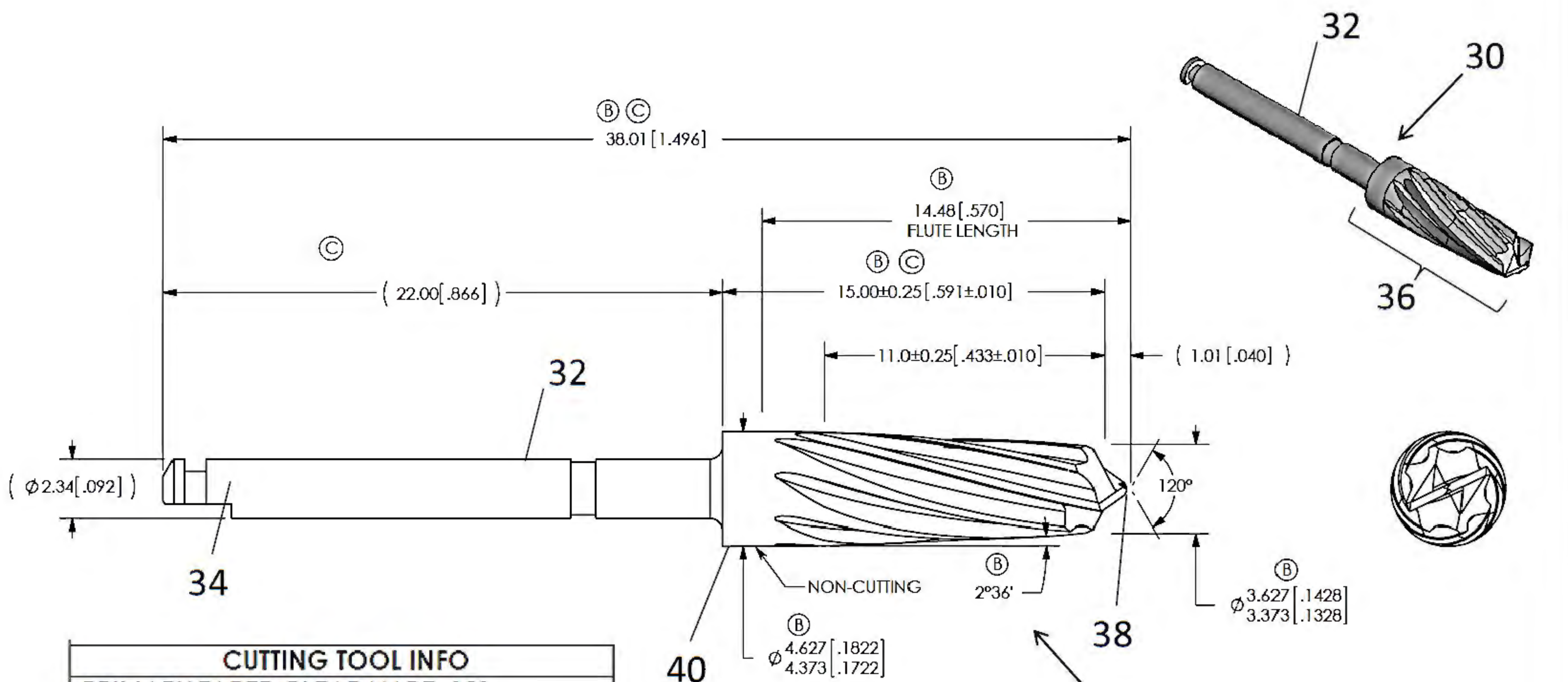
| COATING: N/A |

| NOTE |
|---|
| 58 - 62 Rc |

FIG. 6

HUWAIS-P0003P




| CUTTING TOOL INFO |
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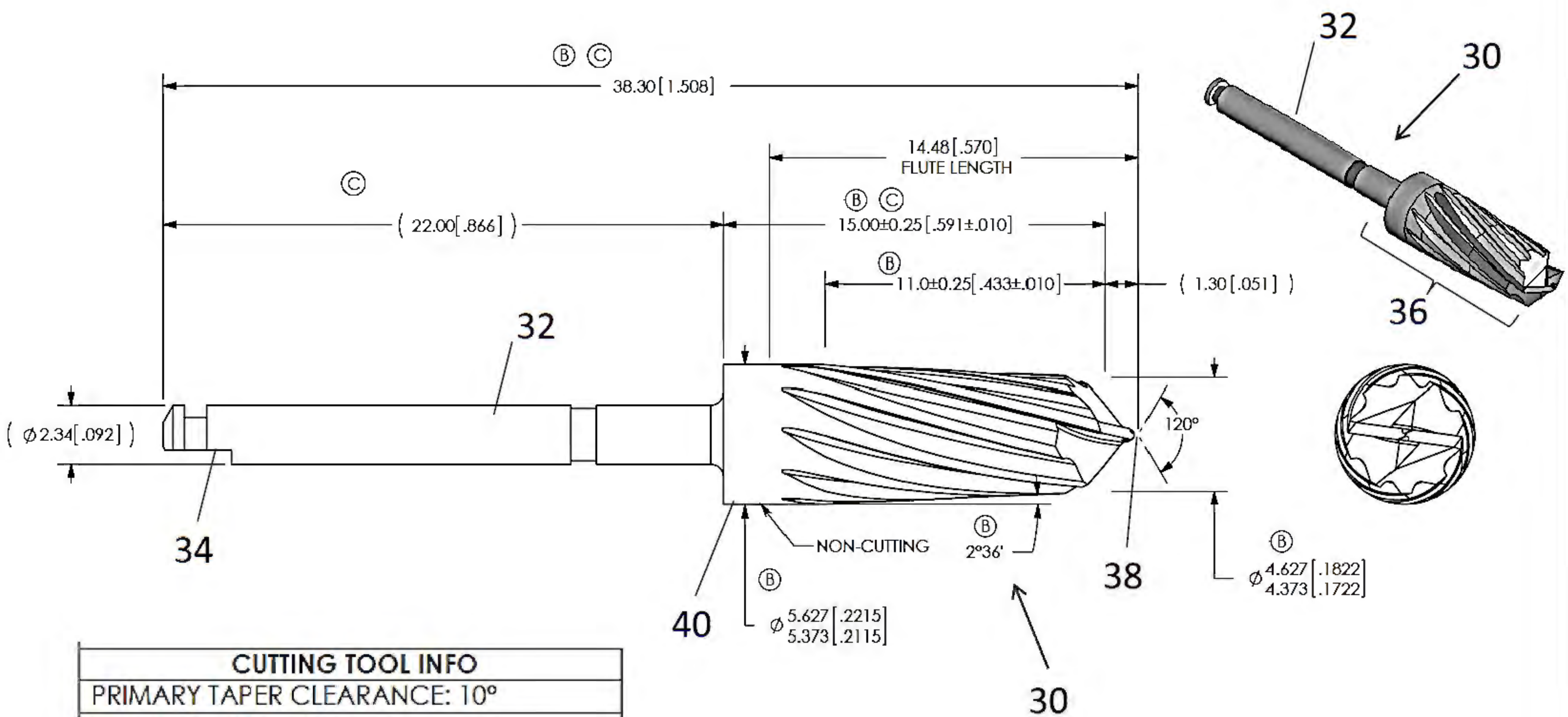
| COATING: N/A |

| NOTE |
|---|
| 58 - 62 RC |

FIG. 7




| CUTTING TOOL INFO |
|---|
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| PRIMARY POINT: 20° |
| SECONDARY POINT: 45° |
| FLUTE RAKE ANGLE: 0° |
| FLUTES: 10 (A) |
| HELIX: 15° RHS-RHC |
| POINT TYPE: CUSTOMER SPECIFIC |
| BTPI: N/A |
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| COOLANT THRU: N/A |
| COATING: N/A |

| NOTE |
|---|
| 58 - 62 RC |

FIG. 8

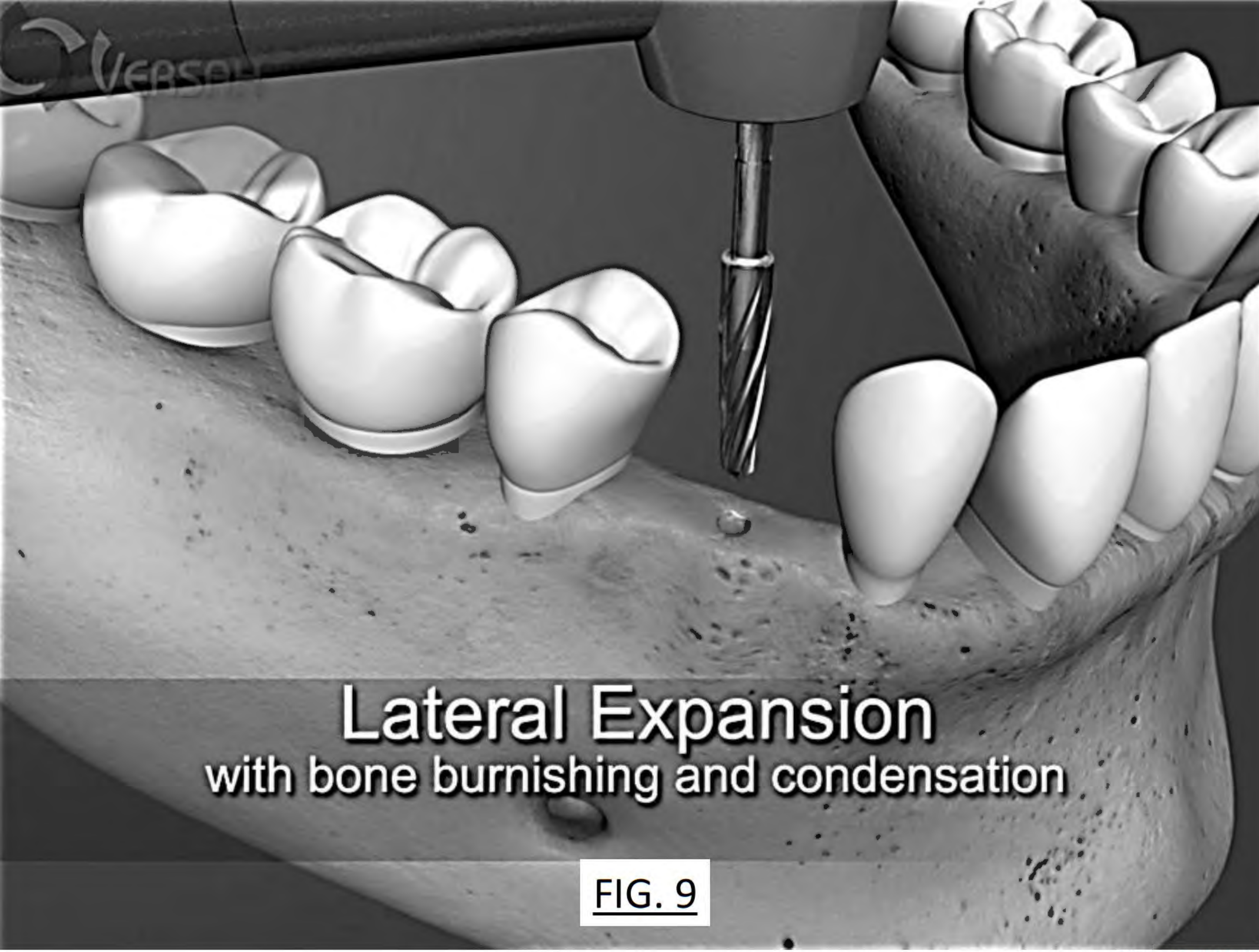



FIG. 9

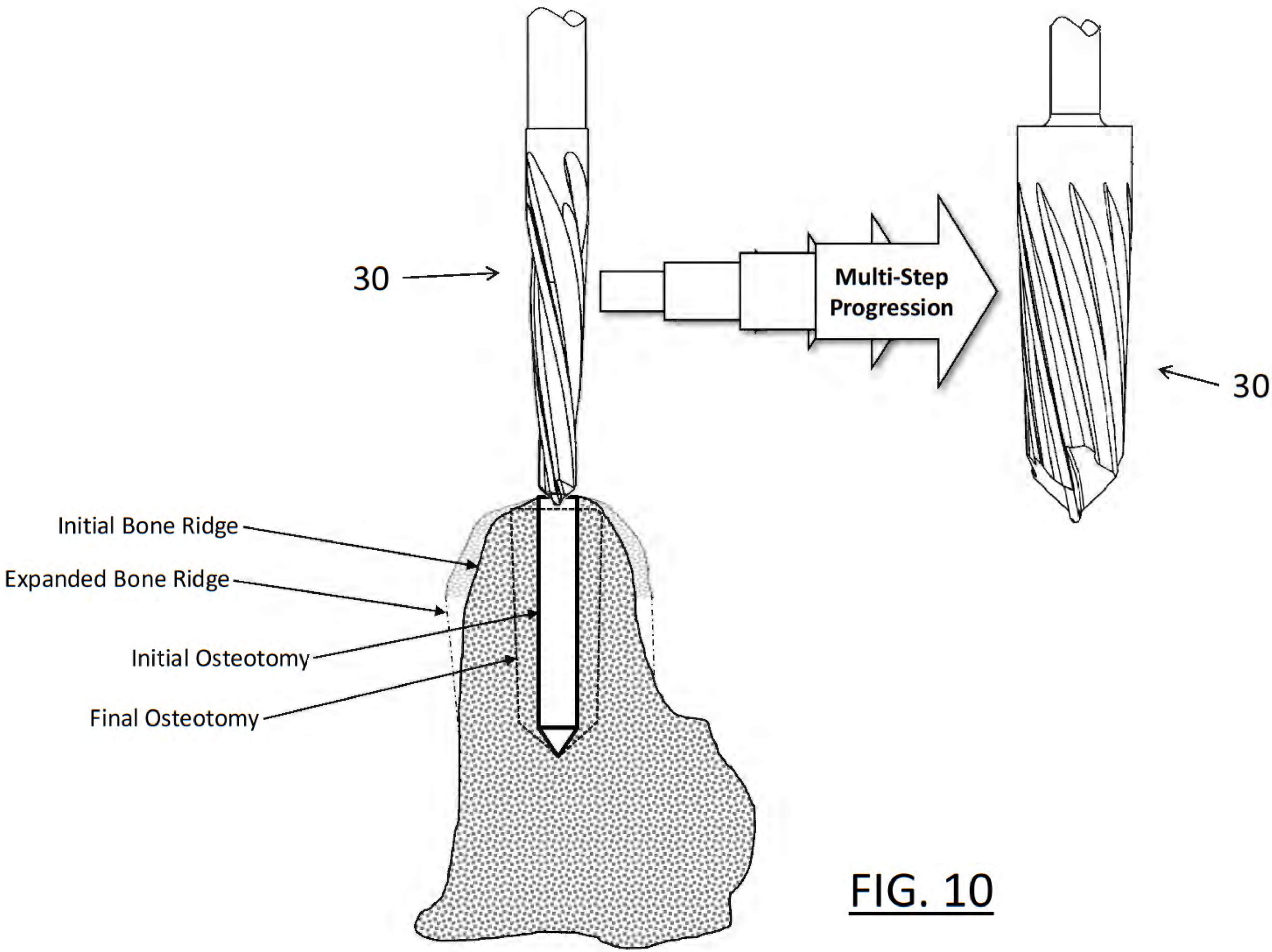
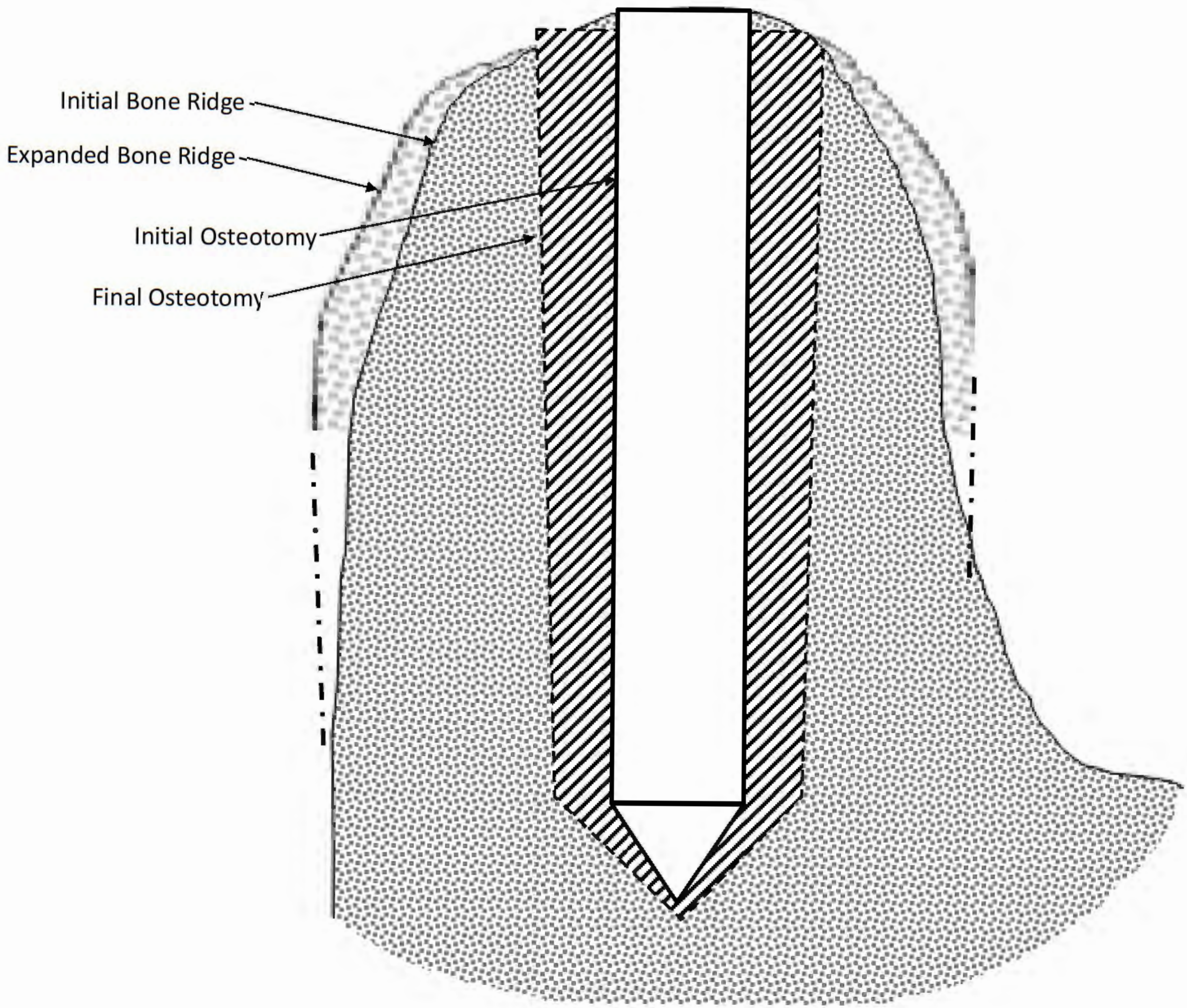
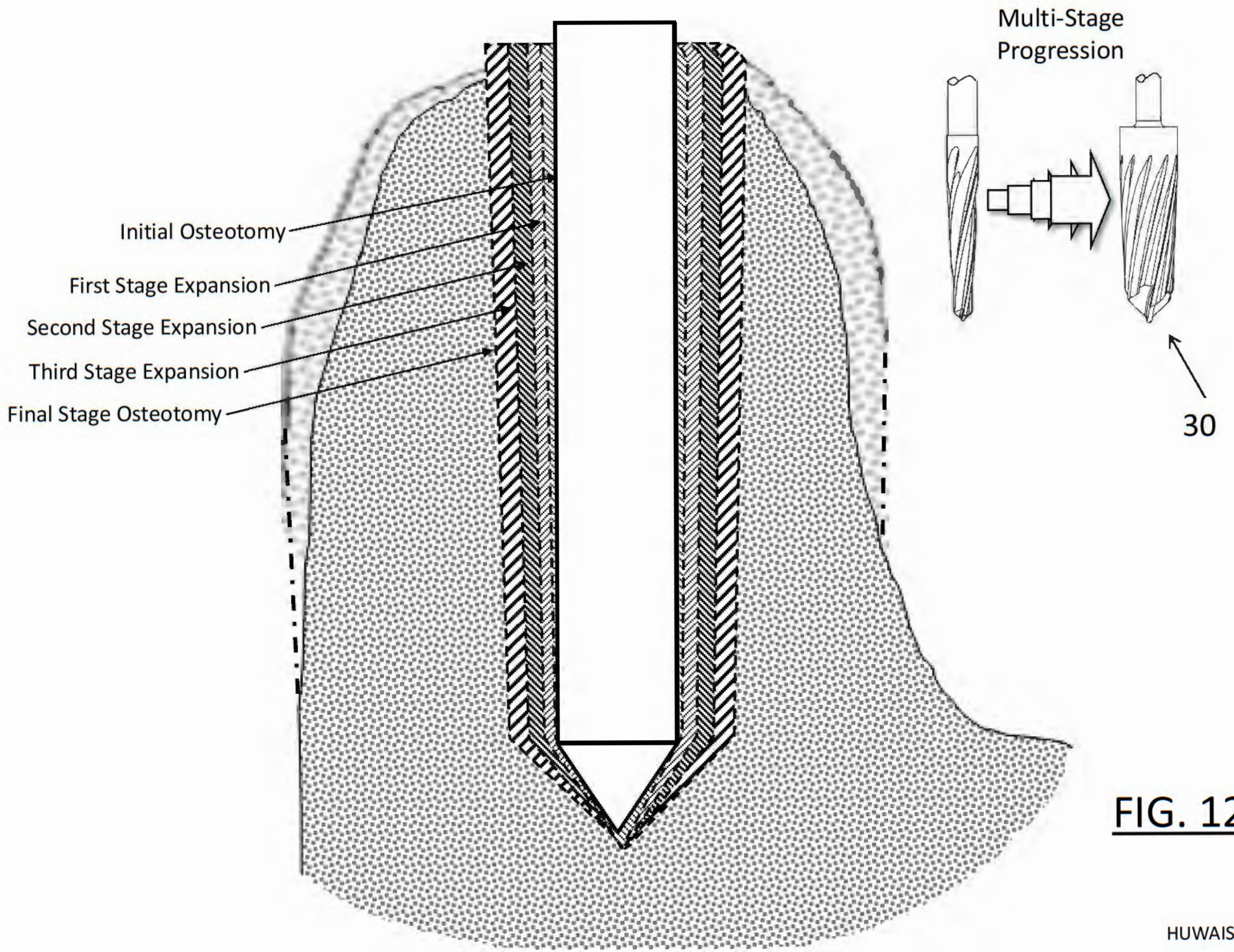

30
Multi-Step
Progression
30
Initial Bone Ridge
Expanded Bone Ridge
Initial Osteotomy
Final Osteotomy

FIG. 10



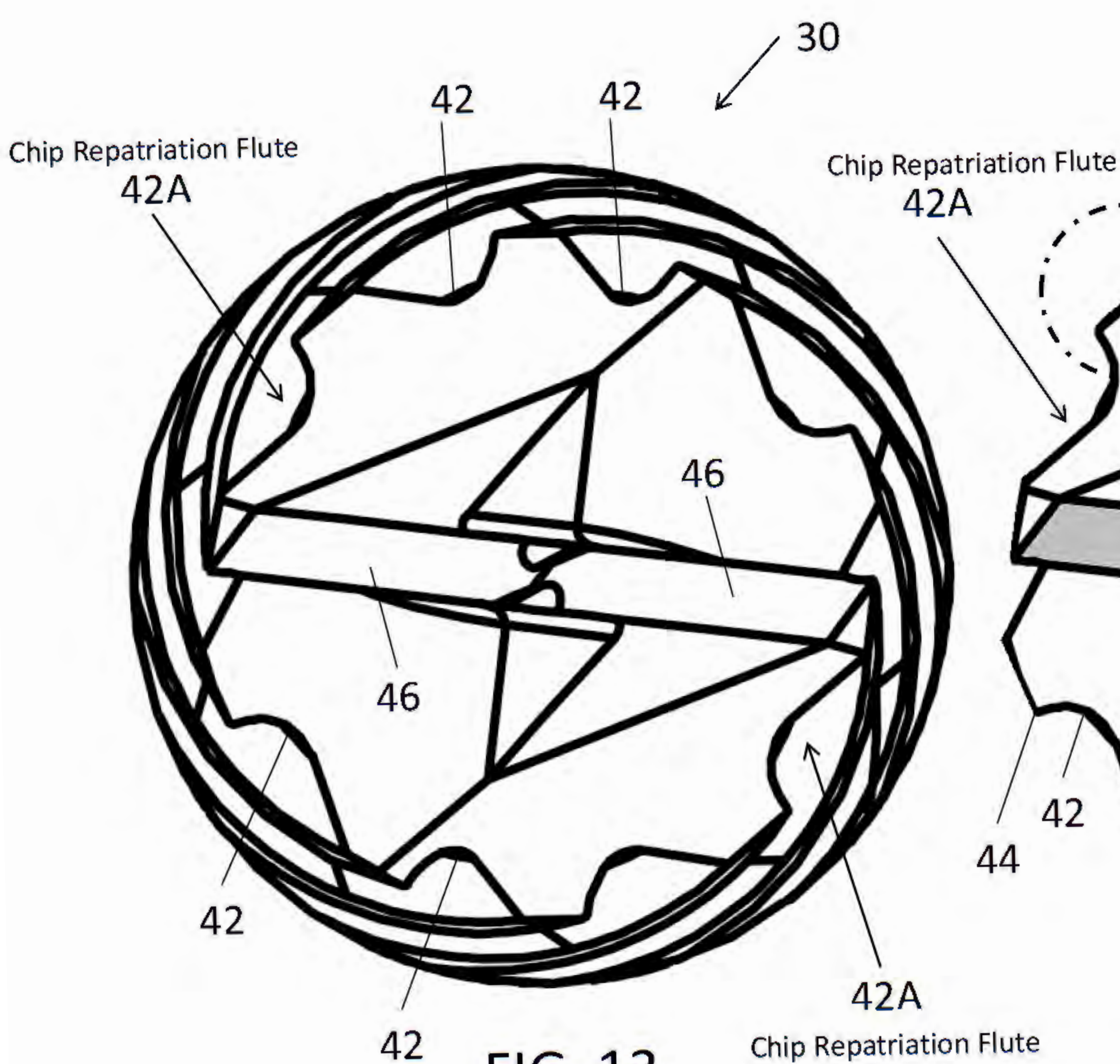
Initial Bone Ridge
Expanded Bone Ridge
Initial Osteotomy
Final Osteotomy

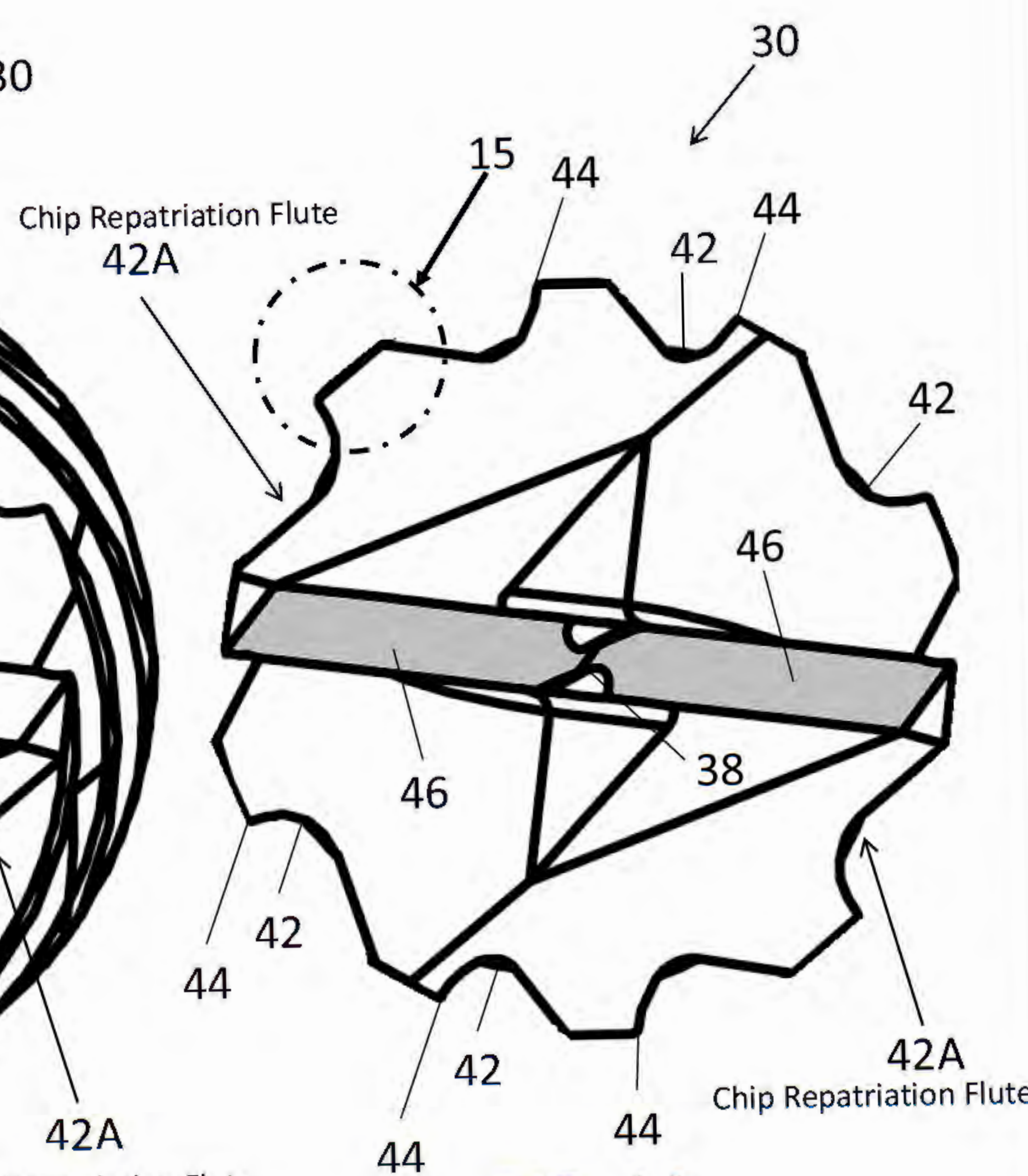

FIG. 11



Multi-Stage
Progression
30
Initial Osteotomy
First Stage Expansion
Second Stage Expansion
Third Stage Expansion
Final Stage Osteotomy


FIG. 12


30
42
42
Chip Repatriation Flute
42A
46
46
42
42
42A
Chip Repatriation Flute
FIG. 13


30
15
44
44
42
Chip Repatriation Flute
42A
42
46
46
38
44
42
44
42
44
42A
Chip Repatriation Flute
FIG. 14

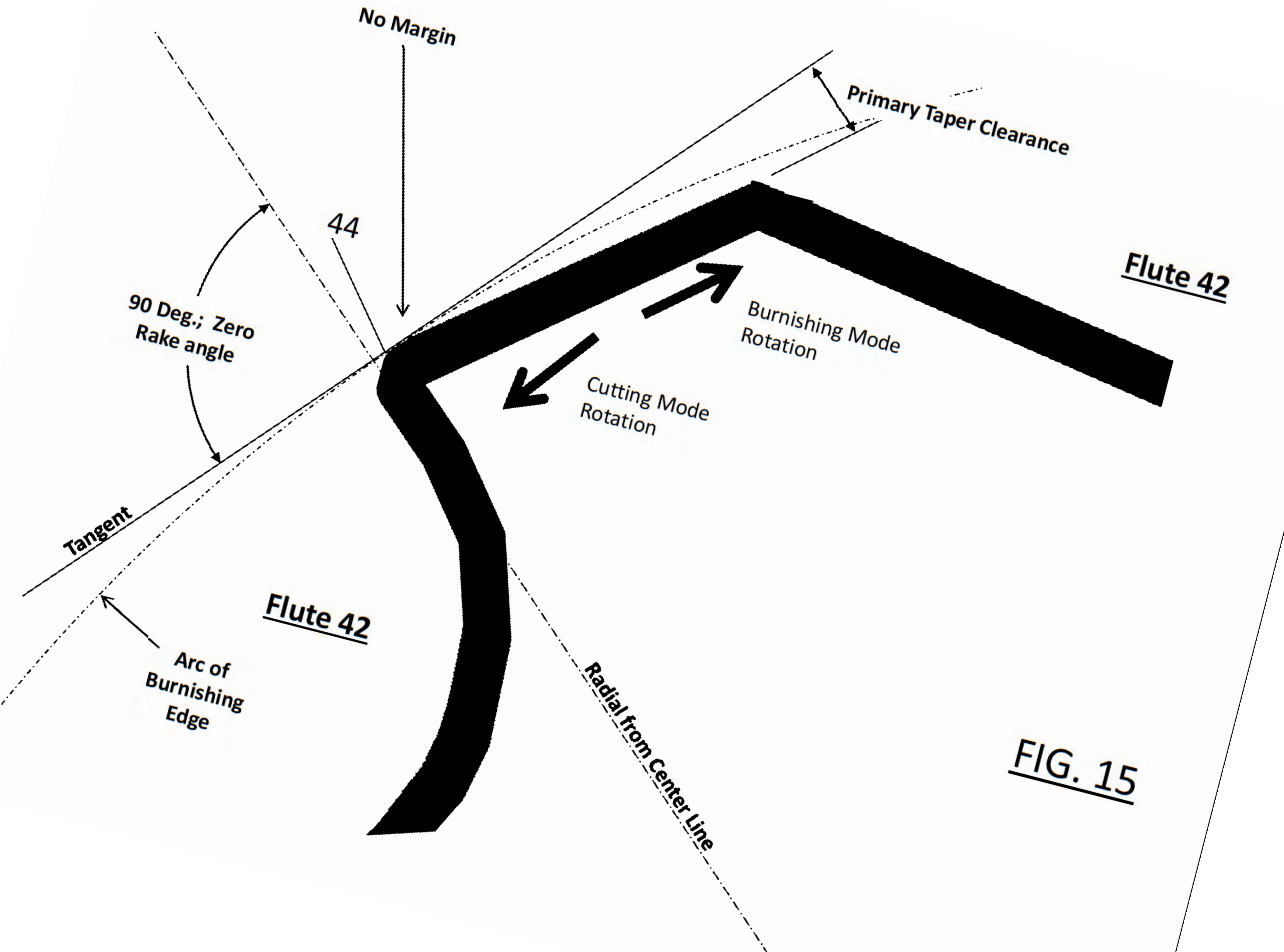

No Margin
Primary Taper Clearance
44
90 Deg.; Zero
Rake angle
Flute 42
Burnishing Mode
Rotation
Cutting Mode
Rotation
Tangent
Flute 42
Arc of
Burnishing
Edge
Radial from Center Line

FIG. 15

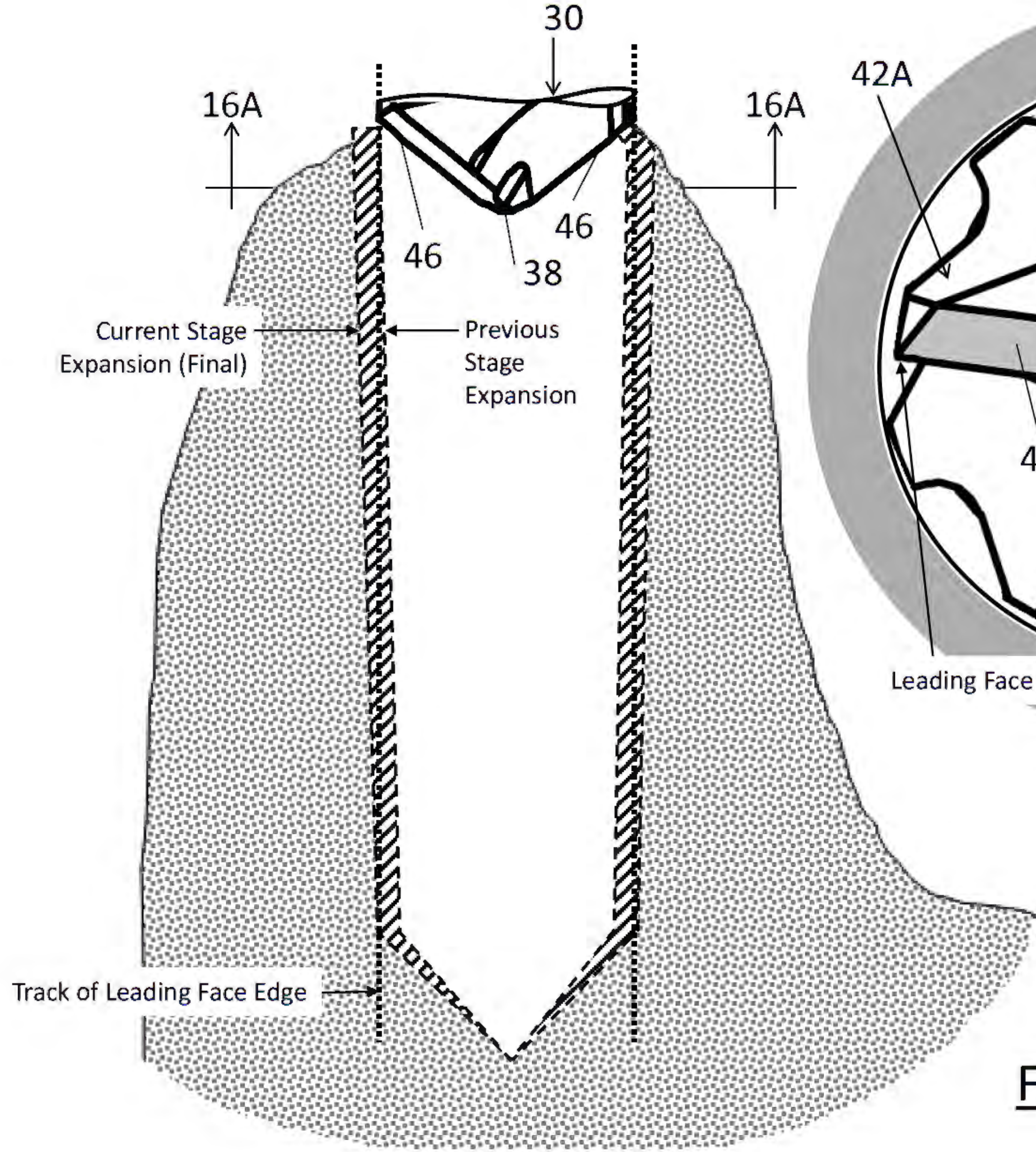



FIG. 16

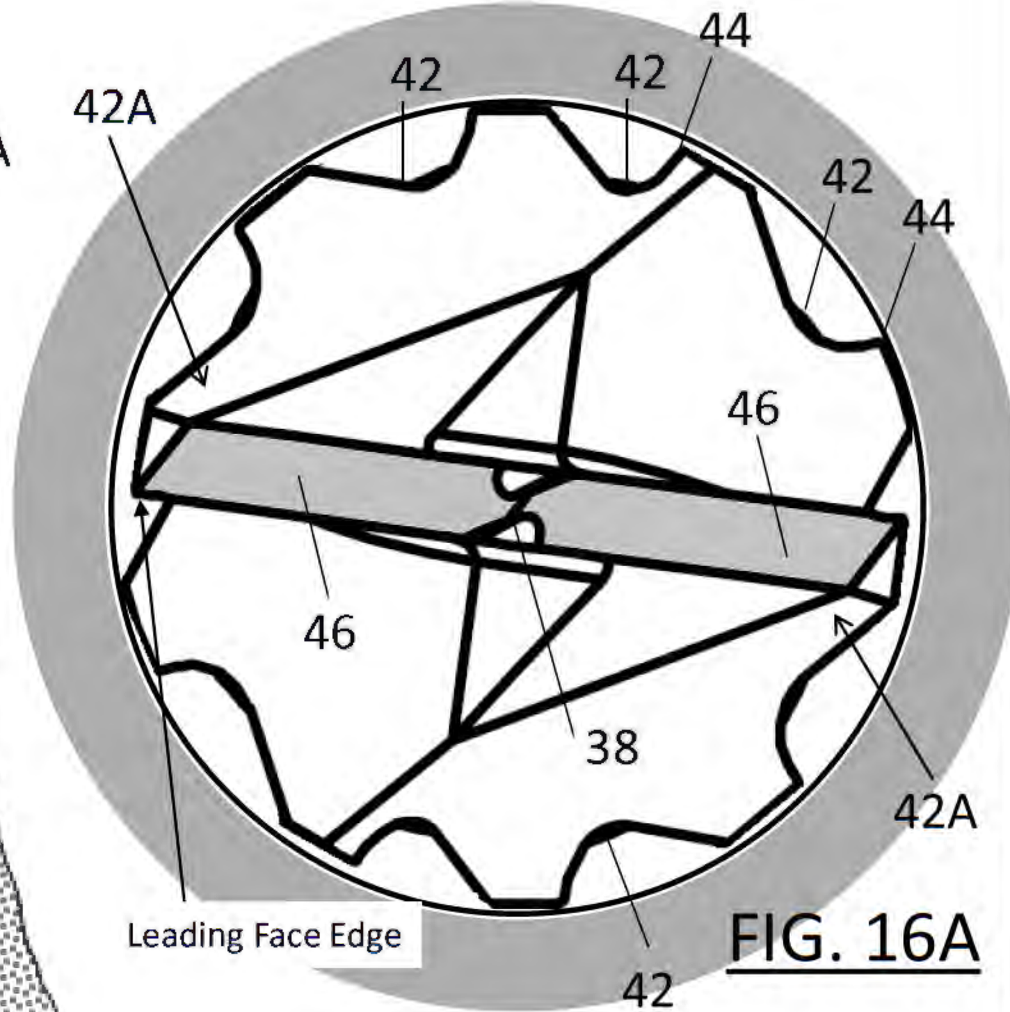



FIG. 16A

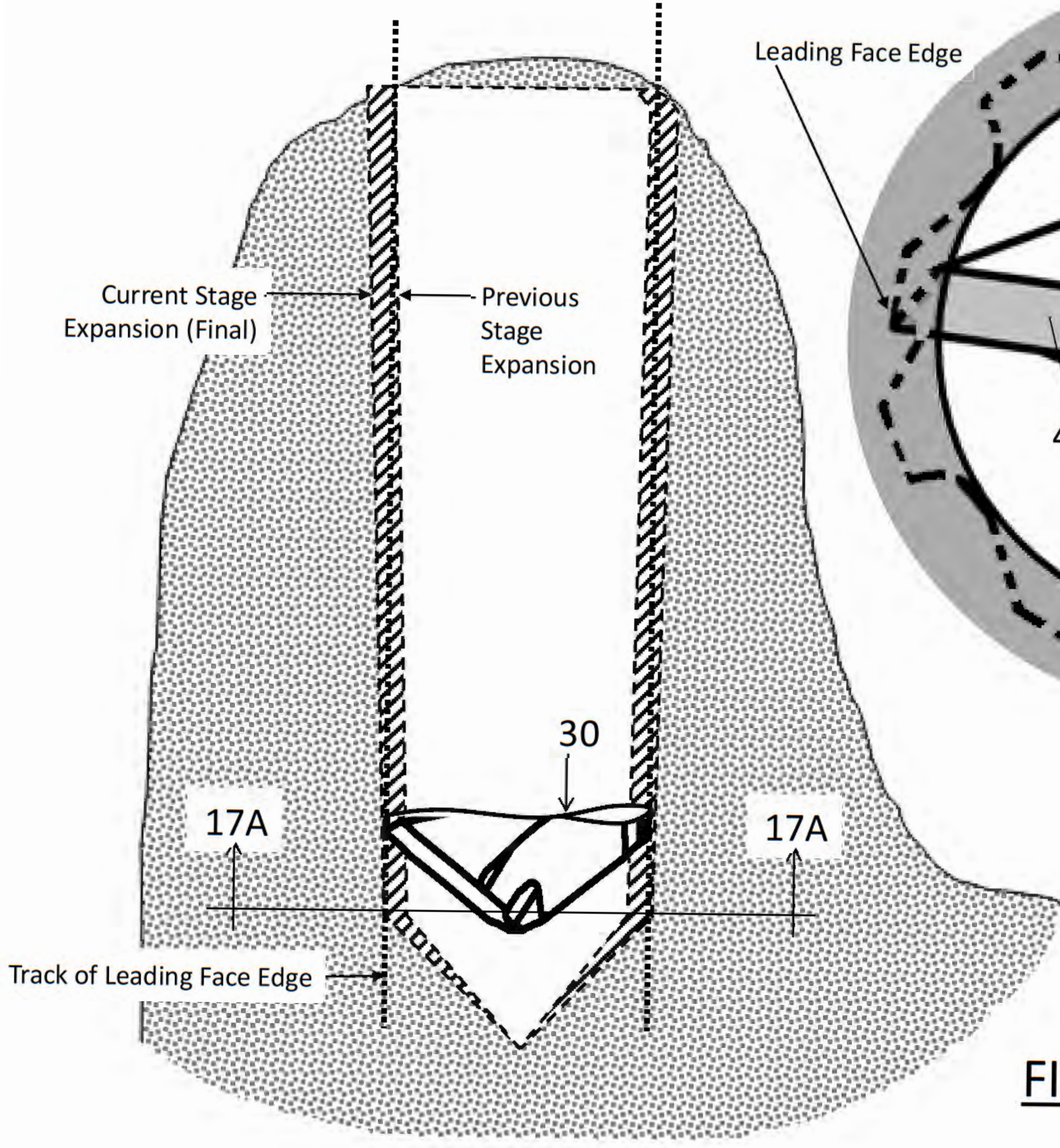



FIG. 17

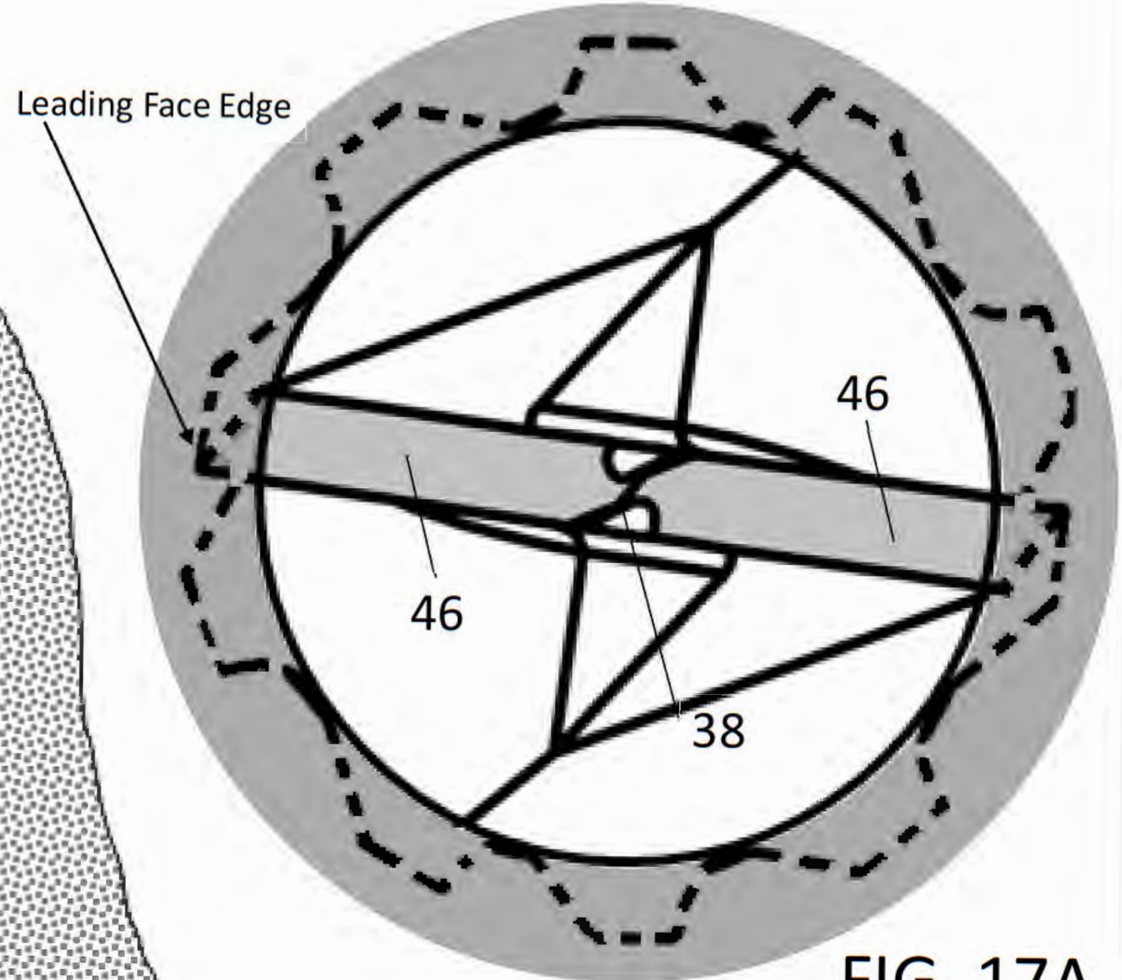



FIG. 17A

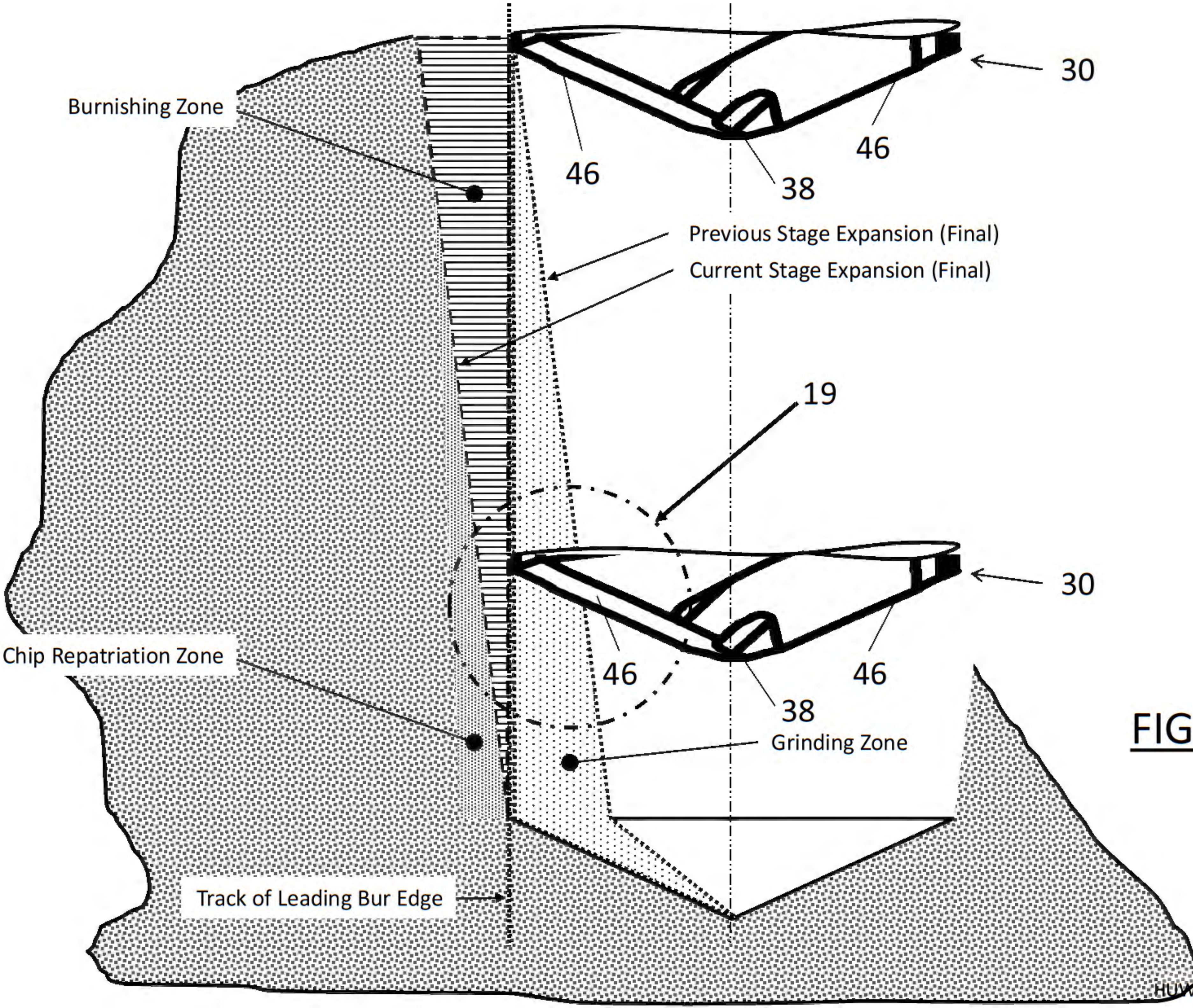



FIG. 18

HUWAIS-P0003P

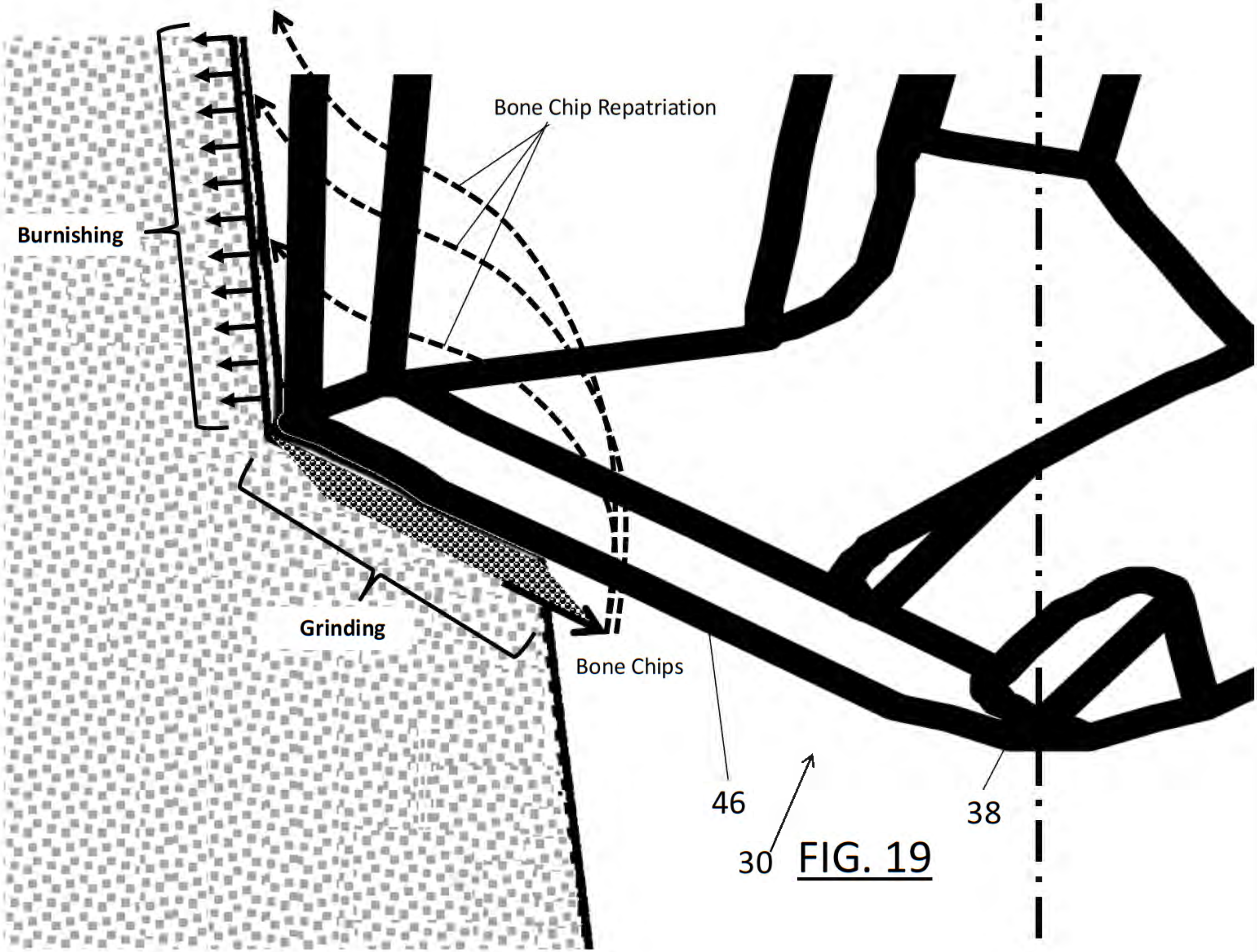

Bone Chip Repatriation
Burnishing
Grinding
Bone Chips
46
38
30

FIG. 19

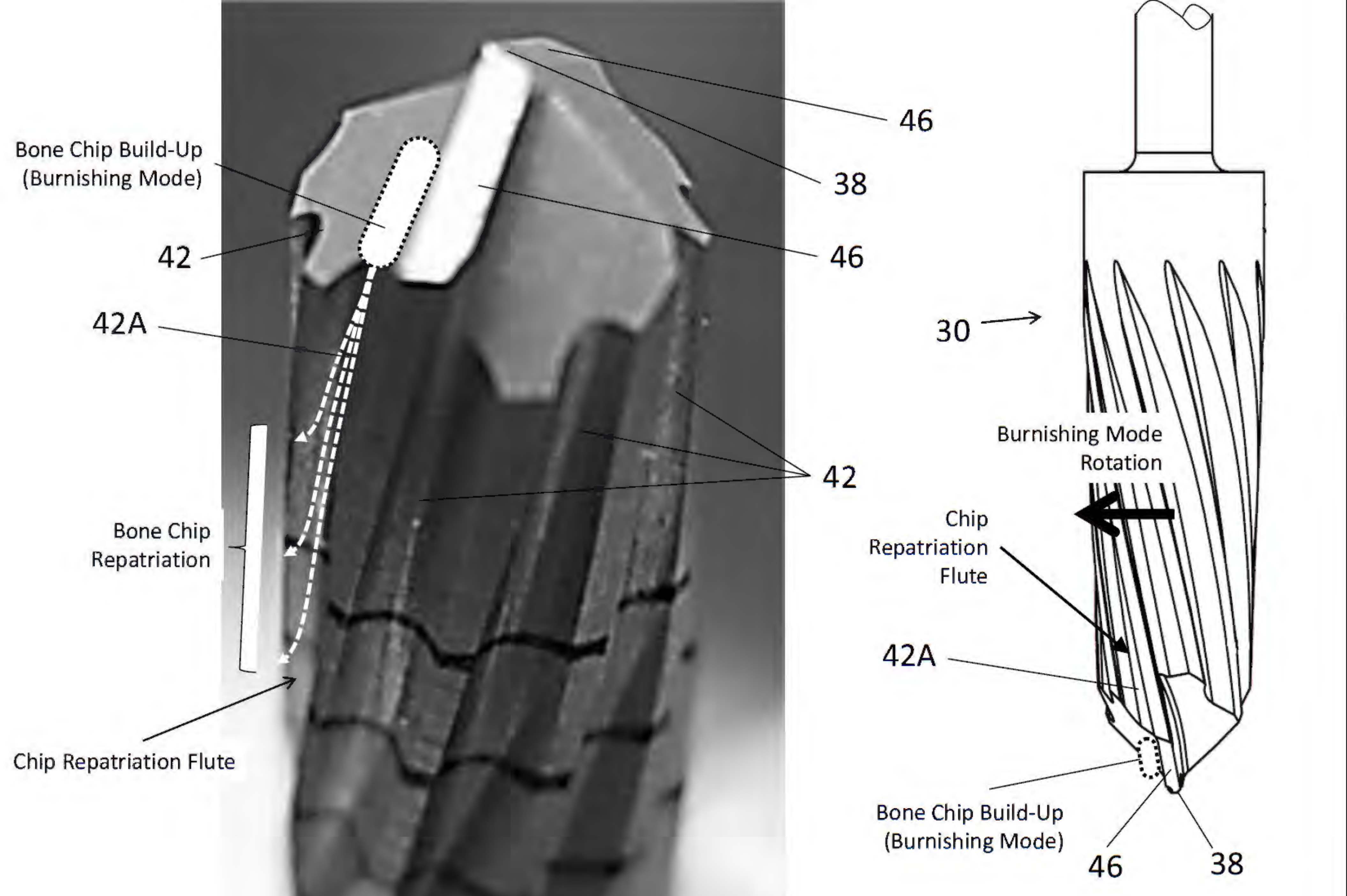



FIG. 20

HUWAIS-P0003P

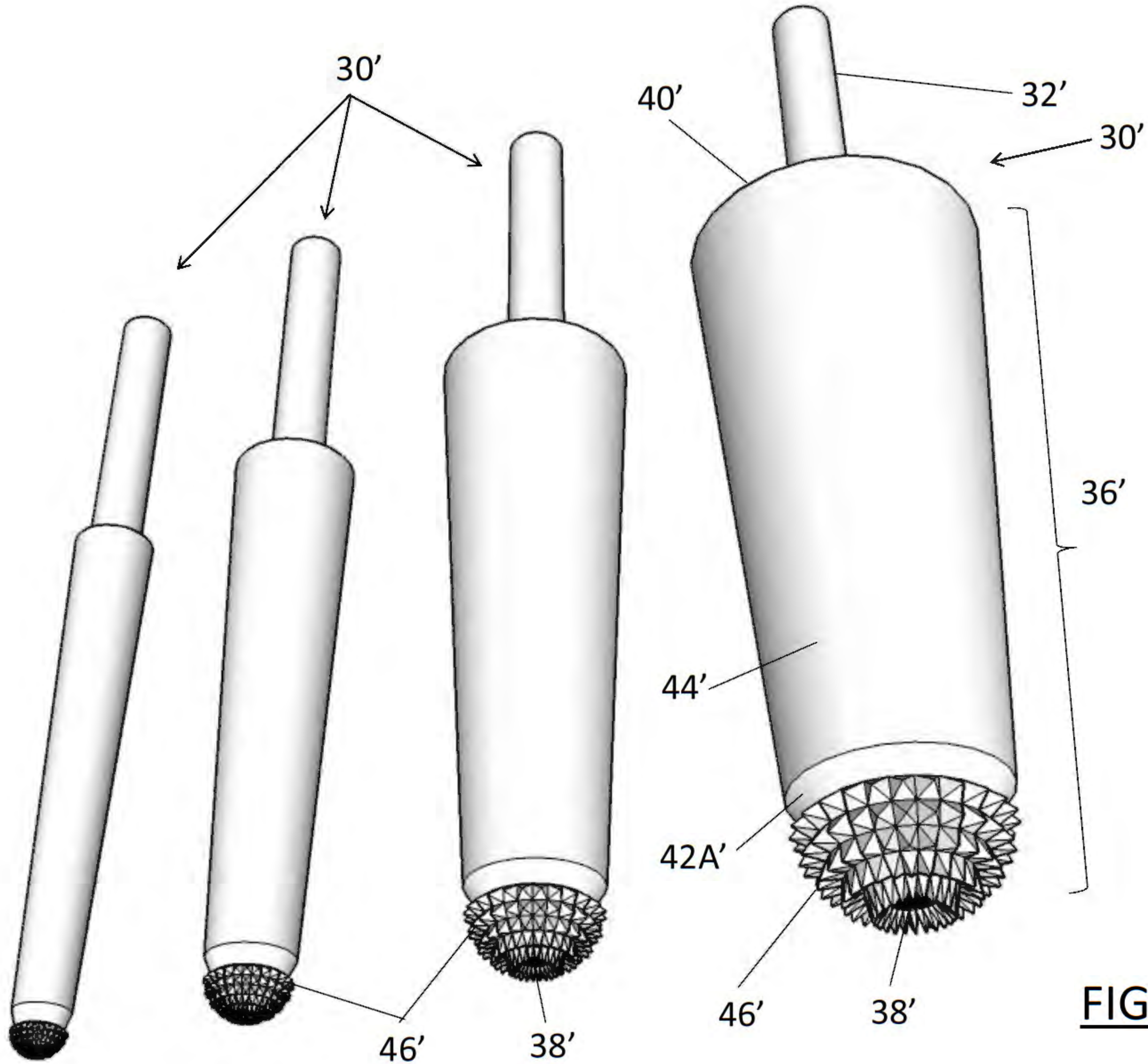



FIG. 21

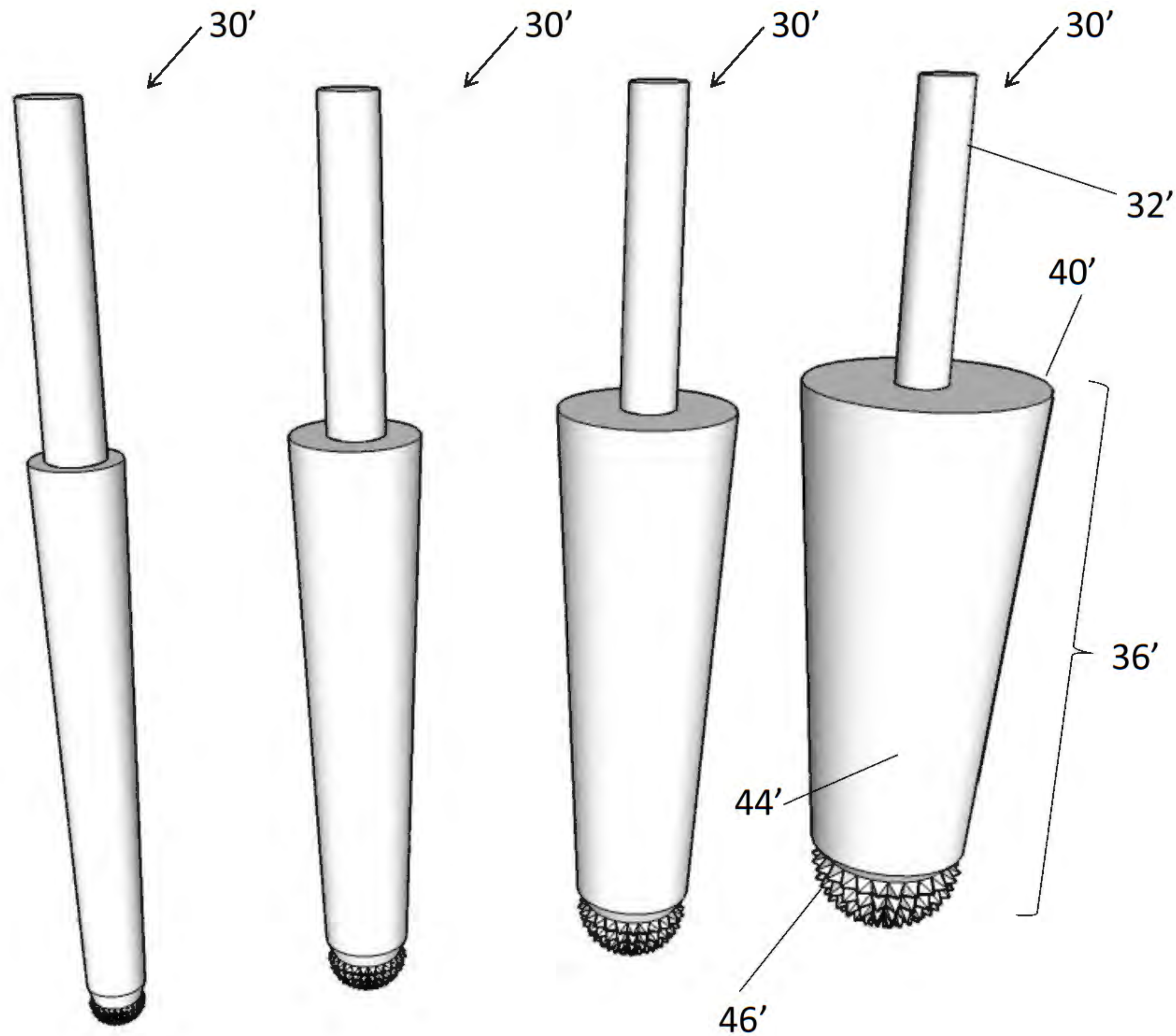



FIG. 22

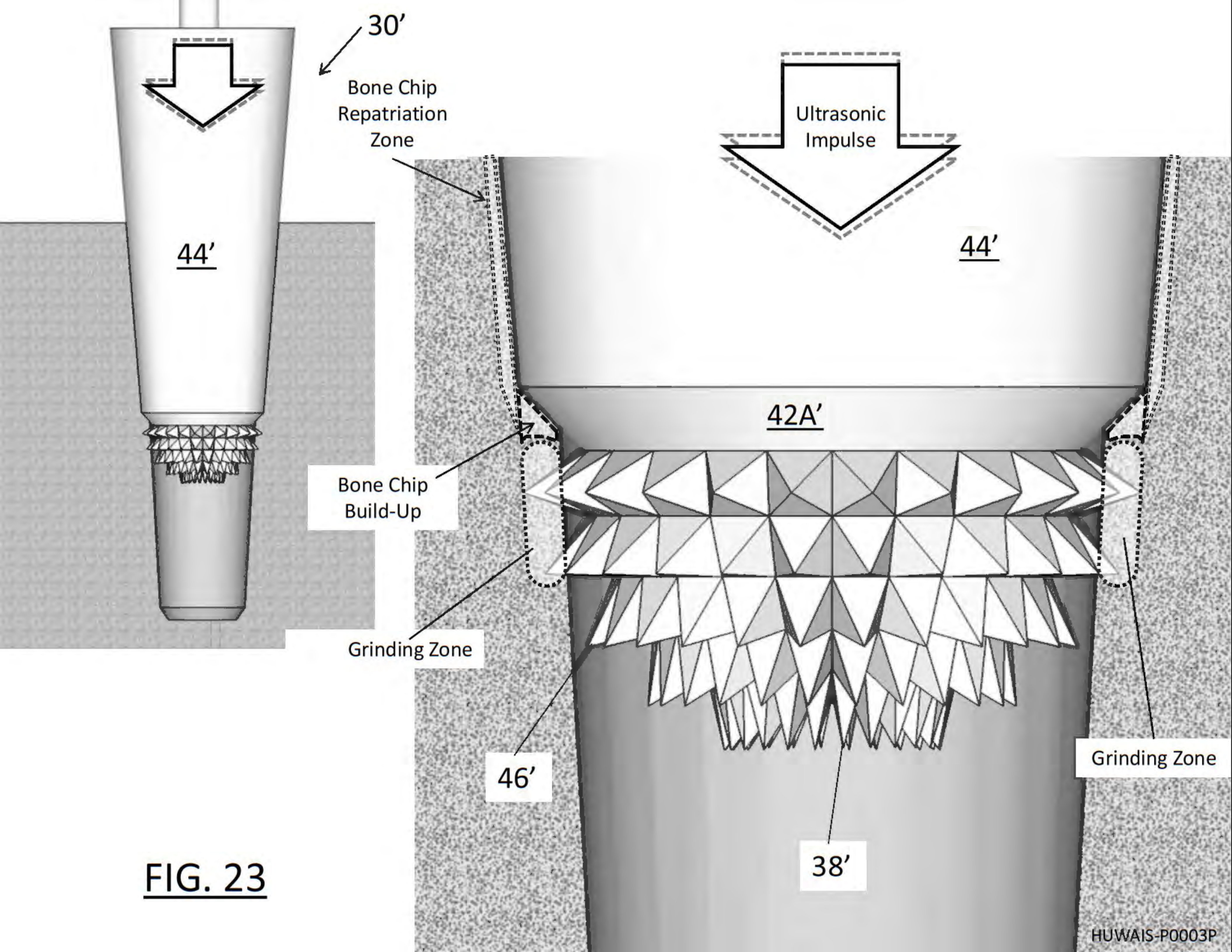

30'
Bone Chip Repatriation Zone
Ultrasonic Impulse
44'
44'
42A'
Bone Chip Build-Up
Grinding Zone
Grinding Zone
46'
38'
HUWAIS-P0003P

FIG. 23

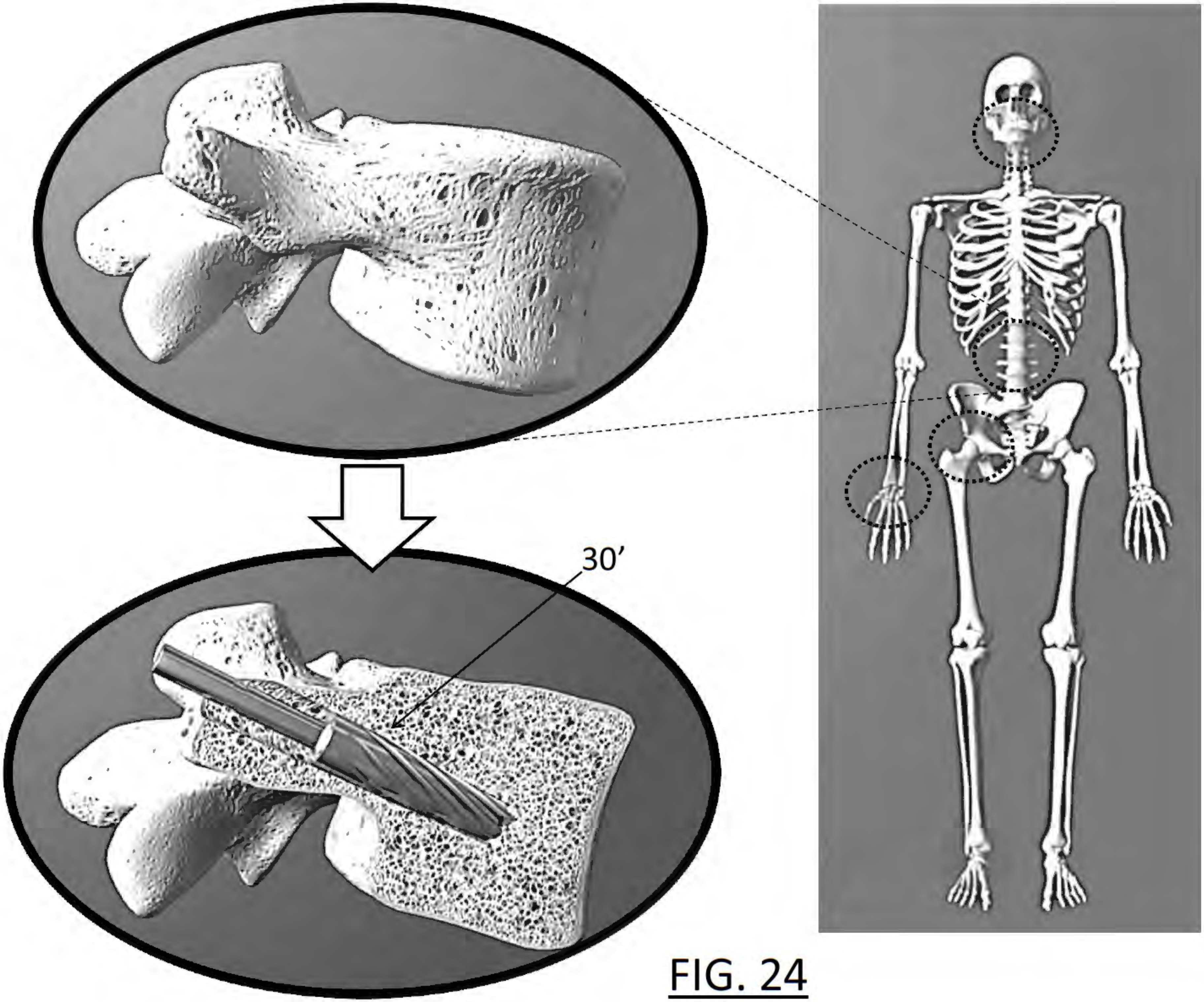



FIG. 24

Metal Foam

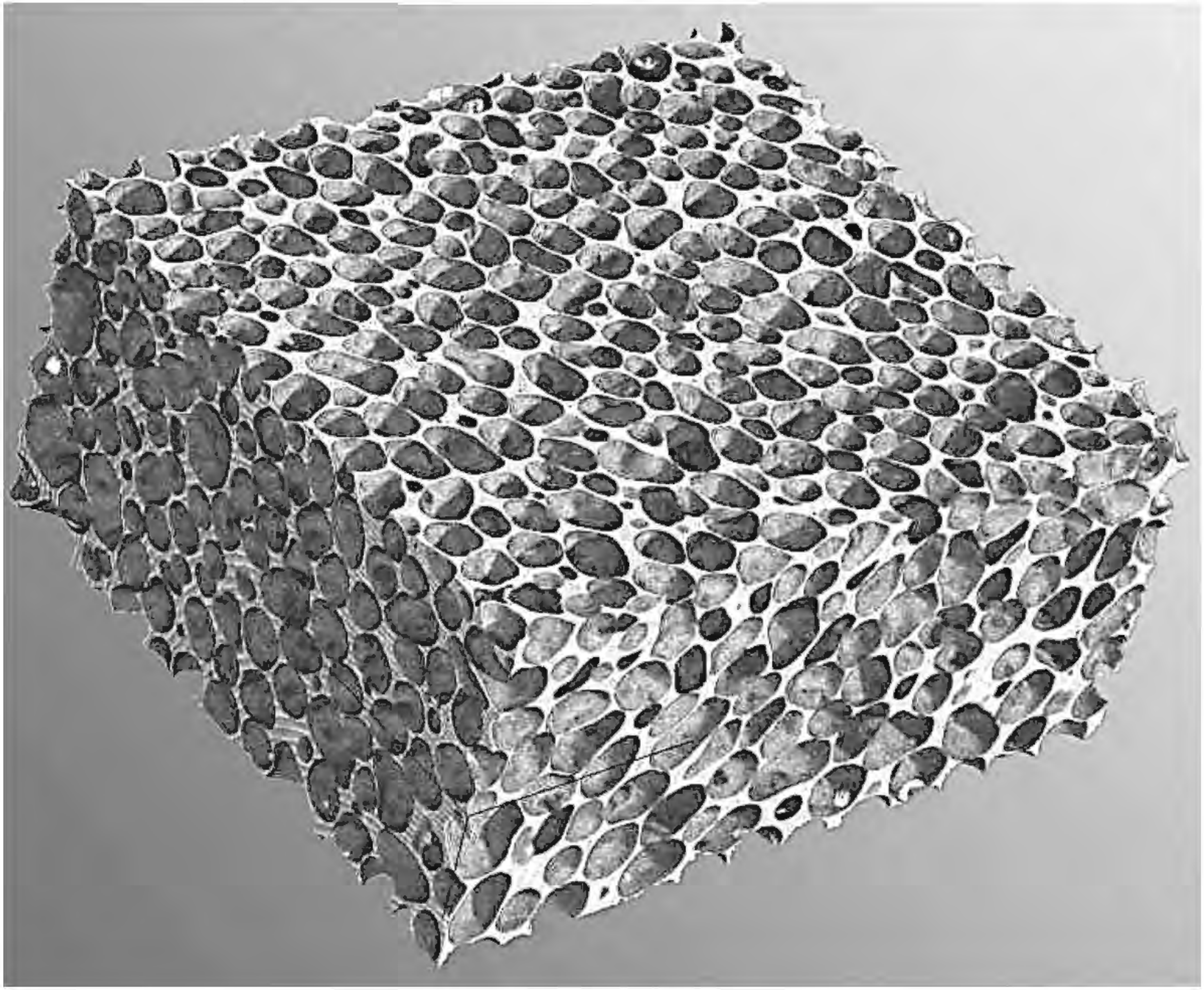


FIG. 25

HUWAIS-P0003P