

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VIKING DRILL & TOOL, INC.

Petitioner

v.

HONGJIA WANG

Patent Owner

IPR2023-00473

U.S. Patent No. 11,007,583

**DECLARATION OF WILLIAM J. ENDRES
IN SUPPORT OF
THE PATENT OWNER'S PRELIMINARY RESPONSE
TO THE PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 11,007,583**

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DECLARATION OF WILLIAM J. ENDRES

I, William J. Endres, Ph.D., declare as follows:

1. I am an Associate Professor of Mechanical Engineering, holding a Richard and Elizabeth Henes Endowed Professorship, at Michigan Technology University, in Houghton, Michigan and have held this position for over 21 years. Before that, I was an Assistant Professor in the Mechanical Engineering Department at the University of Michigan in Ann Arbor, Michigan. I attach my CV at Exhibit 1 to this declaration.

2. As can be seen from my CV, I have been deeply immersed in cutting tool technology for over 34 years, since my graduate research in cutting mechanics, machining dynamics, and mechanistic process modeling techniques from 1988 to 1992 at the University of Illinois at Urbana-Champaign, Illinois.

3. I am the founder and president of Endres Machining Innovations, LLC, of Houghton, Michigan, which designs and consults on advanced cutting tools of various types, <https://endresmachining.com/about-us/>. In that capacity I have led, many times as the creative impetus, multiple highly innovative (i.e., beyond ordinary skill in the art) cutting-tool development and commercialization projects with both commercial and government funding (for example, some results of which that are publicly disclosable can be seen at <https://revocut.com/>, https://www.youtube.com/channel/UCQaG6ntd7ZBO4ILKunwNA_w, and as a contracted R&D source for Rotary Technologies Corp. at <https://www.rotarytech.com/>). Approximately 25 years ago, I was hired by Vermont American Corp. (<https://vermontamerican.com/>) to prepare and deliver a short course on designing twist drills, some of the content from which is the basis for a chapter in my book entitled Machining Processes: Model-based Planning and Diagnostics (self/company-published).

4. I hold roughly nine patents, most of which are specifically directed to cutting tools.

I. A Person of Ordinary Skill in the Art Would Understand that Hongjia Wang Possessed the Claimed Invention at the Time He Filed His '900 Application

5. Hongjia Wang's own '900 Application (U.S. Patent Application No. 15/847,900) is not prior art. The '900 Application ("the Wang '900") is the '583 Patent's parent national stage patent application in the United States, the national stage application of Mr. Wang's Chinese-language PCT patent application (PCT Patent Application No. PCT/CN2016/073767)

6. In Wang '900, the term “flute” **4** is used to describe the regions of material removed from the flank **3**. The term flute in drills commonly refers to the chip evacuation flute, designated as IV in the '583 Patent. More generally, the term “flute” refers to a gouge cut out of the base material. The chip-evacuation (“CE”) flute is such a gouge cut out of the cylindrical surface, and, in the '900 application, each flute **4** is a gouge cut out of the flank surface **3**. I will refer to the former as a CE flute and the latter as a flute **4**.

7. Wang '900 supports the patent claim term “spirally.” Specifically, each of the challenged patent claims recites the term “spirally” in connection with the following phrase:

a plurality of composite cutting blade groups formed sequentially and spirally on a cone portion exterior from a front end of the cone portion to a rear end of the cone portion, each of the plurality of composite cutting blade groups comprising:
a conical first step surface;
a cylindrical second step surface adjacent to the conical first step surface; ...

(The '583 Patent, claims 1 and 8).

8. This configuration is illustrated in the embodiment shown in Figure 3 (reproduced to the right) and described in col. 5:1-5 and 6:10-13:

[The] diameters of the composite cutting blade groups sequentially increase from the front end to a rear end of the cone portion, and the composite cutting blade groups each comprise a first step surface **141** and a second step surface **142** which are adjacent.

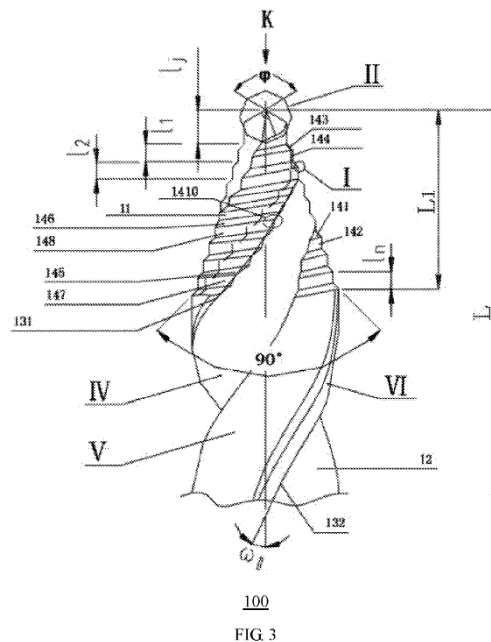
* * *

The composite cutting blade groups conically and spirally extend along the rake face **133** of the spiral flute IV towards the shank (shank portion **2**) and terminate at the maximum outer diameter of the twist drill **100**.

(The '583 Patent, col. 5:1-5 and 6:10-13).

9. Wang '900 describes this very configuration and more than sufficiently demonstrates that the inventor had known and sufficiently described this concept of the composite cutting blade groups (“CCBG”) that are formed “spirally” as early as the filing date of Wang '900.

10. Where the Wang '583 Patent describes this configuration as “a plurality of” CCBGs, the Wang '900 application describes these same CCBGs in terms of the “plurality of flutes **4**” that form them. For example, Figure 5 of Wang '900 illustrates one embodiment of a plurality of these flutes distributed on the cone portion of the twist drill:



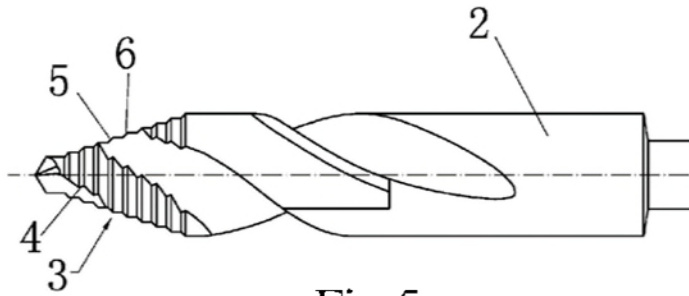
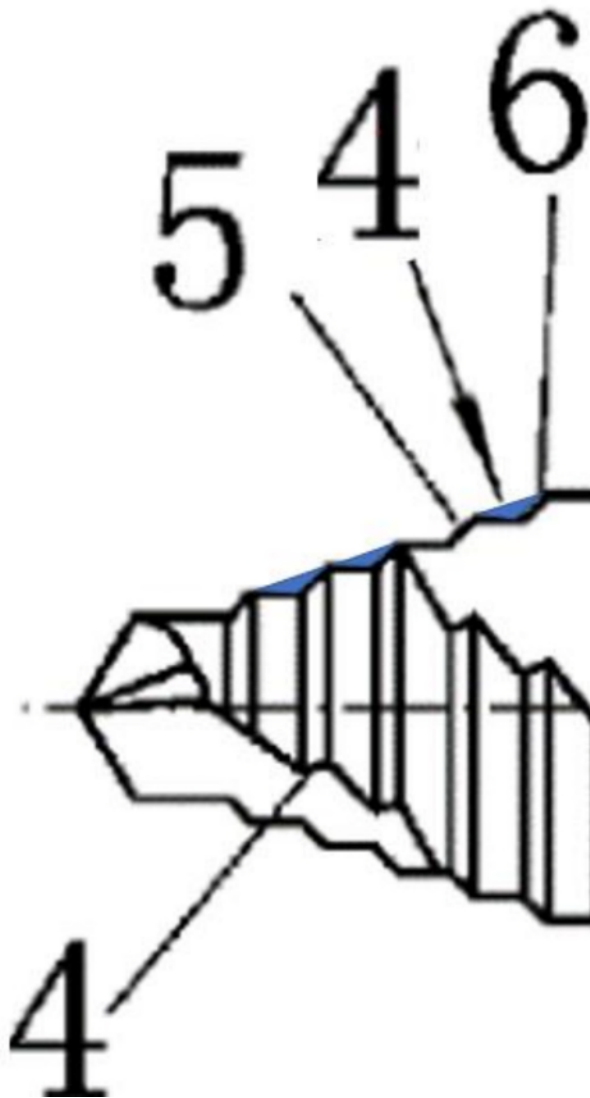


Fig.5

11. I have created an enlarged version of Figure 5 of Wang ' 900, highlighting three of these flutes in blue:



12. In Figure 5, the plurality of flutes **4** form CCBGs with little to no perceivable axial relief, but Wang '900 also notes in the Summary of the Invention that, preferably, they form a

spiral structure. (Wang '900, paragraph [0010], in the Summary) (“Preferably, connecting lines of the flutes form a spiral structure.”).

13. The term “connecting lines” is used by Viking as a point of contention. In Wang '900, the term connecting line is clearly used in a general sense and then applied in two places with specificity. The general sense of the term is a line that connects two surfaces by traversing from one to the other. And further it is a line in that, by necessity of forming a “line” in a three-dimensional geometric construct, is formed at and by the intersection of two other surfaces. This general term is then specifically applied to (1) the flutes **4** (being arc-shaped or “spiral” at the intersections of surfaces **141** and **142**) and also to (2) the cutting blades **5** and **6** (formed at and by the intersection of surfaces **141** and **142**, respectively, with the CE flute and, thus, forming a step-like structure; this is the “ends of the flutes **4**”). So, connecting lines are used rather than simply “line” in that “connecting line” indicates the line is not simply formed by the intersection of two surfaces, but also traverses or connects between two other surfaces, this all being inherent in three-dimensional geometry.

14. Viking’s construction misinterprets the term “connecting lines” as the lines that connect the *ends* of the flutes **4** and only that, not recognizing the other specific use of the general “connecting lines” term to the flutes **4** themselves. In contrast to “Preferably, *connecting lines* of the flutes form a spiral structure”, just four paragraphs up in paragraph [0006], Wang '900 had already described the connecting lines of the *ends* of the flutes **4** as forming a “step-like structure.”

[0006] An efficient twist drill for layered drilling comprises ... an the operation portion [that] has a cutting portion at a front end, wherein ... the flutes divide main cutting blades into a plurality of first cutting blades and second cutting blades; and connecting lines of the first cutting blades and the second cutting blades form a step-like structure.

15. Wang '900 repeats this distinction in the Detailed Description of his invention:

[0031] **A plurality of flutes 4** distributed in parallel and at intervals are symmetrically arranged along a **flank surface 3** of the cutting portion; the **flutes 4** divide main cutting blades into a plurality of **first cutting blades 5** and **second cutting blades 6**; and *connecting lines* of the **first cutting blades 5** and the **second cutting blades 6** form a step-like structure (which can also be called a ladder-like structure), *i.e.*, the main cutting blades of the present disclosure are step-like structures.

* * *

[0035] The flutes of the present disclosure may be arc-shaped flutes adapted to a radian of the flank surface, or the *connecting lines* of the flutes form a spiral structure.

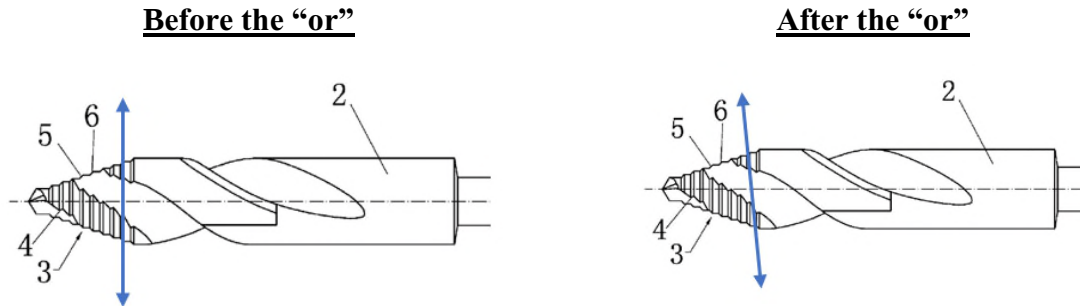
(Wang, at paragraphs [0031] and [0035]).

16. That is, according to paragraph [0035], the “plurality of flutes **4**” of the invention “may be arc-shaped,” that is, circular around the flank surface, as shown in Figure 5, or “the connecting lines of the flutes,” i.e., between/connecting the CE flute corresponding to the CCBG and the other CE flutes, “form a spiral structure.”

17. In other words, a person of ordinary skill in the art (POSA) would understand that the conical first step surface **141** of the '583 Patent is shown as the first cutting blade **5** of Wang '900 and the cylindrical second step surface **142** of the '583 Patent is shown as the second cutting blade **6** of Wang '900. The flutes **4** of Wang '900 are what form both first and second cutting blades **5** and **6** of Wang '900, and the connecting lines of the flutes **4** are the same as the intersections of the conical first step surfaces **141** and the cylindrical second step surfaces **142** of the '583 Patent. Thus, when the connecting lines of the flutes **4** form a spiral structure, this corresponds to the CCBGs in the '583 Patent being “formed spirally.” Thus, the concept of the CCBGs being formed spirally was in Wang’s possession when he filed the Wang '900 patent application.

18. I disagree with Viking’s claim that the phrase “the connecting lines of the flutes **4** form a spiral structure” in paragraph [0035] is ambiguous and could refer to either “lines along the leading edges of the cutting blade groups” or “radial relief along the flank surfaces behind the cutting edges.” Pet. at 28–31.

19. A POSA would not interpret the “connecting lines of the flutes **4**” to refer to “lines along the leading edges of the cutting blade groups.” Wang '900 expressly distinguishes between the connecting lines of the flutes **4** and the connecting lines of the cutting blades **5** and **6**, at the ends of the flutes **4**. Paragraphs [0006] and [0031] of Wang '900 describe the “connecting lines of the first cutting blades **5** and the second cutting blades **6**” as “forming a step-like structure;” they are lines, not surfaces, and thus must mean the lines at the end of the flute **4**, where the flute **4** surfaces **141** and **142** intersect with the CE flute. On the other hand, Wang '900 describes the “connecting lines of the flutes **4**” as forming either a circular (arc-shaped “adapted to a radian of the flank surface”) or a spiral structure. A POSA would thus understand that long dimension of the flutes **4** may be circular or the long dimension of the flutes **4** may form a spiral structure, as I illustrate with the blue arrows below:



20. Viking’s interpretation of the term “connecting lines forming a spiral structure” is completely out of context. A POSA would understand the phrase in light of the full context of paragraph [0035] of Wang ’900, i.e., “The flutes of the present disclosure may be arc-sharped flutes adapted to a radian of the flank surface, **or** the connecting lines of the flutes form a spiral structure.” Paragraph [0035] of Wang ’900 becomes nonsensical if Viking’s interpretation is adopted.

21. Nor would a POSA understand the paragraph to refer to “radial relief along the flank surfaces behind the cutting edges.” Relief on cutting tools is well known to be a surface, not a line and therefore not a “connecting line.” Again, Viking’s interpretation would render paragraph [0035] of Wang ’900 nonsensical.

II. Bannister Does Not Render the ‘583 Patent Obvious in View of Zhou and/or Welty

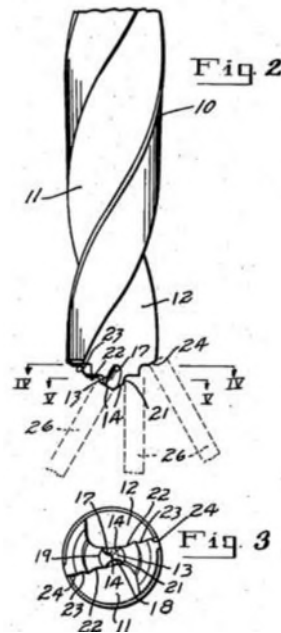
A. Bannister does not disclose the majority of the elements recited in the ‘583 Patent’s claims

22. I disagree with Viking’s assertion that “the only element of claim 1 missing from Bannister is a first step surface that is conical in shape.” To the contrary, Bannister does not disclose many of the elements recited in the ‘583 Patent’s claims.

23. Bannister discloses a standard pilot point drill bit with an additional beveled outer shoulder **24**. As Bannister explains, the additional beveled shoulder is included to produce long chips, especially when working on soft metals, which Bannister explains is to entangle and carry out any fine chips created by the straight intermediate cutting blades **22**. Otherwise, the fine chips could remain behind and cause the drill bit to jam and freeze during operation. (Bannister, col. 3:10-19 and col. 4:7-12).

24. Importantly, Bannister discloses that the intermediate major cutting edge **22** is “preferably” normal (perpendicular) to the axis, not non-normal as is the case when the CE flute

intersects a conical surface (**141** in the '583 Patent). (*Id.*, col. 3:6-10 and 3:74-75). This is also shown in Fig. 2 where grinding wheel **26** is specifically oriented parallel to the drill bit axis when it is forming cutting edge **22** even though it is angled from parallel when it is forming the first cutting edge **14** and the additional shoulder **24**. (*Id.* at col. 4:19-22).



25. A POSA would not understand Bannister to have a cone portion in front of a cylinder portion. Instead, Bannister merely grinds two normal surfaces, in a sense creating terraces cut/ground into the otherwise/typical 118° major cutting edge point angle of a standard twist drill:

In grinding my improved drill, as will be seen in Fig. 2, all the series of cutting edges from those of the central pilot unit **13** to the last cutting edge **24** are formed within an angle of approximately 59° to the axis of the drill, or an included angle of 118° , which is considered the most efficient angle in grinding twist drills. See Calvin and Stanley, "Machine Tools and Their Operation," first edition, part II, pages 395, 396; Machinery's Encyclopedia, Vol. II, pages 432 and 43. In this way I do not sacrifice any strength in the point, nor do I lose drilling time which would be the case if the steps were longer.

(*Id.* at col. 4:56-69).

26. That is, according to Bannister, it is important to stay along this conventional 118° cutting edge so as to not sacrifice any strength or drilling time. (*Id.* at col. 4:67-69).

27. Thus, Bannister does not disclose at least the following elements recited in the two independent claims of the '583 Patent:

an operation portion comprising a cone portion ...

a plurality of composite cutting blade groups formed sequentially and spirally on a cone portion exterior from a front end of the cone portion to a rear end of the cone portion, each of the plurality of composite cutting blade groups comprising:
a conical first step surface; ...
a major cutting edge defined by the intersection of the conical first step surface and the sidewall of the spiral flute;

* * *

wherein a diameter of each of the plurality of composite cutting blade groups increases sequentially from the front end of the cone portion to the rear end of the cone portion; and ...

* * *

wherein at least one cylindrical second step surface is immediately adjacent to a conical first step surface of a next composite cutting blade group; and the diameter of the last composite cutting blade group located at the rear end of the cone portion immediately adjacent to the cylinder portion is equal to the cylinder portion diameter.

(‘583 Pat., Cls. 1 and 8)

28. In addition, Bannister provides no support for the following elements, recited in the dependent claims of the ’583 Patent:

a straight major cutting edge length of the top blade is greater than each of the major cutting edges of the plurality of composite cutting blade groups.

(‘583 Pat., Cls. 7 and 12)

a straight minor cutting edge length of the top blade is greater than each of the minor cutting edges of the plurality of composite cutting blade groups.

(‘583 Pat., Cl. 13)

the cutting tips of the plurality of composite cutting blade groups are formed spirally on a cone portion exterior from a front end of the cone portion to a rear end of the cone portion.

(‘583 Pat., Cls. 19 and 22).

29. In other words, while the ’583 Patent explicitly calls for the top blade radius to be larger than the lengths of the CCBGs, Bannister is clearly emphasizing with intention the opposite, that the central drilling unit **13** is as small as possible.

30. Notably, the only element that Viking introduces Zhou and Welty for is the concept that the intermediate cutting edge **22** could be conical. Thus, even if a POSA combined Bannister with Zhou and Welty (which they would not), they would not arrive at the claimed invention of the ’583 Patent.

B. A POSA would not combine Bannister with Zhou and/or Welty

31. Bannister specifically requires that the intermediate cutting edge **22** be perpendicular to the drill bit axis in order to form short chips when cutting into the workpiece. Bannister specified that only the outer edge be beveled and this was critical to form long chips in

order to have these long chips carry away the shorter chips formed by the perpendicular intermediate cutting edge 22. (Bannister, col. 3:10-19 and col. 4:7-12). A POSA would therefore not use the teaching of Zhou (or Welty) to modify Bannister to form conical first step surface for the intermediate cutting edge as recited in Claim 1 of the '583 Patent. Bannister's point was to make the central portion small to reduce feeding force/work, and not to make the intermediate portions small rather to make them intentionally normal to the axis in order to create small, broken chips.

32. Zhou illustrates and describes a twist drill with a top blade, intermediate cutting edges 3 and 4 (on opposite sides of flute 9) and outer cutting edges 1 and 2 (on opposite sides of Flute 9). The innovation Zhou attempts to disclose is that his cutting edges 1 and 3 are offset axially from each other and cutting edges 2 and 4 are offset axially from each other.

33. That is, as Figures 1 and 2 of Zhou show, the top blade 5 is flanked by intermediate cutting edges 3 (on one side of flute 9) and 4 (on the other side). The drop from top blade 5 to cutting edge 3 is greater than the drop from top blade 5 to intermediate edge 4. Then, the drop from top blade 5 to cutting edge 2 is greater than the drop from top blade 5 to edge 1 (i.e., the cutting edges are simply asymmetrical, with $h3 > h4$ and yet $h1 < h2$).

34. A POSA would not find Zhou to be operative, much less look to combine Zhou with Bannister. The configuration that Zhou discloses would seem to cause walk in most applications or at least a wobble, deriving from the uneven work being done by cutting edge 3 versus cutting edge 4 and by cutting edge 2 versus cutting edge 1.

35. Also, Zhou teaches forming a groove in intermediate cutting edge 4, but not edge 3, and a groove in outer cutting edge 1, but not edge 2. The grooves are intended to improve

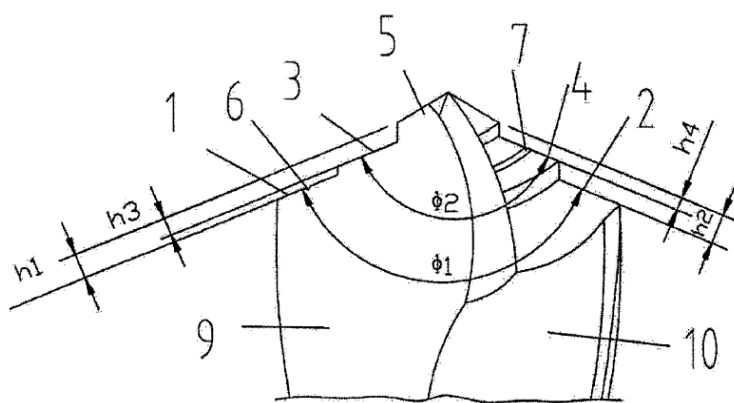


Fig. 1

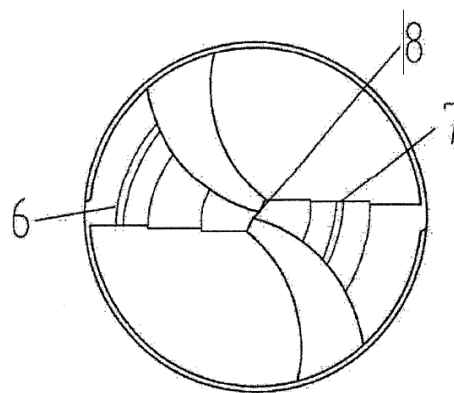
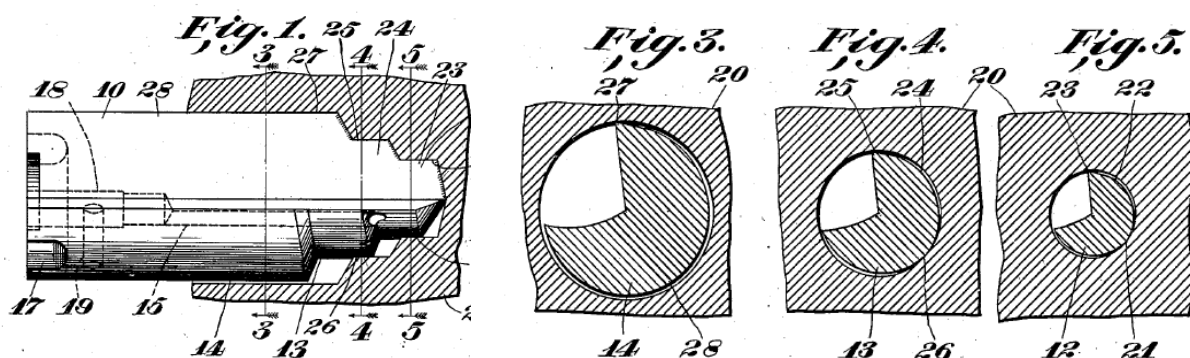


Fig. 2

swarf separation. Overall, it appears that Zhou attempts to produce swarf separation with a configuration that is considerably different than the configuration recited in the '583 Patent claims.

36. Welty is focused on providing a cutting edge and a heel opposite the cutting edge, with noticeable radial relief in between, to, according to Welty, greatly reduce breakage of drill bits due to freezing up.

37. Specifically, Welty discloses a top blade 12 having a cutting edge 23 and a heel 24 with regions of radial relief on either side of the heel 24, and an intermediate blade 13 having a cutting edge 25 and heel 26 with regions of radial relief on either side of the heel 26. The body 10, on the other hand, has a cutting edge 27, but no heel. Unlike the top blade and the intermediate step, the drill bit body has a true circular cross-section:



38. Welty does not teach or suggest that the cutting tips be arranged in any spiral pattern. The swarf-evacuating flute is expressly straight, as shown in Figures 2-5. The trailing surface of the single straight flute is very slightly curved, but the leading surface of the flute, the surface that intersects the cutting edges 23, 25, and 27 to form the cutting tips, is clearly straight. This results in cutting tips that are not formed spirally.

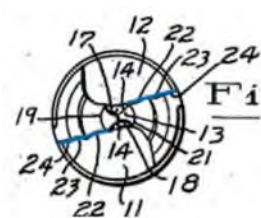
39. Welty's intent is to support the cutting loads acting on the anti-symmetrical design, that is a single cutting edge rather than the common two opposing cutting edges on the twist drills referenced in the majority of this document. As such, Welty teaches a single cutting edge per each of the three diameters (23, 25, and 27) and "heels" (21 and 23) that "also serve as bearing supports for the cutting edges" by being placed roughly opposite the cutting edge in the direction of the resultant force in that axis-normal plane. Welty is essentially a gun drill, which is its own class of

specialty tool for drilling very deep holes on the order of 100:1, and these days, up to a 300:1 depth-to-diameter. Gun drills evolved from the very early days in the late 19th century when twist drills were welded to a long shaft. In the early 20th century tubes were used with a single-edge blade at the cutting end so that coolant could be delivered through the tube to the cutting end and then backflow to flush chips out and up the tube. Having a single blade allows large chip evacuation space while maintaining strength of the drill. Welty achieves the same, including oil delivery, but introduced the three cutting edges at their respective diameters. Being a specialty type of drill, the twist drill being the commonplace baseline type of drill, it is my opinion that a POSA of using one or the other would not combine Welty for any of its features with Bannister.

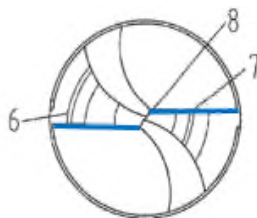
C. A POSA Would Not Combine Bannister With Zhou, Welty, and/or Korb

40. Claims 18 and 22 recite the additional limitation “wherein the cutting tips of the plurality of composite cutting blade groups are formed spirally on a cone portion exterior from a front end of the cone portion to a rear end of the cone portion.” Claim 13 recites the additional limitation “wherein, a straight minor cutting edge length of the top blade is greater than each of the minor cutting edges of the plurality of composite cutting blade groups.”

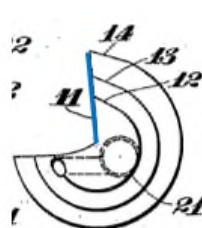
41. Bannister, Zhou, and Welty each has a straight—not spiral—arrangement of the cutting tips. I have marked with blue lines in Bannister, Zhou, and Welty, below, the straight arrangement of the cutting tips. As can be seen, each discloses only two or three cutting tips, and always in a straight line. This is in stark contrast to the spiral configuration of cutting tips at issue in Wang ’900, which I have marked in red below.



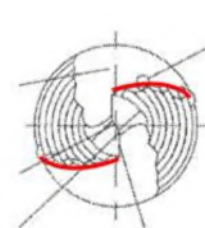
Bannister



Zhou



Welty



Wang

42. Also, the mere two cutting tips behind the top blade disclosed by Bannister, Zhou, and Welty cannot form a “spiral arrangement” by themselves. At a minimum, a plurality of cutting tips would have to number four or five to arguably form a spiral of any sort.

43. On the other hand, Korb is a step drill. It is configured to be able to drill holes of different diameters in a metal sheet, I-beam, or other relatively thin workpieces. This is a far different application from that of Bannister and Zhou, which are each twist drills, and Welty, which is a gun drill type of tool. Gun drills and twist drills configured to bore deep into (a blind hole) or through a relatively thick workpiece. Step drills have evolved over decades for the sole purpose of making any one of many sizes of holes in thin material. Like gun drills, they are a specialty class of drill in contrast to twist drills being the commonplace baseline type of drill. A twist drill, including that of Mr. Wang's, is of a whole other class of tools, intended for making a single sized hole for that given drill's size/diameter. Further, if Mr. Wang's conical portion is really thought to be a step drill, it would be relatively useless as the axial dimension of each step would constrained to cutting through such thin material that the material will have little structural stiffness and strength to keep it from being not be destroyed. Of course, given the length of the drill behind the conical portion, this would be nonsensical to consider it as a step drill.

44. It was not at all obvious to combine features of a step drill disclosure to the structure of a twist drill. Twist drill innovators have had no motivation to combine the teachings of step drills with the structure of a twist drill. Twist drills have existed since the 1800s. Step drills have existed since the mid-1900s. Yet, prior to the introduction of Mr. Wang's patented drill configuration, no one combined a cone portion on the front of the structure of a twist drill and formed a plurality of stepped surfaces on the cone's exterior that define a plurality of cutting tips in a spiral arrangement for the purposes and benefits described in the Wang '900 and the '583 Patent.

45. Without Wang's specification itself, used as a blueprint making hindsight 20/20, there is no reason any twist drill innovator would take Korb to create a new twist drill as recited in the Wang '900 and the '583 Patent claims.

III. Closing Comments of Reality

46. Much of the petitioner's positions argue that a person of ordinary skill in the art would make various connections of publicly available information thus rendering Mr. Wang's invention obvious. At the risk of coming across as arrogant, which I despise, I would claim that I am a world-leading expert on the subjects related to how cutting tools and their geometry ACTUALLY "work" to do their job, including but not limited to elements of cutting mechanics,

plasticity, shear zone, specific energy, size effect, friction, heat transfer, and effects of real tool geometry like lead angles, corner radius, edge microgeometry/prep, and wear lands that form over time. Further I am, again at the risk of sounding arrogant, one of a small number in the world who is able to translate such theory to practice in an industry that is over 150 years old, highly incremental, and risk averse. All said, having done so by way of leading numerous highly innovative cutting-tool development teams/projects, as noted in Paragraph 3, above, I am **ACTUALLY far beyond one of ordinary skill in the art**. And yet, with all that at my disposal, when I first saw the actual commercial product based on Mr. Wang's '583 Patent, I thought "Hmm, how about that? Yeah, I see why that would be really good. Why didn't I think of something like that. Hindsight is 20/20, but..."

47. And the tool does work. To sum it up in a word, I leave it to what one of my students in senior design said, who is one of 151 students currently in the program and is a student on one of the seven (7) teams I currently personally advise, which are seven (7) of the thirty (30) teams I currently oversee as Director of the program... "phenomenal." That is the answer he gave me just this morning when I asked him how the Hyper-Step drill I loaned him worked to drill four 5/16-inch holes using a hand drill through 1/4-inch steel plate already affixed to their prototype in a vertical orientation at five feet from the floor. Given the age of the field of cutting tools, and the branches that have formed in application-specific specialty classes of tooling (just in creating holes where holes did not previously exist) like step drills and gun drills and annular cutters and the more general twist drill not to mention the myriad point geometries for the latter, to conceive and commercialize what Mr. Wang has done, something someone with my "beyond ordinary skill in the art" knowledge and commercial R&D experience does not find obvious, is pretty admirable.

I declare under penalty of perjury under the laws of the State of Michigan that the foregoing is true and correct.

Executed on this 13th day of April, 2023.

 Digitally signed by
William J. Endres (WJE)
Date: 2023.04.13
18:08:43 -04'00'

William J. Endres, Ph.D.