

**Patent Owner's Copy of Paragraphs added to Corrected and Supplemental
Declaration of Dr. William Endres filed on November 7, 2023**

52. Viking argues that Zhou anticipates Claims 1, 2, 5, 8, 13-15, and 19 of the '583 Patent. Viking further argues that Zhou renders Claims 1, 2, 5, 7, 8, 12-15, 18, 19, and 22 of the '583 Patent obvious in view of Bannister and/or Gentry and/or Durfee. In my opinion, Zhou does not anticipate the challenged patent claims of the '583 Patent, nor does it render the challenged claims obvious in view of Bannister and/or Gentry and/or Durfee.¹

(a) Anticipation

53. In my opinion, Zhou does not anticipate Claims 1, 2, 5, 8, 13-15, and 19 of the '583 Patent, because it fails to disclose a number of claimed features in independent claims 1 and 8, as discussed below. I understand that a patent claim cannot be anticipated by references that do not teach every element of that claim. Anticipation requires that all claim elements and their limitations be shown in a single prior art reference, in complete detail as contained in the patent claim. Furthermore, I understand that each claim element must be shown in a single reference, arranged or combined in the same way as recited in the claims.

54. The several elements in Claims 1 and 8 that are not found in Zhou, include, but are not limited to, that:

¹ Paragraph numbers 5–51 intentionally omitted.

- “a plurality of composite cutting blade groups formed sequentially;”
- “at least one cylindrical second step surface is immediately adjacent to a conical first step surface of a next composite cutting blade group;” and
- “each of the plurality of composite cutting blade groups is configured to crush cutting chips into finer chips;

55. In my opinion, Zhou fails to disclose, among other limitations recited in claim 1, the “sequentially” element of “a plurality of composite cutting blade groups formed sequentially.” Instead, for every one major cutting blade, or cutting blade group as Wang calls it, Zhou does not have a sequential cutting blade group given that the next/sequential edge is not a cutting edge, rather is an edge specifically and intentionally suppressed from the cutting action of the drill bit as described in the following paragraphs. For the same reason, Zhou fails to disclose the “immediately adjacent” element of “at least one cylindrical second step surface is immediately adjacent to a conical first step of a next composite cutting blade group.” Since there is no cutting blade group immediately adjacent to a next cutting blade group, there is no cylindrical second step surface of one cutting blade group that is immediately adjacent to a conical first step of a next composite cutting blade group.

56. Upon further inspection of Zhou since my first inspection for my June 14, 2023 declaration in connection with Mr. Wang's preliminary response, I have discovered how Zhou's drill works. In my prior inspection, the asymmetrical nature was viewed by me as unfavorable as it is in contradiction to what is normally attempted in grinding drill points. In fact, Zhou even states such, that "international standards all stipulate that the edge heights of the two main cutting edges of a twist drill should be symmetrical; the height difference thereof is generally less than 0.03 mm." (See **Ex. 1007**, Zhou, para. 0002:5-8). When the antisymmetric nature becomes larger than, say, 0.03mm, the loading on the two (or more) main cutting edges of a twist drill becomes imbalanced causing the potential for wobble, wandering, and uneven wear.

57. Now, in my second inspection, I discern that in fact what I had identified as cutting edges, segmented outer sunken edge 2 and segmented inner sunken edge 3, are actually not

cutting edges per se. (See **Ex.**

1007, Zhou, Figs. 1 and 2,

especially Fig. 1, reproduced

here). The potential for

imbalance actually is not

present because cutting happens only on edges 1 and 4, equally on each. Being on

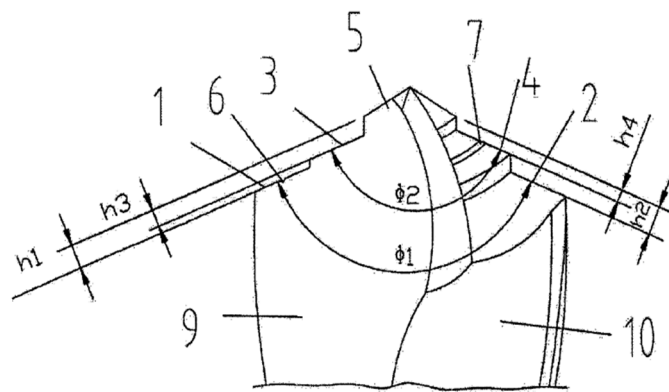


Fig. 1

opposite sides of the drill point, this equal cutting action on edges 1 and 4 effectively balance out to all practical purposes, torque aside due to the different radius at which those edges lie. Zhou's drill functions as a result of grinding the other two edges back to a large extent, when measured relative to the typical maximum feed per revolution, such that they do not even cut a nominal chip; that is, edges 2 and 3 are suppressed from participating in the cutting action, short of pushing the drill to a feed rate higher than what is commonly recommended for that drill diameter and what is clearly, from the numbers, the maximum feed for which Zhou's drill is designed. The counterparts to segmented outer sunken edge 2 and segmented inner sunken edge 3, that is, segmented outer protruding edge 1 and segmented inner protruding edge 4, respectively, do all the cutting, forming chips of cut material that are half the width and twice the thickness as they would be in their respective chip-evacuation flutes for a nominal twist drill without the geometry of Zhou.

58. Perusing the internet will uncover recommended maximum feed per revolution for a twist drill, a high-speed steel one for instance, to be about 0.5 mm for a drill of the size in embodiment 1 of Zhou — 30 mm in diameter. Some recommendations are even less than that. Noting that the axial difference in height, measured from edge 5 as a reference, between edges 1 and 2 is 0.25 mm ($h_2 - h_1 = 0.25 \text{ mm}$), and between 3 and 4 ($h_3 - h_4 = 0.25 \text{ mm}$). As such, once edges 1 and

4 remove material at an instant in time, meaning at a particular instant of drill rotation angle, after another 180 degrees of drill rotation (for the two-fluted drill considered), the drill bit has moved/fed axially (upward in Zhou's Fig. 1) by one-half the feed per revolution, so no more than 0.25 mm based on the recommended maximum feed per revolution (i.e., per 360 deg of rotation) being 0.5 mm. As such, edges 2 and 3, rotating in the shadow of the cuts made by edges 1 and 4, respectively, would be at most skimming the surface created by their predecessor counterpart 1 and 4. Note that a cutting edge requires a minimum penetration below the unmachined surface to actually create/remove a chip versus burnishing the surface by way of sliding contact. All said, any feed per revolution less than 2×0.25 mm, or 0.5 mm, would result in edges 2 and 3 not even skimming, rather having no contact, and "skimming" or not, no chip would be formed by way of cutting the workpiece material; that is, no cutting done by edges 2 or 3. For this reason, Zhou does not even include major cutting edges, that is, edges that cut, at locations 2 and 3 despite the words used to describe them in the claims.

59. Further support of the design intent to support a maximum feed per revolution of 0.5 mm is that the depth of Zhou's added chip-splitting grooves, or swarf separation grooves 6 and 7 as they call them, are specified to be 0.5 mm deep. Pushing the feed to beyond 0.5 mm per revolution would cause malfunction — the chip (or swarf) formed on either of the two cutting edges, edge

1 and edge 4, would not be fully split/separated. These numerical analyses can be performed for the other embodiments where, for the noted drill diameters of 15 mm and 4 mm, the differences in edge position (h1 vs. h2 and h3 vs. h4) relative to edge 5, specified respectively to be 0.15 mm and 0.05 mm, are consistent with common maximum recommended feed per revolution for those sizes of twist drills. In fact, the presence of swarf separation grooves on only edges 1 and 4, and absent on edges 2 and 3, further supports the understanding that edges 2 and 3 are not cutting material and, thus, have no need for swarf separation grooves, and as such are not actually “cutting edges,” rather simply inactive surfaces on the tool body.

60. Consequently, Zhou discloses only a top blade 5, an inner cutting blade 4 and an outer cutting blade 1. It teaches no other cutting blade groups because edges 2 and 3 do not perform any cutting. Since cutting blades 4 and 1 are not on the same side of top blade 5, they are not arranged sequentially as that term is defined in the '583 Patent. Also, since these are not immediately adjacent to one another, no “cylindrical second step surface is immediately adjacent to a conical first step surface of a next composite cutting blade group.”

61. Further, in my opinion, Zhou fails to disclose, among other limitations recited in claim 1, the “spirally” elements of “a plurality of composite cutting blade groups formed sequentially and spirally on a cone portion.” There is no evidence in Zhou of spiral formation of cutting blade groups given the straightness of the segmented (cutting) edges 1 and 4 and the alignment of tips along a line. (See **Ex. 1007**, Zhou, Fig. 2, reproduced here and colored red).

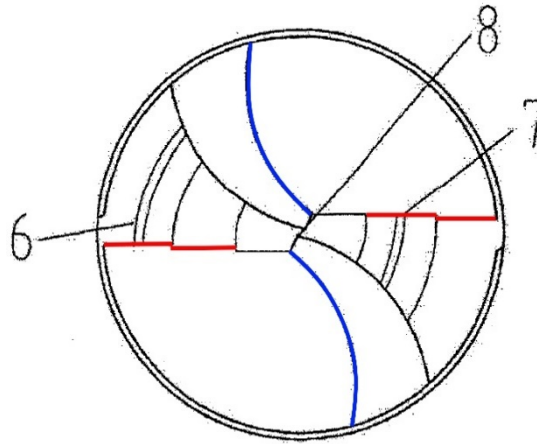


Fig. 2

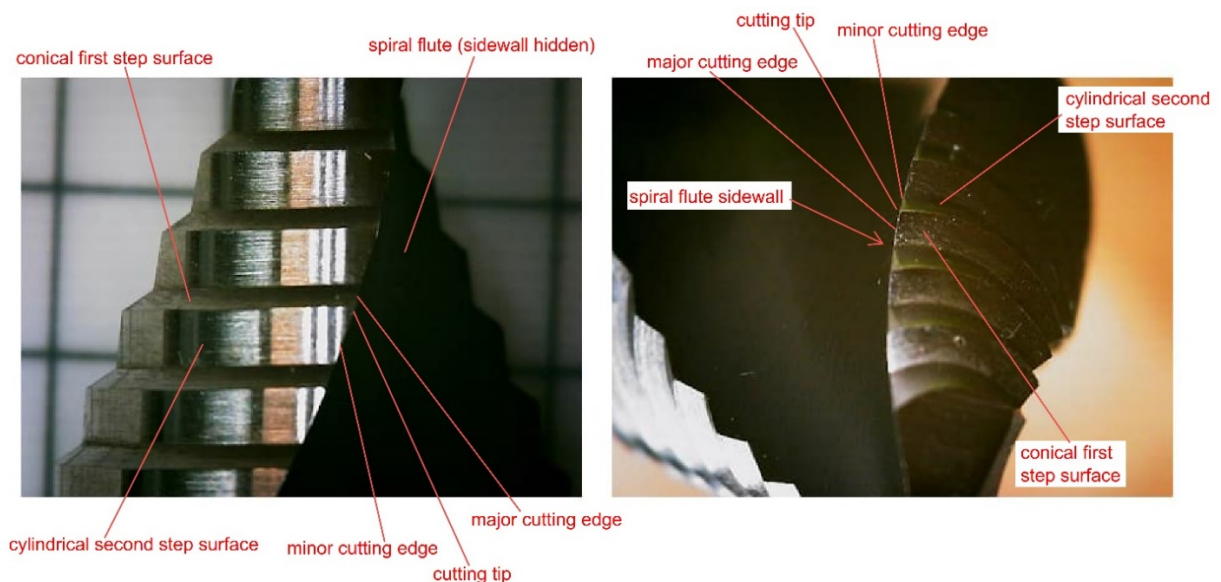
62. Further, in my opinion, Zhou fails to disclose, among other limitations recited in claim 1, that “each of the plurality of composite cutting blade groups is configured to crush cutting chips into finer chips.” The chips produced by the cutting edges 1 and 4 are twice the thickness as typical twist drill chips because of Zhou’s novel design. The chips, being half the width and twice the thickness as they would be for a nominal twist drill, result in an improved cross-sectional aspect

ratio for flow in the chip-evacuation flute than for a standard twist drill. However, thicker chips are less prone to breaking in such applications.

63. That is, Zhou's cutting blade groups are configured to produce cutting chips that are less likely to be crushed into finer chips. I would add that, if anything, the fact that Zhou's design makes chips thicker will also reduce the mechanical energy associated with the respective volumes of material removed, by way of what is referred to as specific energy being nonlinearly related to chip thickness in such a way that increasing chip thickness decreases specific energy thus increasing force at a less than proportional rate relative to the increase in chip thickness; this is called the "size effect in metal cutting." In other words, when Zhou mentions "An object of the present utility model is to provide a twist drill which exhibits a further significant reduction in drilling axial resistance and torque and thereby achieves significantly increased drilling efficiency and drill life." (emphasis added) (*See Zhou*, para. 0005) The potential for size-effect induced reduction of the tangential cutting force component, and by way of that the torque associated with it, is further evidence that Zhou's intents are consistent with his methods, specifically, that increasing the thickness of chip as a necessary outcome of apportioning the full width of each standard twist-drill cutting lip to be half that width on each of the two sides will not tend to increase torque.

64. The Wang '583 Patent, in contrast, claims the means of “crushing” the chips which occurs by forming very thin and very narrow chips. For larger-diameter drills, the chips can be formed narrower by more than a factor of 10, while not thickening them, the combined effect being to make the chips quite fragile such that they break up into shorter pieces as they are formed and enter into and traverse the chip-evacuation flute, or “crushing.”

65. Zhou also discloses and illustrates major and minor cutting edges that are entirely straight. (See **Ex. 1007**, Zhou, Figs. 1 and 2, reproduced above). Zhou does not teach or suggest major or minor cutting edges that are curved as in the '583 Patent. Below, these photographs of the ¾” Matco Tools Hyper-Step Part No. DBHS48, which embodies the claims of the '583 Patent (see, Section II.A) show the curvature of the major cutting edge and the minor cutting edge due to being “defined by the sidewall of the spiral flute”:



66. To summarize, Zhou does not actually anticipate a composite cutting blade group immediately adjacent to another composite cutting blade group because edges 3, and 2 are not cutting blades, thus Zhou anticipates neither “composite cutting blade groups formed sequentially” nor arranged “immediately adjacent.” Also, Zhou does not anticipate “spirally formed” as the cutting tips are aligned linearly, and does not anticipate “the plurality of composite cutting blade groups [to be] configured to crush cutting chips into finer chips.”

(b) Obviousness

67. In its second alleged Ground for rejection, Viking admits that Zhou does not teach or suggest composite cutting blade groups that are formed spirally (as recited in Claims 1 and 8), a top blade major cutting edge that is longer than the major cutting edge of the composite cutting blade groups (as recited in Wang’s Claims 7 and 12) or a plurality of cutting tips that are arranged spirally (as recited in Wang’s Claims 18 and 22). To overcome these limitations, Viking argues that Zhou renders the ‘583 Patent obvious in combination with Bannister and Gentry or Durfee. Viking also attempts to combine Zhou with Korb, although not specifically stated in its obviousness grounds. Viking’s assertion fails for two main reasons: (1) a combination of Zhou with Bannister would not result in several additional limitations of the ‘583 Patent; and (2) a POSA would not have combined Zhou with Gentry, Durfee, or Korb.

68. Zhou discloses a twist drill with a top blade, intermediate cutting edges 3 and 4 (on opposite sides of the flute 9) and outer cutting edges 1 and 2 (on opposite sides of flute 9). The innovation Zhou describes is that his cutting edges 1 and 3 are offset axially from each other and his cutting edges 2 and 4 are offset axially from each other. (Ex. 1007, pp. 8-9, ¶¶ [0022]-[0024] and Fig. 1).

69. 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 intermediate cutting edge 3 is greater than the drop from top blade 5 to intermediate cutting edge 4. (*Id.*). Then, the drop from edge 4 to edge 2 is greater than the drop from edge 3 to edge 1, and overall, the drop from top blade 5 to outer cutting edge 2 is greater than the drop from top blade 5 to outer cutting edge 1 (i.e., the cutting edges are simply asymmetrical, with $h_3 > h_4$ and yet $h_1 < h_2$). (*Id.*).

70. In addition to the above-mentioned admissions by Viking and the failure of Zhou to disclose the major and minor cutting edges, a POSA also would not be motivated to modify Zhou's straight cutting tips with the cutting tips of Gentry or Durfee to create the claimed cutting tips formed spirally on a cone portion exterior. Claims 1 and 8 require:

1) a spiral flute with a sidewall “extending from a front end of the cone portion and at least partway up the cylinder portion”,

2) “a major cutting edge defined by the intersection of the conical first step surface and the sidewall of the spiral flute”,

3) “a minor cutting edge defined by the intersection of the cylindrical second step and the sidewall of the spiral flute” and

4) “a cutting tip defined by the intersection of the major cutting edge, the minor cutting edge, and the sidewall of the spiral flute.”

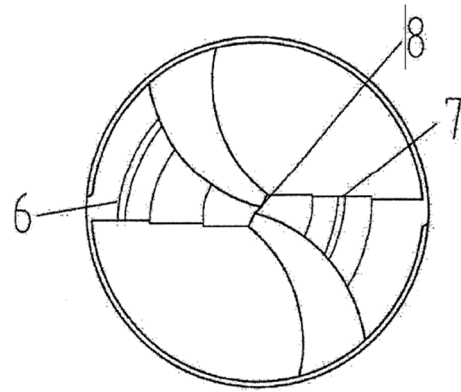


Fig. 2

71. Dependent claims 18 and 22 add to claims 1 and 8, respectively, the limitation “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.”

72. Zhou teaches an obtuse point angle for the protruding and sunken edges (1, 2, 3, 4), ranging between “a point angle of 90° - 160° ”. *See Zhou*, paras. 0008-9. In Zhou’s Fig. 1, the point angle between edges 1 and 2 is 135° ($\Phi 1$); and the point angle between edges 3 and 4 is 140° ($\Phi 2$). *See Id.*, para. 0024 and Fig. 1.

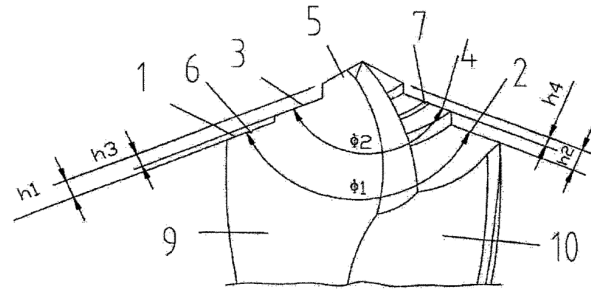


Fig. 1

73. Zhou expresses a strong desire to take a standard twist drill and improve its performance. Zhou states “In order to increase drilling efficiency and drill bit life, experts in various countries have many methods of grinding the drill tips (i.e. chisel edges) and main cutting edges of twist drills in increasing drilling efficiency which help considerably and drill bit life; examples are the Chinese “multi-facet drill”, and cross-sharpened drill types commonly used in America.” *Zhou*, para. 0003. Zhou posits “[w]ould it be possible to take advantage of progress in modern processing techniques to achieve a further reduction in the drilling axial resistance and torque of a twist drill by precisely changing the technical parameters of the main cutting edges thereof, so that swarf is separated and expelled more smoothly, and the new drill type is suitable for large-scale industrial production?” *Id.* at para. 0004 (emphasis added).

74. Zhou further states “[a]n object of the present utility model is to provide a twist drill which exhibits a further significant reduction in drilling axial resistance and torque and thereby achieves significantly increased drilling efficiency and drill life. *Id.* at para. 0004. To further emphasize the desire to make

specific modifications to standard twist drills, Zhou also states “Compared with world standard twist drills, and cross-sharpened twist drills in common use throughout the world, the most notable distinguishing features of the present utility model are the main cutting edge segmentation and the asymmetrical edge heights, which are intended to achieve a further reduction in the drilling axial resistance and torque, so that swarf is separated and expelled more smoothly, making it possible to further increase drilling efficiency and drill bit durability.” *Id.* at para. 0014; *see also* para. 0029.

75. It is clear that Zhou took the straight main cutting edges of a standard drill within the standard obtuse point angle range and made them segmented with asymmetrical edge heights (that is, the step heights on one side do not match those on the other side). This addition to standard drill bits creates the benefits of a “reduction in the drilling axial resistance and torque, so that swarf is separated and expelled more smoothly, making it possible to further increase drilling efficiency and drill bit durability”. *Id.*

76. Nevertheless, Petitioner argues that a POSA would have modified Zhou to create the claimed invention. However, Zhou would require a substantial redesign to include cutting tips formed spirally on a cone portion exterior and such a redesign would defeat Zhou’s principle of operation. Given the analysis earlier noting how Zhou’s drill functions (with two of the four edges not serving to cut

material, causing the cutting blade to in fact cut thicker chips), its fundamental difference in approach to that of Wang makes this argument of forming a plurality of much smaller cutting tips (to in fact cut thin chips that can then break into finer chips) nonsensical in this context.

77. Each of Zhou, Bannister, and Welty seem to have appreciated these difficulties and yet, Welty determined to avoid spiral flutes altogether, Bannister chose to interrupt the typical twist drill cutting edge with two flattened edges, and Zhou opted to alternate the cutting edges on opposite sides of the top blade.

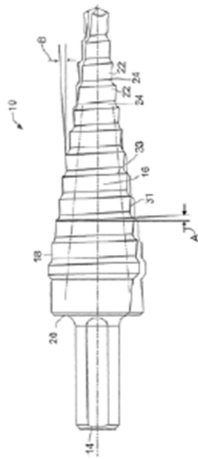
78. Furthermore, Zhou *already* includes the advantage of efficiently removing swarf from the hole. Zhou describes the [b]eneficial effects of the present utility model: [which include] reduced drilling axial resistance and torque, so that swarf is separated and expelled more smoothly, further increasing drilling efficiency and drill bit durability. *Zhou*, Abstract. Zhou elaborates that “the most notable distinguishing features of the present utility model are the main cutting edge segmentation and the asymmetrical edge heights, which are intended to achieve a further reduction in the drilling axial resistance and torque, so that swarf is separated and expelled more smoothly, making it possible to further increase drilling efficiency and drill bit durability.” (Ex. 1007, Para. 0014).

79. Petitioner failed to describe *how* the proposed modifications would provide an advantage over and above the advantages already described in Zhou

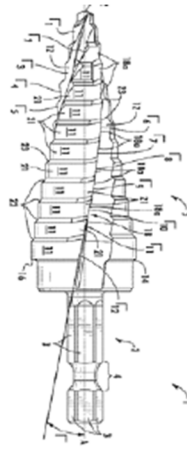
about Zhou's drill bit. Petitioner failed to explain how Bannister, Gentry, and Durfee's swarf removal is not merely redundant with that of Zhou. Zhou, Bannister, Gentry, and Durfee each operates effectively with respect to swarf removal. In my opinion, therefore, a POSA would have no reason to combine the features of Gentry and Durfee with Zhou into a single device. Petitioner has not provided any justification for why its proposed modification of the Zhou drill bit would have been an improvement over what Zhou already provides. Modifying Zhou with Gentry and Durfee to make it look more like Wang ignores the function and purpose of Zhou, Gentry, and Durfee. Yet, it is the function and purpose of a reference, not its appearance, that are the driver of tool design and that a POSA would consider when combining any tool designs and tool design features.

80. Further, Petitioner provided no evidence that forming the cutting tips spirally on the cone portion as illustrated by Gentry and Durfee would further improve swarf removal, or that swarf removal is a problem with Zhou's existing drill bit. In my opinion, modifying Zhou with Gentry and Durfee for this supposed advantage is likewise superficial and purely the product of hindsight.

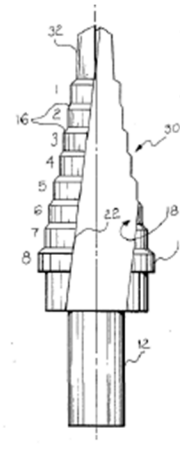
81. Moreover, as Viking admits, Zhou and Bannister describe twist drills. By contrast, Gentry, Durfee, and Korb each describe step drills.



U.S. 8,029,215 (Gentry) (FIG. 1)



U.S. 10,058,929 (Durfee) (FIG. 1)



U.S. 4,582,458 (Korb) (FIG. 7)

82. Twist drills and step drills have different purposes and different applications. Specifically, twist drills, such as those disclosed by Zhou and Bannister, are configured to bore deep into relatively thick workpieces. On the other hand, a step drill, such as those disclosed by Gentry, Durfee, and Korb, are configured to drill holes of any one of the drill bit's different diameters in sheet metal or other relatively thin workpieces, the desired diameter dictating how many "steps" of the step drill the user pushes through the sheet metal or the like. Because step drills are configured to create smooth, round holes of various diameters in thin material, the step height is configured to be taller than the material thickness.

83. It was not at all obvious to combine step-like features, similar in a way to those found in step drills, to the exterior of the cone portion of a twist drill. Twist drill innovators have had no motivation to add a plurality of steps to the exterior surface of the cone portion of a twist drill.

84. In my opinion as set forth in my October 31, 2023 Declaration, there is strong objective evidence of secondary considerations of non-obviousness, including: (1) copying; (2) industry praise; (3) commercial success; and (4) long-felt but unmet need.

A. Viking's Grounds Based on Welty in View of Bannister and Durfee and/or Korb and/or Zhou Are Erroneous

85. As its Third Ground for Invalidity in IPR2023-00474, Viking argues that Claims 1, 2, 7, 19, and 22 of the '583 Patent would have been obvious based on Welty in view of Bannister, Durfee, and/or Korb. And, as its Fourth Ground for Invalidity in IPR2023-00474, Viking argues that Claims 5, 8, 12-15, and 18 of the '583 Patent would have been obvious based on Welty in view of Bannister, Durfee, and/or Korb, in further view of Zhou.

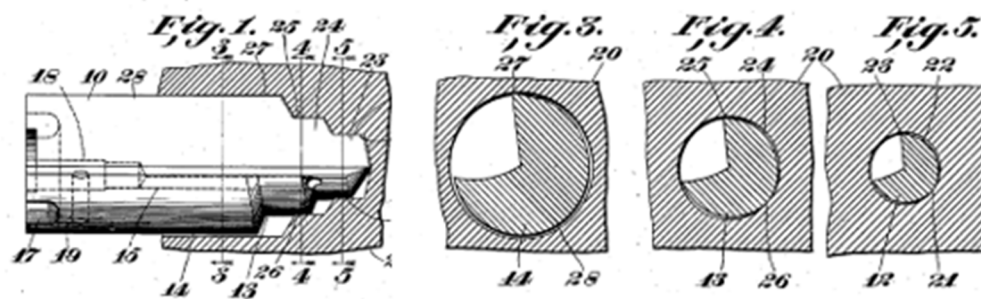
86. For the reasons below, I disagree with Viking's position.

87. Like Zhou, Welty does not afford Viking the patent claim invalidating configuration that Viking seeks. Welty fails to disclose, among other limitations recited in the Claim 1, a spiral flute, either along the cone portion or the cylinder portion, major or minor cutting edges, or a cylindrical second step surface.

88. As background, Welty is 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.

89. 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. Specifically, Welty teaches 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:



90. As an initial matter, Viking acknowledges that Welty does not contain the following limitations: (1) the spiral flute limitation; (2) the major cutting edge defined by the sidewall of the spiral flute limitation; (3) the minor cutting edge

defined by the sidewall of the spiral flute limitation; (4) cutting tips arranged spirally on a cone portion exterior; and (5) the chisel tip.

91. In my opinion, Petitioner fails to convincingly argue motivation to combine Welty with the spiral flute of Durfee, Korb, or Bannister.

92. This is because Welty already teaches a suitable method for swarf removal, and there is no reason to think that the spiral flutes of Durfee or Korb (which are not used for deep drilling) would be effective in the applications contemplated by Welty. As Welty provides: “[o]ne of the objects of my invention is to provide a drill for boring accurate diameters of great depth.” (Ex. 1008, *Welty*, p. 1, col. 1:3-5) (emphasis added). “A duct 15 is provided to furnish oil for lubricating the drill and cleaning the chips from the drill.” (*Id.*, p. 1, col. 1:41-43) (emphasis added). The drill 10 includes “a single flute 11 for removing chips, which are used by the boring operation.” (*Id.*, p. 1, col. 1:36-39). “The cutting edge 27 of the boring portion 14 then comes into operation and contacts the work as shown in Figures 1 and 3, the body portion 28 being retained out of contact with the work due to the heel portions 26 and 26 of the boring portions 12 and 13, respectively, contacting with the walls of the bore.” (*Id.*, p. 1, col. 2:43-50) (emphasis added).

93. A POSA would understand that deep-hole drilling has its own set of associated techniques for swarf removal. Techniques for deep-hole drilling have

been discussed in detail in the industry. As these references show, a POSA would understand that the spiral flutes of Bannister, Durfee and Korb are incompatible with the application of Welty.

94. “The rapid removal of chips from the drilling operation becomes necessary to ensure the proper operation and accuracy of the drill. ... To overcome these problems, deep-hole drilling machines have been developed. ... Normally, the drill is stationary and the work is rotated in a chuck with steady rests providing support along its length, but where it is difficult to rotate the work, the situation is reversed (Fig. 11). ... Equipment of this type requires an efficient cooling system to pump the coolant in large volume and high pressure for cooling the tool and flushing the chips.” (Ex. 2099, *ASM Metals Handbook*, Ninth Ed., Vol. 16, Machining (1989), p. 216). “Gun drills ..., which are used in horizontal deep-hole drilling machines (see the section ‘Deep-Hole Drilling Machines’ in this article), have a single V-shaped flute; the single cutting face is sharpened offset to form two cutting angles. When drilling, these angles form two chips broken into short lengths for easier expulsion. The drill body is usually a steel tube through which a cutting fluid passes under pressure and in sufficient volume to cool and lubricate the cutting area and flush out chips.” (*Id.* at 222-23)

95. To counter the unbalanced cutting force of the single cutting edge, wear pads (usually carbide) are provided in the drill opposite the cutting face to

keep the drill on center. Gun drills are used to drill soft as well as hard material. ... Gun drills are increasing in use because they can frequently produce holes as accurate as reamed holes in one pass. ... For maximum efficiency in gun drilling, the cutting fluid should provide a fluid film between wear pads and work material, prevent welding of chips to the cutting edge of the drill, cool the drill and the work, and dispose of chips by flushing out the hole.” (*Id.* at 222-3). “Gun drills operate at much smaller feeds than conventional twist drills, but the cutting speeds are higher.

96. Each type of drill has only a single cutting edge with a straight flute running throughout its length. The chips are carried out of the hole along the flute of the drill as rapidly as they are formed. ... Gun drilling is especially well suited to producing long holes to close tolerances. In some applications, such as the drilling of deep blind holes, gun drilling may be the only practical method of drilling a hole to concentricity tolerances. Hole straightness, roundness, and size can be held within closer limits with a gun drill than with a twist drill ... A gun drill was compared with a standard twist drill ... the gun drill not only produced markedly better finish and dimensional accuracy than the twist drill but also drilled twice as many pieces per grind ...” (*Id.*). (Emphasis added).

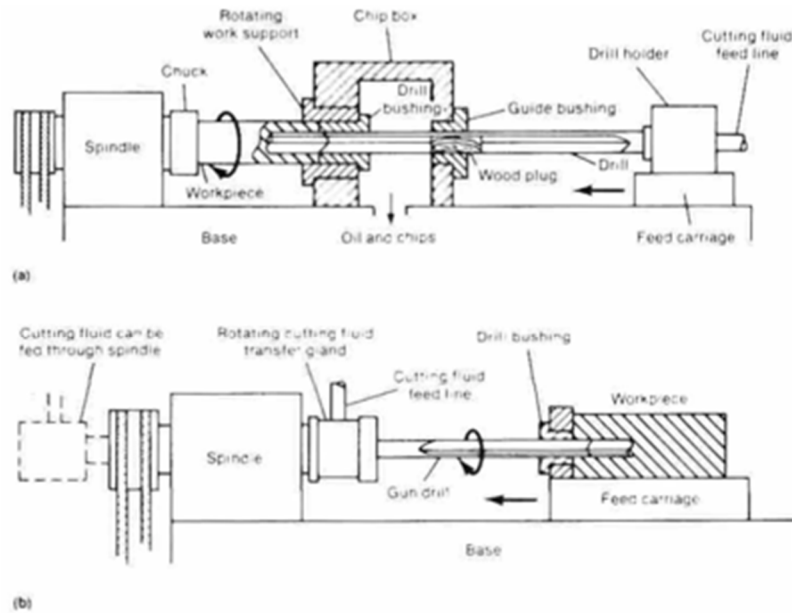


Fig. 11 Two methods of gun drilling. (a) Workpiece rotates while the tool is held stationary. Cutting fluid is fed directly through the drill from the back end. (b) Tool rotates while the workpiece is held stationary. Cutting fluid is fed through a rotating oil gland from the fluid feed line or through the machine spindle.

97. “During the process the cooling lubricant is delivered through one or more holes which pass through the tool shank (Fig. 20). The mixture of chips and cooling lubrication is removed along a flute The resulting surface quality of the bore hole can be decreased when the chip get in contact with the bore hole wall.” (Ex. 2101, *Deep hole drilling, CIRP Annals Manufacturing Technology* at 3.1.1) (emphasis added). “Deep hole drilling is a metal-cutting method used for producing new as well as for machining of existing bore holes. Deep bore holes . . . refer to bore holes, which are machined by classical deep hole drilling methods and/or drilling methods with a length-to-diameter ratio larger than 10.” (*Id.* at 1.2 and Fig. 1, below). “In general, the tool structure of single-lip deep hole drills consists of the three elements: drill head, tool shank and clamping sleeve (Fig. 21).” (*Id.* at 3.1.2). “Deep hole drilling processes, which differ significantly from

conventional drilling processes, are relevant for a lot of different applications where holes with high length-to-diameter-ratios and very good qualities are necessary.” (*Id.* at Abstract).

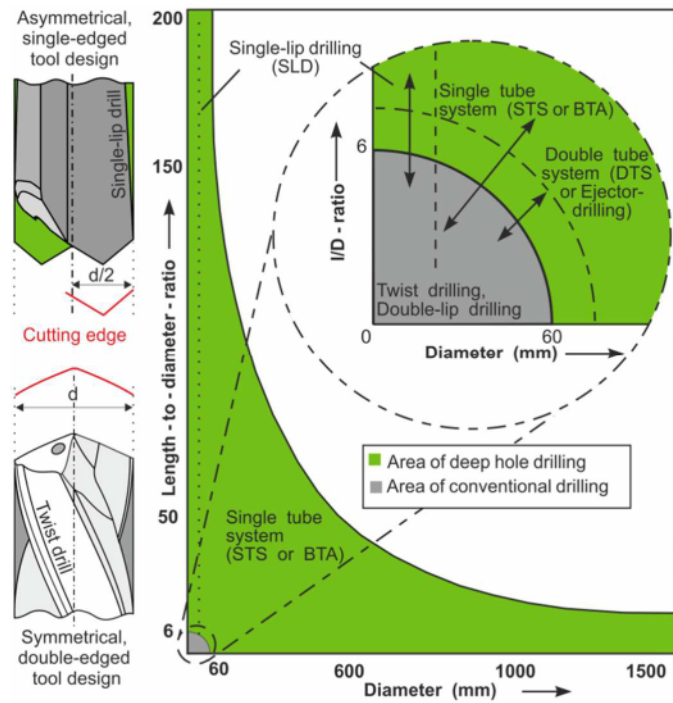


Fig. 1. Field of application of conventional and deep hole drilling [189]

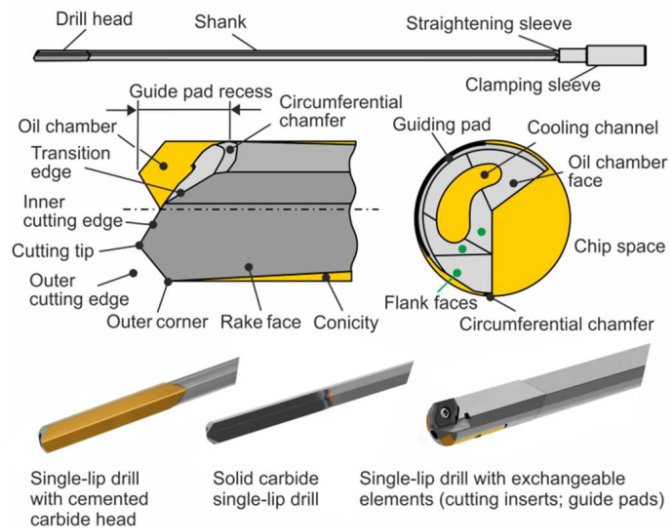


Fig. 21. Schematic tool design of single-lip deep hole drills [117,176,187]

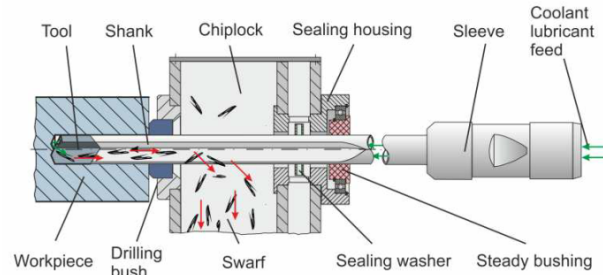
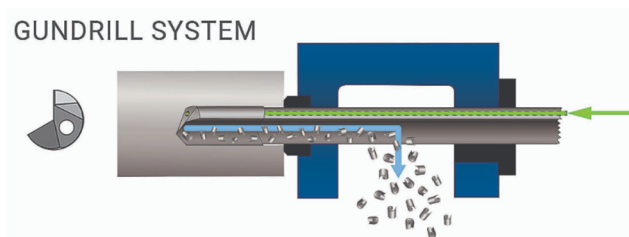


Fig. 20. Schematic process principle single-lip drilling [70,189]

98. “Deep holes generally are defined as having a depth-to-diameter ratio of greater than 10-1 and thus require special techniques and equipment to ensure reliable results. ... The term gundrilling routinely is used to describe deep-hole drilling ... A true gundrill is a single-flute, self-piloting tool that also burnishes the hole that it generates. Unlike the spiral flutes of twist drills, the straight flute of a gundrill extends for the length of the drill, and through-tool coolant reaches the cutting zone via an outlet at the drill tip. High-pressure coolant then pushes chips up the bore, along the straight flute and out of the hole.” (Ex. 2100, *Cutting Tool Engineering*, Vol. 75, Issue 3, March 2023, p. 34).



99. “To use twist drills for deep holes one must first drill a spot hole, then drill using a ‘pecking’ cycle with the drill bit lubricated by a spray mist, followed by a ream to set the final diameter. ... The highest-quality deep holes are drilled with another approach called gun drilling. In this the lubrication is provided by

high-pressure oil that flows through a channel inside the drill bit and out its tip.

Drilling is continuous (no ‘pecking’) and single pass (no spotting or reaming).

Typical tolerances are straightness of 0.001" per foot, holes diameters to 0.0005", and hole taper to less than 0.0005". Hole centering to 0.0005" is obtained by

drilling through a bushing to contain the whipping of the long gun-drill bit.” (Ex.

2102, *Deep Hole Drilling for the Rear Endplate of the BaBar Drift Chamber*,

McDonald, April 13, 1996, p. 1).

100. As commentators have agreed, deep hole boring/drilling using a gundrill, such as the one described in Welty, includes a large, straight, single flute, with the purpose of flushing chips out as unencumbered as possible, flushed out with a large volume of lubricant/coolant provided through an axial bore in the drill. Because the chips are flushed away from the cutting tip as soon as they are formed, beyond any initial chip formation/chip breaking, there is no time nor desire to “crush cutting chips into finer chips” as claimed using any gundrill. In Welty, like most gundrills, a coolant duct 15 carries a large flow of coolant just below the front tip and opposite cutting edge 23 and 25. Any chips that are formed at the front tip or by cutting edges 23 and 25 are immediately flushed down the straight flute and out of the hole.

101. Substituting the straight flute taught in Welty for the spiral flute taught in Bannister, Durfee, and Korb would cause damage to the hole wall and

decrease accuracy. The depth of a hole that the drill is intended for is limited by the drill design. Spiral twist drills are generally limited to a depth of approximately 10 times the drill diameter. Drilling deeper than this increases the opportunity for damaging the hole, because it requires the drill to be removed from the hole to extract chips. It is well accepted that the straight flute disclosed in Welty is excellent for and generally preferred for drill very deep holes. On the other hand, a POSA would understand that spiral flute designs become ineffective in drilling deeper holes and have difficulty removing chips, resulting in the scouring of the hole walls, jamming, and heat build up. Adding a spiral flute to Welty would also create a longer path for the cooling/lubricant, thereby impeding chip removal, and increase the amount of contact between the drill and the hole wall, and the change for damage along with that.

102. Thus, in my opinion, modifying Welty to include the spiral flute of Bannister, Durfee, or Korb would render Welty's drill inoperable for its intended purpose and destroy its basic objective of "provid[ing] a drill for boring accurate diameters of great depth." (Ex. 1008, at p. 1, col. 1:3-5). A POSA would interpret this statement to mean a deep hole drilling operating using a deep-hole drilling machine.

103. Not only would modifying Welty in this manner make Welty's drill inoperable for its intended purpose and destroy its basic objective, but there is no

reason to modify Welty in this manner. Welty's disclosed system of using lubrication to cool the cutting edges and heels and flush the chips away rapidly through the straight flute and exiting the hole, is perfectly suitable for its intended purpose.

104. Additionally, Welty does not disclose the "cylindrical second step" required by Claims 1 and 8, since heels 21 and 26 cause the second surfaces expressly to have non-circular cross-section. Rather, the second step surfaces have cross-sections that are oblong in shape, not substantially circular. The single cutting edge defining one side of the straight flute in Welty creates minimal contact between the drill and the hole. In my opinion, a POSA would understand that this is desirable for Welty's intended operation.

105. Welty also does not teach that the cutting tips be arranged in a spiral pattern, as required by Dependent Claims 18 and 22. As explained in detail above, the swarf-evacuating flute is expressly straight, as shown in Figures 2-5. 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.

106. Viking admits that Welty does not teach or suggest "composite cutting blades formed sequentially and spirally" limitation recited by independent claims 1 and 8 of the '583 Patent. As such, Viking attempts to combine Welty with

Bannister to overcome this limitation. However, the cutting surface of Bannister is not “configured to crush cutting chips into finer chips, then shunt the finer chips.”

107. Furthermore, Viking admits that Welty does not teach or suggest either a chisel tip or a minor cutting edge of the top blade that is longer than the minor cutting edge of the intermediate blade (as recited in Claims 5, 8, 12-15 and 18). Viking proposes combining Welty with Zhou (in further view of Bannister, Durfee, and Korb) to overcome this limitation. However, as noted in detail, Welty is a gun barrel bore cutting tool. Zhou and Bannister are twist drills. And, Durfee and Korb are step drills. Given the vastly different purposes served by each, a POSA would have no motivation or reasonable expectation of success in combining a gun drill with features of a twist drill or a step drill. My opinion is supported by the strong evidence of secondary considerations, discussed below.