

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VIKING DRILL & TOOL, INC.
Petitioner

v.

HONGJIA WANG
Patent Owner

Case IPR2023-00473
U.S. Patent No. 11,007,583
Issued: May 18, 2021

**DECLARATION OF STEVEN R. SCHMID, PH.D., IN SUPPORT OF
PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO.
11,007,583**

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I, Dr. Steven R. Schmid of Charlotte, North Carolina, declare that:

I. INTRODUCTION

1. I have been retained on behalf of Petitioner Viking Drill & Tool, Inc. (“Petitioner”) as an independent expert consultant. I am not and have never been an employee of the Petitioner or any affiliated companies.

2. As part of this engagement, I have been asked to provide my opinions regarding the subject matter claimed in U.S. Patent 11,007,583 (“’583 patent”) (Ex-1001)¹, including specifically the scope and content of the prior art relating to the subject matter of the ’583 patent and what the prior art would disclose and/or teach and suggest to a person of ordinary skill in the art (“POSA”) at the time of the purported invention. My opinions are set forth below.

3. I am being compensated for my time actually spent studying this matter and preparing this declaration. I am being compensated at my usual hourly rate of \$400 per hour. I am being separately reimbursed for any out-of-pocket expenses. I am not receiving any other compensation.

4. My compensation does not depend in any way on the outcome of this case or the particular testimony or opinions I express. I have personal knowledge

¹ In this Declaration, I refer to exhibits I understand will be attached to the petition for *inter partes* review of the ’583 patent (the “Petition”).

of the facts stated in this declaration, and I could and would competently testify to them if called upon to do so.

5. In this declaration, I include several figures with annotations to aid in explaining my opinions. I note that these figures are not necessarily intended to imply literal, precise physical or bodily combination or modification in exactly the way shown or annotated. Instead, I provide the figures and accompanying annotations to help illustrate various concepts. They should not be taken as showing the only disclosure of a particular element, or the only way that a person of ordinary skill in the art would have modified or combined the prior art.

II. BACKGROUND AND QUALIFICATIONS

6. I am providing my independent opinions in this Declaration. I have worked in the field of mechanical engineering, in both industry and academia, for over thirty years. All of my opinions are based on my own personal knowledge, experience, and professional judgement from my education and experience in the field of mechanical engineering. I am over 18 years of age and, if I am called upon to do so, I would be competent to testify as to the matters set forth herein.

7. Along with this Declaration, I am providing my curriculum vitae (filed as Ex-1005), which includes a complete list of my qualifications. Below I provide an overview of some of my qualifications and experiences relevant to this matter.

8. I was a Professor of Mechanical Engineering at the University of Notre Dame from 1993 to 2019, and the Belk-Woodward Distinguished Professor of Mechanical Engineering at the University of North Carolina at Charlotte since 2020. My areas of research include manufacturing and machining, as well as tribology. I write the world's most popular manufacturing textbook, Manufacturing Engineering and Technology, currently in its eighth edition. I write the chapter on Machining in the well-known Marks Handbook for Mechanical Engineers, and have a large number of technical papers in the field. From 2012-2013, I served as the first Faculty Fellow at the Advanced Manufacturing National Program Office, where I helped design the Manufacturing USA program. I was a Program Director at the National Science Foundation, where I reorganized the manufacturing research programs into one over-arching Advanced Manufacturing program. I started the Blue Skies initiative at the North American Manufacturing Research Conference, and served as President of NAMRI in 2012. In 2019, I was awarded the Gold Medal from the Society of Manufacturing Engineers for my research in manufacturing processes.

III. MATERIALS THAT I REVIEWED

9. My opinions contained in this Declaration are based on my knowledge and experience gained from my education in the field of mechanical engineering, my experience in the field of machine tool design and engineering in both

academia and industry over the last 30 years, and the specific references, documents, and other materials I discuss in this Declaration.

10. In forming my opinions, I reviewed the following (along with any other materials I discuss in my Declaration):

- U.S. Patent No. 11,007,583 (Ex-1001)
- Prosecution history of U.S. Patent No. 11,007,583 (Ex-1002)
- File history of Re-examination Proceeding No. 90/014,941 (Ex-1003)
- U.S. Patent No. 2,193,186 (“Bannister”) (Ex-1006)
- Chinese Patent App. Pub. No. 103084629 (“Zhou”) (Ex-1007)
- U.S. Patent No. 2,276,532 (“Welty”) (Ex-1008)
- U.S. Patent App. Pub. No. 2018/0133808 (“Wang”) (Ex-1009)
- U.S. Patent No. 8,029,215 (“Gentry”) (Ex-1010)
- U.S. Patent No. 10,058,929 (“Durfee”) (Ex-1011)
- U.S. Patent No. 4,582,458 (“Korb”) (Ex-1012)
- U.S. Patent No. 5,452,971 (“Nevills”) (Ex-1013)
- G.B. Patent No. 2,405,820 (“Sheldon”) (Ex-1014)
- J.P. Patent No. 63,016,912 (“Shibata”) (Ex-1015)
- U.S. Patent No. 38,119 (Ex-1016)

- The Tool and Manufacturing Engineers Handbook, Fourth Edition (1983), Volume I, Chapter 9 (Ex-1017)
- The prosecution history of U.S. Patent Pub. No. 2018/0133808 (Ex-1018)
- PCT Pub. No. WO 2017136966 (PCT Application PCT/CN2016/073767) (Ex-1019)
- Patent Owner's and Petitioner's Joint Claim Construction Statement October 24, 2022 in Civil Action No. 21-cv-02759 (Ex-1021)
- Patent Owner's Supplemental Infringement Contentions of July 8, 2022 in Civil Action No. 21-cv-02759 (Ex-1022)
- Viking Drill & Tool Product Catalog published in 2014 (Ex-1023)
- Matco Tools, Hyper-Step Drill Bits brochure published in 2018 (Ex-1024)
- Aerospace Industries Association, National Aerospace Standard 907 published in 1997 (Ex-1025)

11. All of the papers and publications I reviewed in forming my opinions for my Declaration are materials that experts in my field would have knowledge of and would reasonably rely on in forming certain opinions set forth in my

Declaration. In addition, all of the papers and publications were widely available to a person of ordinary skill in the art (“POSA,” discussed further below) at least as of the time of the filing of the ’583 patent. Based on my experience, people in my field at the time of the alleged invention ordinarily and customarily relied on published papers and textbooks including those listed above, and ordinarily and customarily relied on such publications as having been published as of the publication date listed in the document. I am not aware of any facts or circumstances that call into question the authenticity of any of the above materials or the accuracy of their publication dates.

12. I formed my opinions discussed in this Declaration by placing myself in the position of a POSA back in November 28, 2019 (an easy task, as I have been at or above the level of ordinary skill for at least 30 years).

IV. LEVEL OF ORDINARY SKILL IN THE ART

13. I understand that, in the context of an invalidity analysis, a POSA is a hypothetical person who would be aware of the prior art at the time of the invention. I further understand that the factors that may be considered in determining the level of ordinary skill include: (1) the problems encountered in the art; (2) the prior art solutions to the problems encountered in the art; (3) the rapidity of innovation; (4) the sophistication of the technology; and (5) the education level of active workers in the field. I understand that these factors need

not all be considered for the analysis and that one or more of these factors may control.

14. At the time of the alleged inventions, a POSA would be an individual educated in mechanical engineering with a bachelor's degree and one or two years of experience in the development of drill bits, or an associate's degree and at least five years of experience in the development of drill bits. A POSA would typically work in a team with machinists and would be aware of developments in the field of machine tools, particularly drill bits, for example by attending trade shows, being contacted by tooling suppliers, purchasing consumables for their company, and by reading patents and trade journals.

15. I have been asked to provide my opinion on the level of one of ordinary skill in the art assuming that the invention date is the filing date of the continuation-in-part application no. 16/699,089, i.e. November 28, 2019. Based on my consideration of the factors above, I believe that the same definition applies, and my opinions expressed herein would not change if a date earlier in time, such as February 14, 2016, was selected as the applicable date.

16. As of November 2019 (or February 2016), I met the qualifications of a person having ordinary skill in the art.

17. All my opinions in this declaration are from the perspective of one of ordinary skill in the art as I have defined it here during the relevant timeframe.

V. RELEVANT LEGAL STANDARDS

18. I am not an attorney and I do not offer any legal opinions in this Declaration. However, in the course of my work in the industry and academia, and in the course of being involved as a co-inventor on patents, as well as having consulted as an expert in patent cases, I have had experience studying and analyzing patents and patent claims from the perspective of a POSA.

19. For the purposes of this declaration, I have been informed about certain aspects of the law that are relevant to forming my opinions. I summarize my understanding of the law below.

A. Claim Construction

20. I am informed that claim construction starts with the plain language of the claims as understood by a person having ordinary skill in the art at the time the patent was filed. I understand that patent claims are to be interpreted in light of a patent's specification and prosecution history.

21. I am informed that while claims are interpreted in light of the specification, it is improper to read limitations into the claims from the specification. I also understand that a patent may be its own lexicographer, so long as the definition of a specific term is clearly set forth in the specification and it is clear the inventor intended to define the term.

22. I am informed that claims must be interpreted the same for

infringement and validity, and that a patentee may not seek to interpret its claims broadly for the purpose of infringement and then seek to save the claims from invalidity by construing them more narrowly.

B. Anticipation

23. I understand that a claim is invalid as anticipated if a single prior art reference discloses each and every limitation of the claimed invention.

24. I understand that a reference may be anticipatory regardless of whether the prior art and the claimed invention are directed to achieving the same purpose, if it contains the claim elements as claimed and would inherently provide any claimed function.

25. I understand that a prior art reference may anticipate a claim without expressly disclosing a feature of the claimed invention if that missing feature is necessarily present, or inherent, in the single anticipating reference.

26. I understand that inherency requires more than a probability or possibility that a claimed feature is present in the prior art, but rather that the feature or characteristic is a necessary part of the prior art. I also understand that a POSA does not necessarily need to recognize the inherency at the time of purported invention.

C. Obviousness

27. I understand that obviousness is determined based on (1) the scope

and content of the prior art; (2) the differences between the claims and the prior art; (3) the level of ordinary skill in the art; and (4) any objective indicia of nonobviousness.

28. I understand that there must be a reason to modify a single prior art reference, or to combine multiple references, to achieve the claimed invention. I understand that this motivation may come from a teaching, suggestion, or motivation to combine. I also understand that a specific teaching, suggestion, or motivation is not required.

29. I also understand that objective indicators of non-obviousness (sometimes referred to as “secondary considerations”) must be considered in evaluating obviousness when present, including commercial success of the claimed invention, whether others copied the invention, a long-felt but unmet need in a particular industry and whether others in the field praised the invention. I understand that in order to support a finding of nonobviousness, the evidence of secondary considerations must be sufficiently tied to the patented features.

30. I understand that, after consideration of all of these factors, a patent is obvious if the difference between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

D. Priority Date and Written Description

31. I understand that patents can claim priority to an earlier-filed patent application, e.g., as a “continuation” or “continuation-in-part.” In that circumstance, the claims of the patent can have a priority date (also called an “effective filing date”) of that earlier-filed patent application if the earlier-filed patent application supports the subject matter of the claims. I further understand that the subject matter of the claims is supported by the earlier-filed application if that application provides a written description for the claimed subject matter.

32. I understand that the priority date analysis is done on a claim-by-claim analysis. I further understand that in order for a patent claim to be entitled to the benefit of the earlier filing date, the entire claim must be supported by the earlier application; if even a single limitation of a claim does not have adequate written description in an earlier application, then the claim is not entitled to the filing date of that earlier application.

33. I understand that to provide a written description for claimed subject matter, an earlier-filed application must make a sufficient description to demonstrate that the inventor had possession of the full scope of the claimed invention at the time the earlier-filed application was filed. Making this determination entails an objective inquiry into the disclosure of the earlier-filed application from the perspective of a POSA, taking into consideration the existing

knowledge in the particular field and the maturity of the science or technology.

34. I understand that an ambiguous disclosure does not provide written description support for a claim element, and that a POSA must be able to recognize that the inventor was in possession of the claimed invention with reasonable clarity. I also understand that even if a vague description might render a claim element obvious, it is not sufficient to provide written description support for that element.

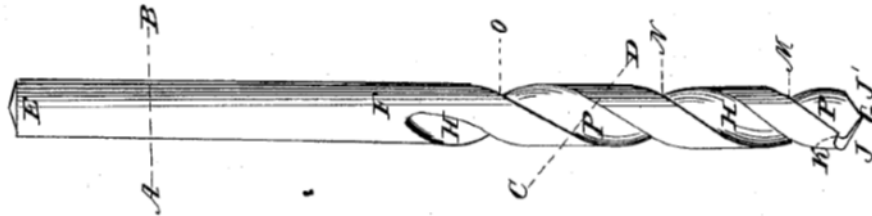
VI. BACKGROUND OF THE TECHNOLOGY

35. In this section, I provide some background on technology as understood by November 2019, or even as of February 14, 2016. I focus the discussion on relevant features of cutting tools, specifically drills, that were known at the time.

A. Twist Drills

36. Machining is a general term used to describe the removal of material from a workpiece and covers a variety of processes. One of the most common processes is drilling, which is the process of forming or enlarging holes in workpieces using a cutting tool. *See* Ex-1017, 9-1. In the drilling process the cutting tool that is used is a drill, sometimes also called a drill bit. Drills are rotary end-cutting tools having one or more cutting lips, and one or more helical or straight flutes for the passage of chips and the admission of a cutting fluid. *Id.*

37. The most common drills are helically fluted twist drills with various shanks and tip geometries. *Id.* They are designed to produce holes rapidly and economically. *Id.* Below is a figure from U.S. Patent 38,119 that issued in 1863. Ex-1016.



38. The above-depicted drill is a “straight shank” twist drill that has a cylindrical shank which is of the same diameter as the body of the drill.

39. A useful resource for understanding drilling technology is the Tool & Manufacturing Engineers Handbook published by the Society of Manufacturing Engineers. In this Background section, I cite extensively from Chapter 9 of the Handbook. Ex-1017. The Handbook is a well-known and widely-relied-on document that was and is available in hardcopy, and now electronic, form in university libraries. Based on my experience, I recall people in my field at the time of the alleged invention ordinarily and customarily relied on this Handbook.

40. Below is an illustration from the Handbook depicting some of the nomenclature used to describe the parts of a twist drill. This figure has also been reproduced in my manufacturing textbooks:

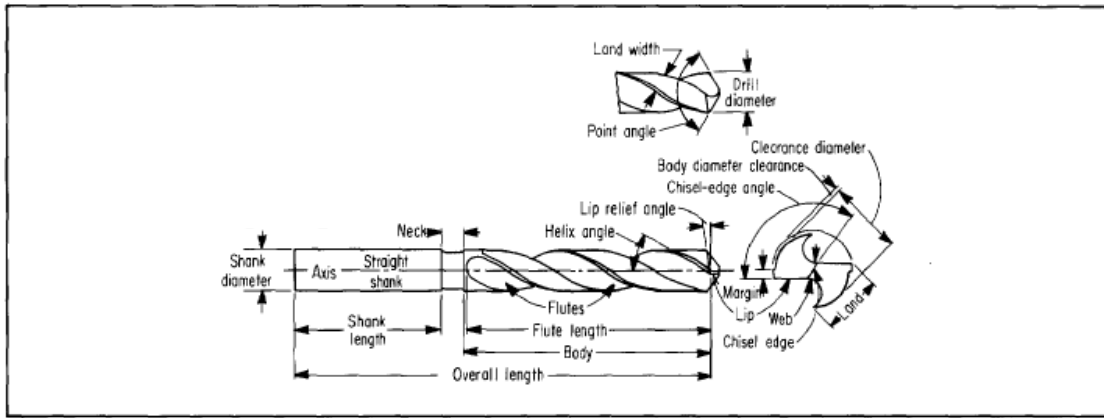
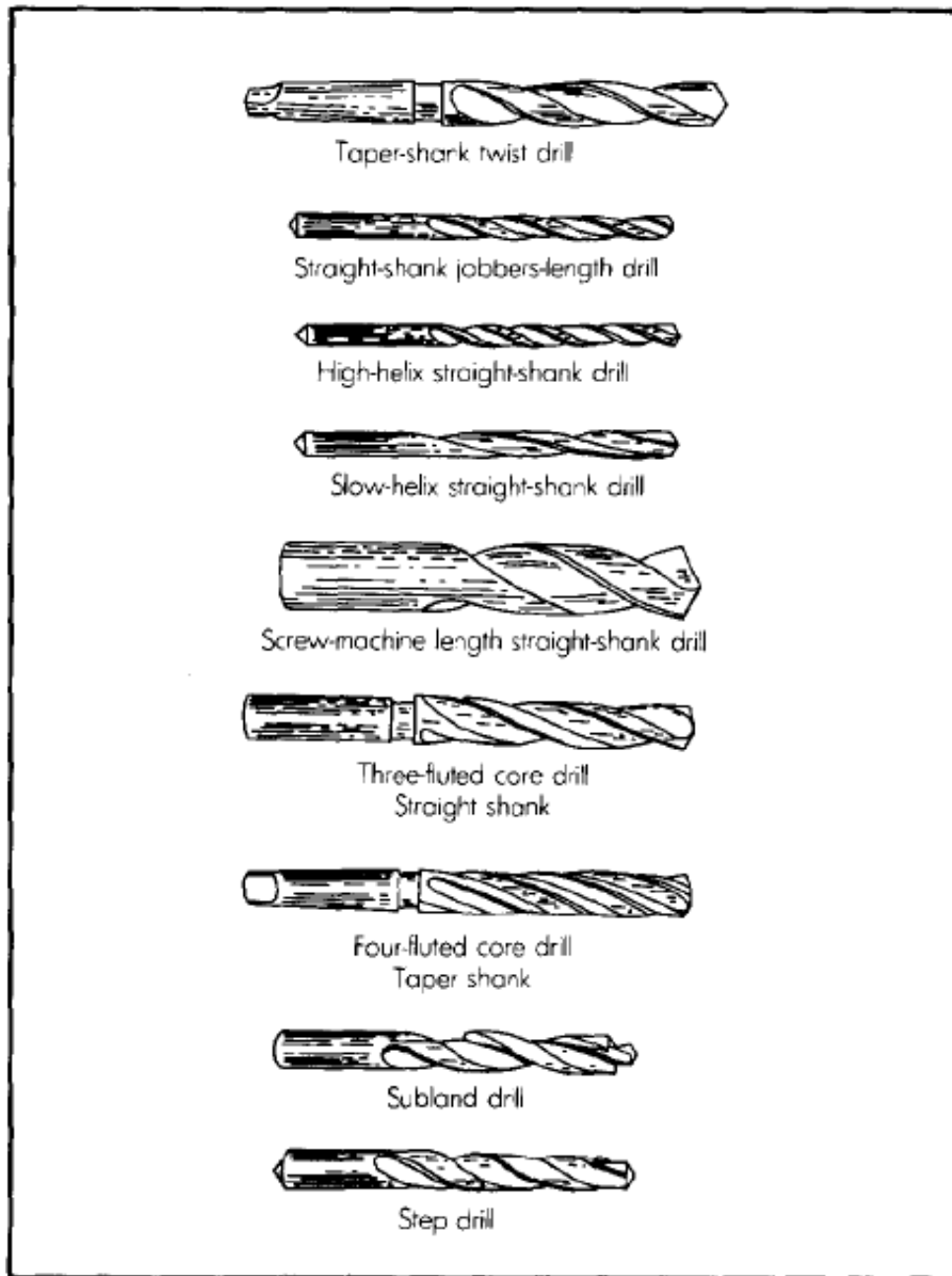


Fig. 9-15 Standard terms used to describe elements of twist drills.

41. The drill axis is an imaginary straight line which forms the longitudinal center line of the drill. Ex-1017, 9-14. The twist drill has a “body,” which is the portion of the drill extending from the shank or neck to the outer corners of the cutting lips, and a “shank,” which is the part of the drill by which it is held and driven. *Id.* The body is provided with one of more “flutes” which are grooves cut or formed in the body of the drill to provide cutting lips, to permit removal of chips, and to allow cutting fluid to reach the cutting lips. *Id.* The cutting end of the drill is known as the “point” and is made up of the ends of the lands, the web, and the lips. In form, the point resembles a cone, but it departs from a true cone to furnish clearance behind the cutting lips. *Id.*

42. Twist drills can be used on solid materials including metal, light metal, wood, plastic, ceramic and masonry workpieces, composites, living or dead tissue, ice, and composite materials. They are classified based on the kinds of shank, number of flutes, hand of cut, length, diameter, and point geometry. Ex-

1017, 9-14. Some known types of twist drills in the art are provided below –



Ex-1017, 9-16. Still further variations on twist drills can be found in the catalog of various drill manufacturers and distributors. Ex-1023 is a 2014 catalog distributed

by Petitioner, which shows other example designs. A POSA would be familiar with all of the drill types shown above and more.

43. Step drills are a type of twist drill that have two or more (often many more) portions of different diameters ground into the lands of the drill. Ex-1017, 9-17. Normally, step drills have two flutes, although it is possible to have more flutes. The diameters or steps are separated from each other by angular cutting edges that are typically conical in shape. Step drills are often manufactured by grinding down and stepping conventional drills. *Id.* They can be used to drill holes to very close tolerances, because the steps tend to center the drill even if the pilot hole created a larger or slightly off-center hole, as shown in the illustration below from the Handbook:

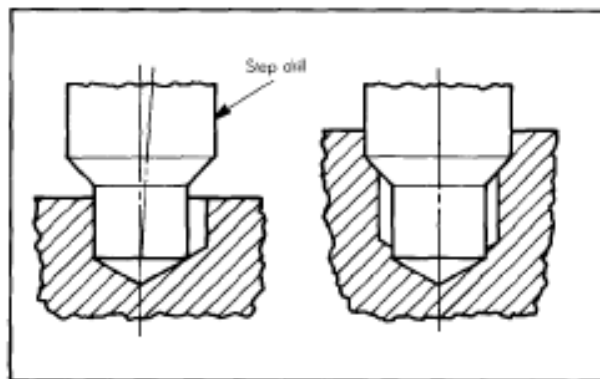
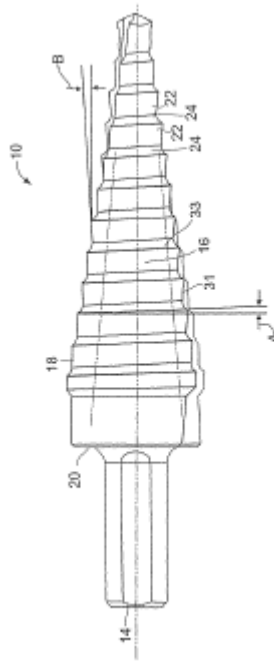


Fig. 9-18 When the smaller diameter pilot of a step drill enters a hole, it may drill oversize (left). When a larger diameter drill body enters the hole, it centers the pilot and produces a hole to close tolerance.

Id., 9-38.

44. Some step drills, like the one shown in the Handbook, have only one or two steps and so appear very similar to a traditional twist drill.

45. Other step drills have a larger number of steps and appear more conical. An example of that is shown in the Gentry patent (Ex-1010):



46. While step drills of this type are typically used to drill through-holes of controlled diameter in thinner work pieces, that certainly is not their only application. They can, and often are used to produce blind or through holes in thicker workpieces. A video showing an example of this from 2019 can be found at the following link: <https://www.youtube.com/watch?v=CED-uTq8TI0>.

47. A wide variety of drill point geometries and types are known. Examples of more tradition point designs are shown in the following illustration from the Handbook:

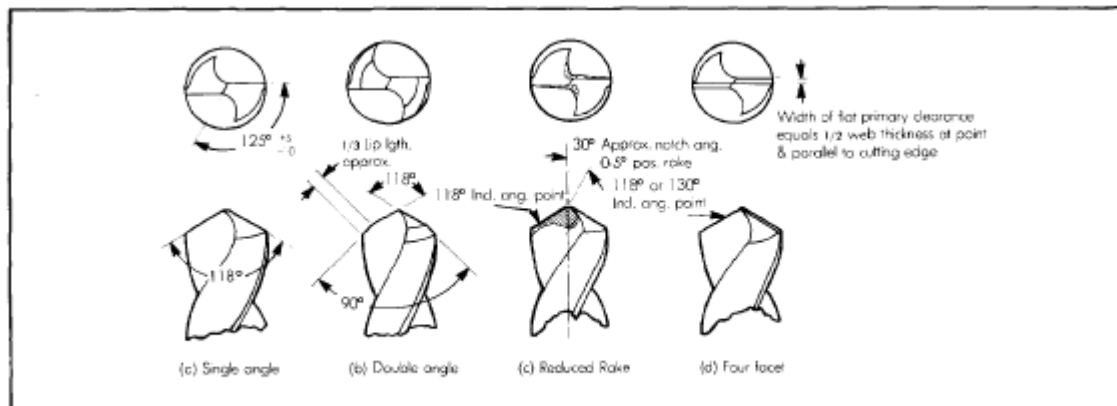


Fig. 9-25 Four types of drill point geometries used for different applications. (Cleveland Twist Drill Co.)

48. Another well-known point design is the split point tip. Below is an illustration from the Handbook showing the geometry of a typical split point tip:

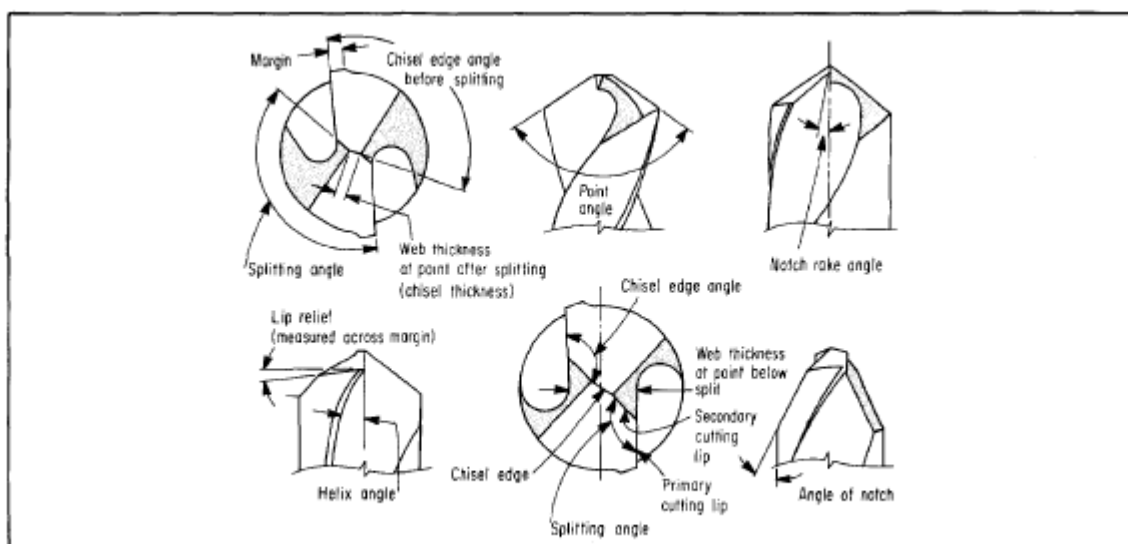


Fig. 9-26 Geometry of split-point twist drill.

49. In a typical split point tip, the cutting lips are separated by a chisel edge, and two secondary cutting lips are formed on either side of the chisel edge. Split point tips are generally recognized as providing the advantages of easier drilling (reduced drilling force) and improved centering.

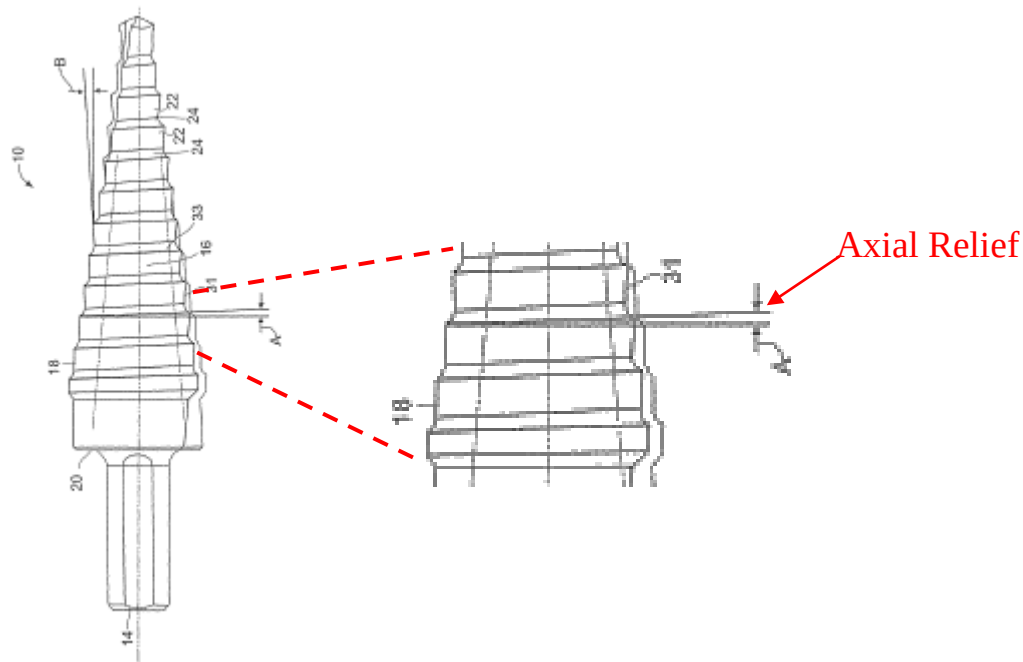
B. Relief

50. All drills employ various types of what is known as “relief.” Relief refers to the geometry of tool material behind or adjacent to a cutting edge to provide clearance and prevent rubbing. This is an important and well-known aspect of drill bit design because without relief, or with inadequate relief, a drill will not cut freely, leading to increased forces and reduced hole quality.

51. Relief is provided on different portions of a drill bit and each relief is known in the art based on the geometry of the relief. For example, “axial relief” is defined in the Handbook as “relief measured in the axial direction between a plane perpendicular to the axis and the relieved surface.” Ex-1017, 9-110. It can be measured by the amount of indicator drop at a given radius in a given amount of angular rotation. *Id.*

52. Axial relief at the tip of a drill is also called “lip relief.” The illustrations from the Handbook reproduced above in paragraphs 47 and 48 both illustrate such lip relief.

53. Axial relief is also routinely employed for each of the steps in a step drill. An example of this can be seen in the Gentry patent, which illustrates the axial relief in Figure 1:

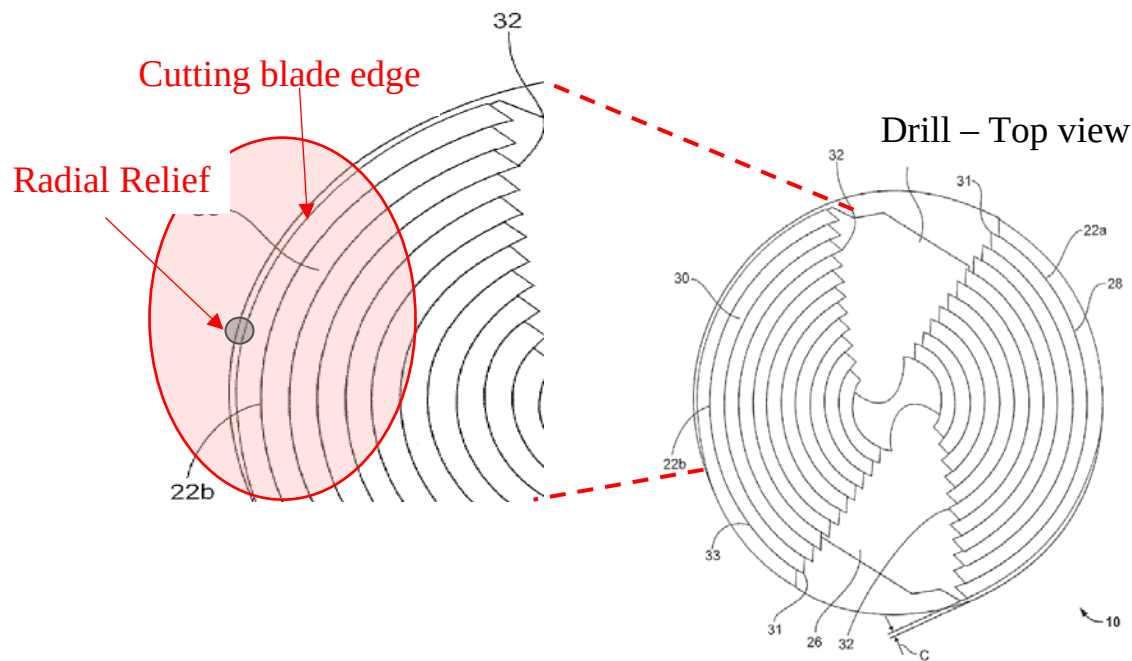


Ex-1010, Figure 1.

54. As stated in the Handbook, the amount of axial relief depends on a number of factors, including drill diameter, cutting edge strength, and the material to be drilled. Ex-1017, 9-43. Higher relief angles generally provide better results with light feeds and low-strength materials (like wood). With heavy feeds, as well as harder workpiece materials, reduced relief angles provide cutting edges with additional support to withstand the higher cutting loads. *Id.* For axial relief at the cutting tip (lip relief), suggested relief angles vary from 6°-29°. *Id.*, 9-43. For axial relief on the steps of a step drill, suggested axial relief angles are 1° or greater. Ex-1010, 1:60-63.

55. Another type of routinely-employed relief is “radial relief.” As the name implies, radial relief is “relief in a radial direction measured in the plane of

rotation.” Radial relief can generally be seen from a top view of the drill, as shown, for example, in this annotated illustration from the Gentry patent:



Ex-1010, Figure 2 (red annotations added). Radial relief is often measured by the amount of indicator drop at a given radius in a given amount of angular rotation.

Ex-1017, 9-110.

56. Relief angles are sometimes not illustrated in patents or other publications relating to drills. However, whether shown or not, it would be obvious to a POSA that appropriate reliefs should be added to prevent rubbing and provide clearance for chip formation.

VII. THE '583 PATENT

A. Claims of the '583 Patent Considered

57. I have been asked to form an opinion regarding claims 1, 2, 5, 7, 8,

12-15, 18, 19 and 22 of the '583 patent.

B. Summary of the '583 Patent

58. The '583 patent relates to “twist drills.” Ex-1001, Abstract. Figure 1 shows a prior art twist drill:



FIG. 1A (Prior Art)

59. The twist drill of the '583 patent is alleged to differ from traditional twist drills in that a plurality of steps are added to the cutting end of the drill. Below is Figure 3 of the '583 patent, which shows the steps (called “composite cutting blade groups”) formed at the cutting end of the drill:

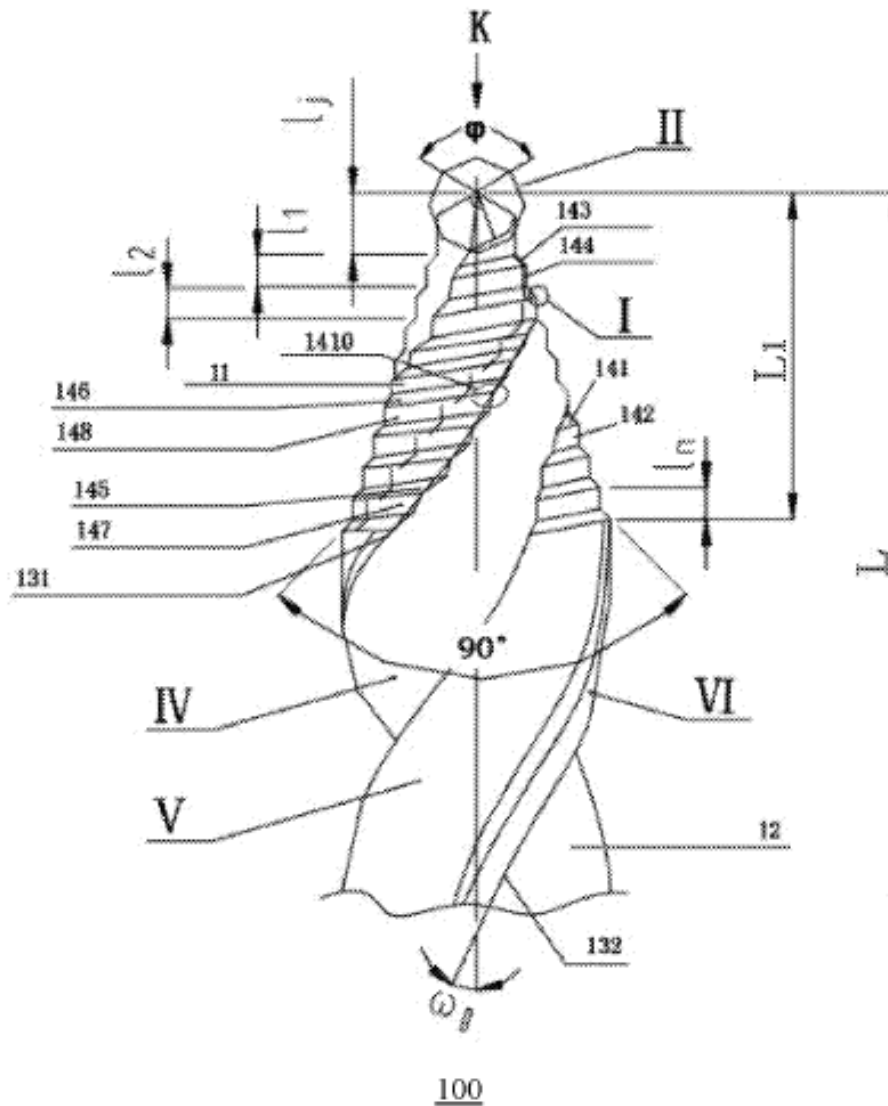


FIG. 3

60. According to the '583 patent, the steps provide improved positioning and allow for reduced cutting force during drilling. Ex-1001, 3:41-45, 8:17-20.

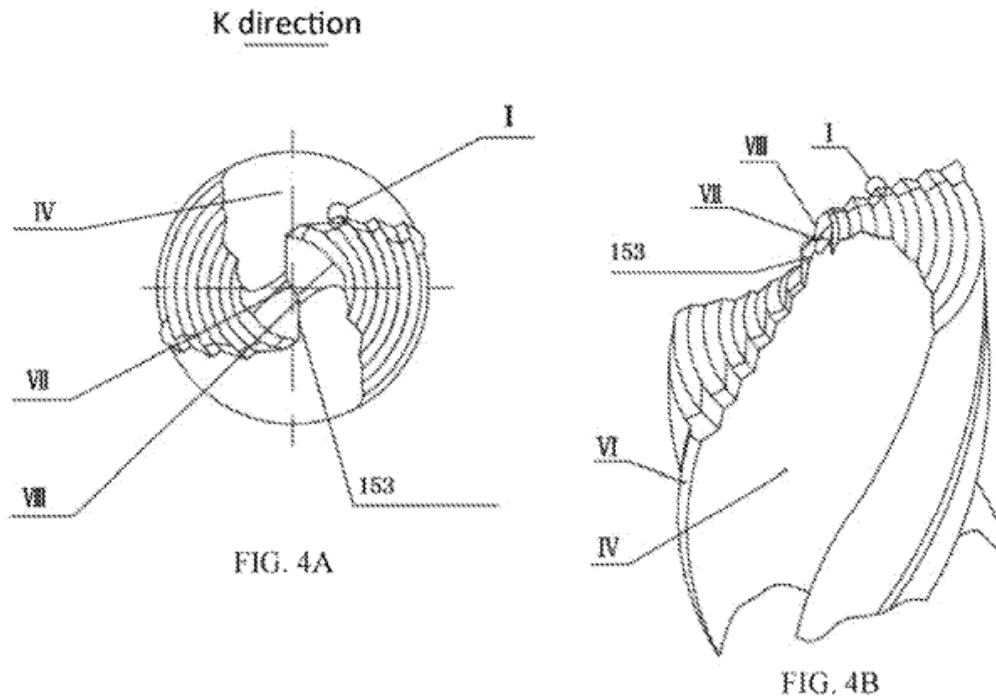
61. With reference to Figure 3 above, each composite cutting blade group is described as being formed on a “cone portion” of the drill and being made up of a first step surface 141 and a second step surface 142. Ex-1001, 5:3-4. The edge where the first step surface intersects the side wall of the flute is the major cutting

edge 143, and the edge where the second step surface intersects the side wall of the flute is the minor cutting edge 144. *Id.*, 5:18-29. The major and minor cutting edges intersect in a cutting tip. *Id.* The major cutting edge 143 is described as having a flank relief surface 145 and a back portion 146, with “a surface on which the back portion 146 of the major cutting edge is located [being] approximately regarded as a conical surface.” *Id.*, 5:39-61. The minor cutting edge 144 is described as having a flank surface 147 and a back portion 148, with “a surface on which the back portion 148 of the minor cutting edge is located [being] approximately regarded as a cylindrical surface.” *Id.*²

² The terminology of the '583 patent is extremely confusing and inconsistent. For example, the patent starts by suggesting that the major and minor cutting edges are simply the cutting edge formed where the first and second step surfaces meet the flute, but then goes on to state that those edges also include flank and back surfaces behind the cutting edges. *Compare* Ex-1001, 5:18-29 with *id.*, 5:39-46. As another example, the patent appears to use the terms “composite cutting blade group” and “composite blade group” to refer to different structures, but also sometimes seems to refer to the terms interchangeably. *See* Ex-1001, 4:66-5:5, 5:46-55, 5:66-6:13. I believe that a POSA would have a very difficult time understanding the specification of the '583 patent.

62. The cone portion of the drill also has a top blade. *Id.*, 5:5-8.

Referring to Figures 4A and 4B, the '583 patent states that the top blade has a chisel edge that includes a chisel edge VII, two straight major cutting edges 153, and two auxiliary cutting edges VIII.



Id. A POSA would understand that the '583 patent is describing a typical split point drill tip.

C. Prosecution History of the '583 Patent

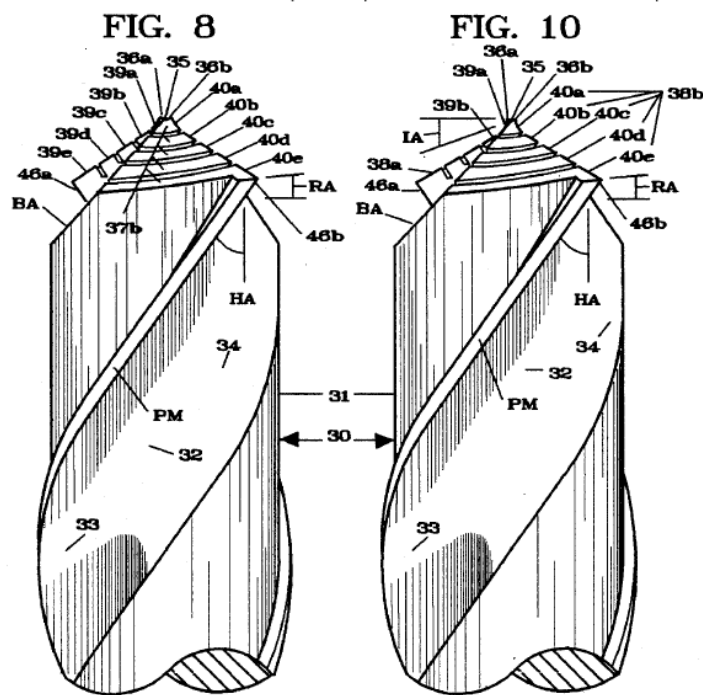
1. The Original Examination

63. I have reviewed the prosecution of the application that issued as the '583 patent.

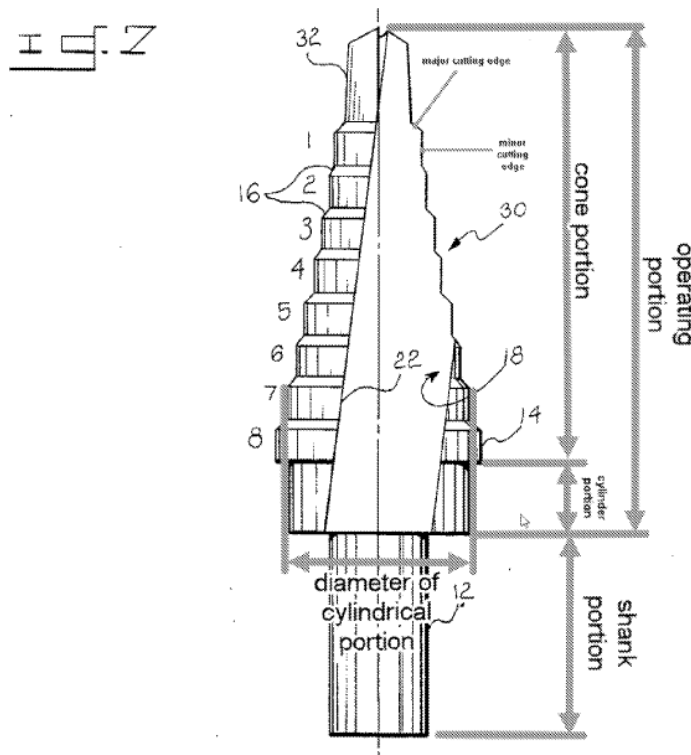
64. The claims as originally filed were very different from the claims that

ultimately issued. Those originally-filed claims were rejected in view of the prior art and thereafter were cancelled and replaced with new claims that were more similar to the claims as issued, but the independent claims still lacked the final paragraph of the claims as issued.

65. These new claims were rejected in another Office Action, with the independent claims being rejected as anticipated by both U.S. Patent No. 5,452,971 (“Nevills,” Ex-1013) and U.S. Patent No. 4,582,458 (“Korb,” Ex-1012). Ex-1002, 239-254. Nevills discloses a spiral-fluted twist drill with grooves formed into the tip:



Korb shows a step drill, which the Examiner annotated as follows:



Ex-1002, 245 (annotations in original).

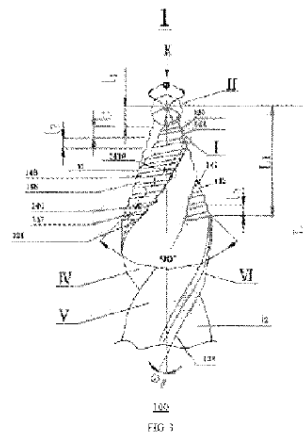
66. In response to this rejection, Patent Owner amended the independent claims to add the requirement: “wherein at least one cylindrical second step surface is immediately adjacent to a conical first step surface of a next composite cutting blade group; and the diameter of the last composite cutting blade group located at the rear end of the cone portion immediately adjacent to the cylinder portion is equal to the cylinder portion diameter.” Ex-1002, 299-302. The claims were subsequently allowed. Ex-1002, 331-35.

2. The *Ex Parte* Reexamination

67. I understand that shortly after issuance of the '583 patent, an unrelated third-party filed an *ex parte* reexamination request (“the Request”) of the patent. I

understand that in an *ex parte* reexamination the requesting party is not permitted to participate in the reexamination after submitting the request.

69. Patent Owner relied on the requirement for “spirally formed” composite cutting blade groups to overcome these rejections. In doing so, Patent Owner first attempted to explain where in the specification the requirement for spirally formed cutting blade groups is taught. Patent Owner did not identify any text of the specification as teaching this feature. Instead, Patent Owner pointed solely to Figure 3:



70. With respect to Sheldon, Patent Owner directed the Examiner's attention to Figures 2A and 2B to support its argument that Sheldon's cutting blade groups are "formed perpendicularly (orthogonally)," not "spirally":

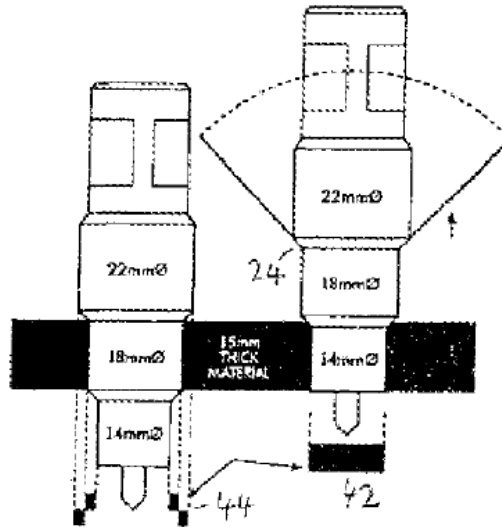
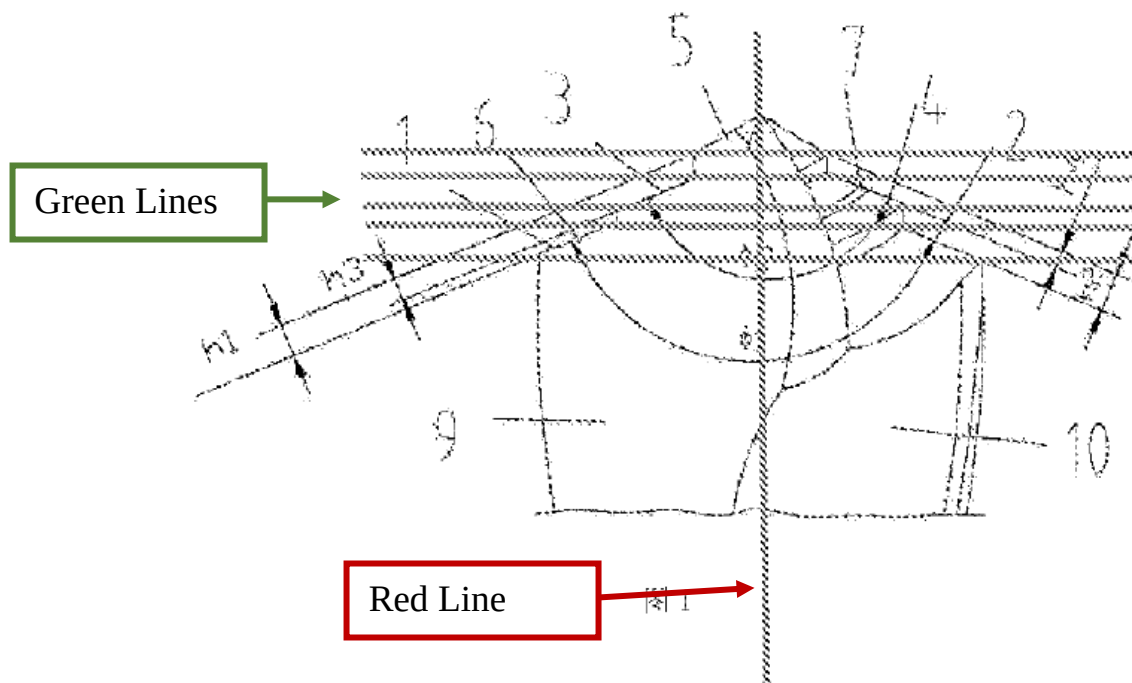


FIG. 2A

Id.; see also *id.*, 511 (Sheldon’s drilling surfaces “do not spiral, but rather are perpendicular or orthogonal with respect to the center line axis of rotation of the drill”).

71. Patent Owner distinguished Zhou on the same basis, arguing that “Zhou, like Sheldon, discloses conical surfaces whose inner and outer edges are perpendicular or orthogonal to the center line axis of rotation.” *Id.*, 513. In doing so, Patent Owner provided an annotated Figure purporting to show a vertical red line corresponding to the drill axis and horizontal green lines connecting

corresponding “landmarks” (such as “the shoulder formed by the inner edge of a given conical surface, its outer edge, the top edge of any cylindrical surface, or its bottom edge”) on either side of the drill axis:



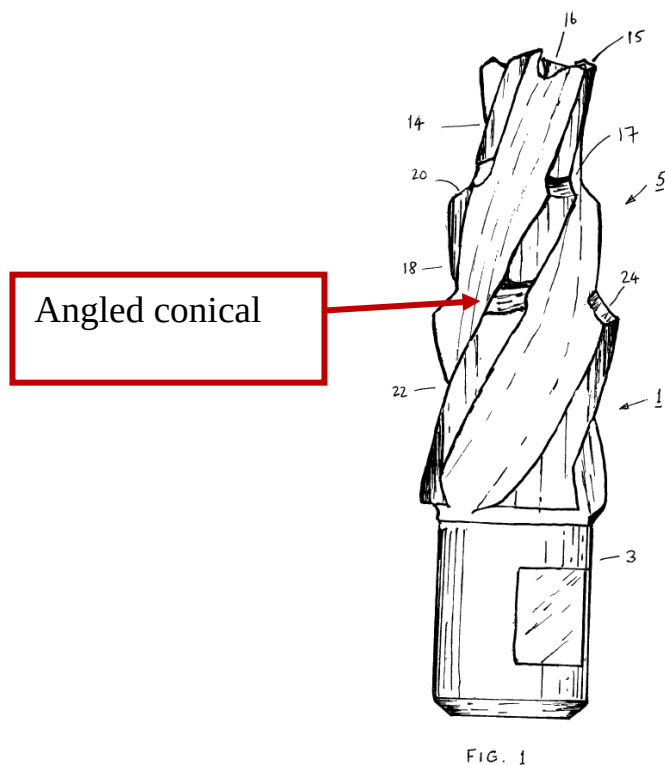
Id. (colored annotations added).³ According to Patent Owner, the red axis line intersects each of the green landmark lines “perpendicularly.” *Id.*

72. The Examiner accepted Patent Owner’s representations. In his Statement of Reasons for Patentability and/or Confirmation, the Examiner stated “[s]pecifically, the examiner concurs that neither Sheldon nor Zhou shows

³ I understand that Petitioner has been unable to obtain a colored version of this illustration from either the prosecution history or from Patent Owner.

specifics of the blade group being formed spirally on the cone portion exterior from the front to the rear of the cone portion.” Ex-1003, 526.

73. The Patent Owner’s description of both Sheldon and Zhou was inaccurate. With respect to Sheldon, the figures to which Patent Owner directed the Examiner’s attention actually show the profile that the drill forms in the workpiece, rather than the profile of the drill itself. Ex-1003, 510. The actual drill is shown in Figure 1. That Figure shows that the conical portions are not “perpendicular” or “orthogonal” to the axis of the drill, as stated by Patent Owner, but rather are oblique to them:



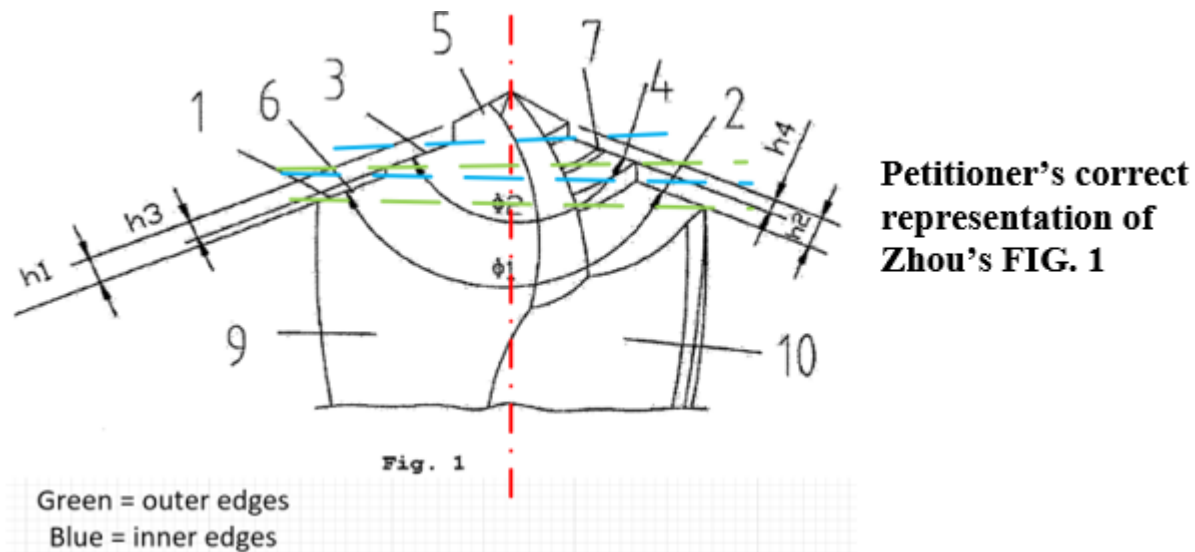
74. Ex-1014, Figure 1. Sheldon also expressly teaches that the conical portions are not perpendicular to the axis, stating that the conical portions (which

Sheldon calls “inclined steps”) are “ground so as to rise slightly in the circumferential direction, following the fluting.” *Id.*, p.3:3-5. I understand that in the district court litigation that Patent Owner filed against Petitioner (hereinafter “the Litigation”), Patent Owner has admitted that Sheldon “clearly disclosed a relief angle” in Figure 1.

75. With respect to Zhou, Patent Owner’s claim that the “landmarks” on either side of the center axis are perpendicular relative to the center axis was not accurate. Indeed, the stated novelty of Zhou’s drill is premised on the fact that corresponding landmarks on opposite sides of the axis are **not** perpendicular relative to the axis of the drill but are, instead, offset from one another. As discussed further below, the stated novelty of Zhou’s drill is that the cutting edges have “asymmetrical edge heights.” Ex-1007, ¶[0014]. Referring to Figure 1, Zhou explains that cutting edges on one side of the drill axis have heights h_1 and h_3 relative to the central cutting blade, while the cutting edges on the other side of the drill axis have heights h_2 and h_4 . *Id.*, ¶[0024]. Edge height h_3 on one side of the central axis is greater than edge height h_4 on the other side, while edge height h_1 is less than edge height h_2 . *Id.*

76. As a result of these asymmetric edge heights, lines connecting landmarks on opposing sides of the drill axis would **not** be perpendicular to the drill axis as asserted by Patent Owner during reexamination, but rather would be

angled as shown in the following corrected re-creation of the illustration Patent Owner submitted during reexamination:



As can be seen, the “landmarks” on either side of the drill axis are **not** at the same height. Moreover, Zhou states that the cutting edges have a “back angle” of 6° - 18°. *Id.*, ¶[0008]. As discussed further, below, a POSA would understand that “back angle” refers to axial relief of the conical surface.

VIII. OVERVIEW OF OPINIONS FORMED

77. Based on my review of the prior art discussed herein, it is my opinion that at least claims 1, 2, 5, 7, 8, 12-15, 18, 19 and 22 of the '583 patent are invalid in view of the prior art. In particular, it is my opinion that:

- At least claims 1, 2, 5, 7, 8, 12-15, 18, 19 and 22 would have been obvious based on Wang in view of any of Gentry, Durfee, or Zhou, and/or the knowledge of a POSA

- At least claims 1, 2, 5, 7, 8, 12, 14, 15, and 19 would have been obvious based on Bannister in view of Zhou or Welty, and/or the knowledge of a POSA; and
- At least claims 13, 18, and 22 would have been obvious based on Bannister in view of Zhou or Welty, and/or the knowledge of a POSA, and further in view of Korb.

IX. CLAIM CONSTRUCTION

78. I have reviewed the '583 patent, including the specification and claims. I have also reviewed (a) the prosecution history of Application Serial No. 16,699,089 (Ex-1002), which issued as the '583 patent; and (b) the prosecution history of Application Serial No. 90/014,941 (Ex-1003), which involved the *ex parte* reexamination of the '583 patent.

79. I have also reviewed Patent Owner's infringement contentions (Ex-1022) in the Litigation asserting that Petitioner's Vortex drill bits infringe the '583 patent, as well as the parties' Joint Claim Construction Statement ("JCCS," Ex-1021) submitted by the parties in the Litigation.

80. For all claim terms not discussed below, I have given the terms their plain and ordinary meaning to one of skill in the art at the time of the invention.

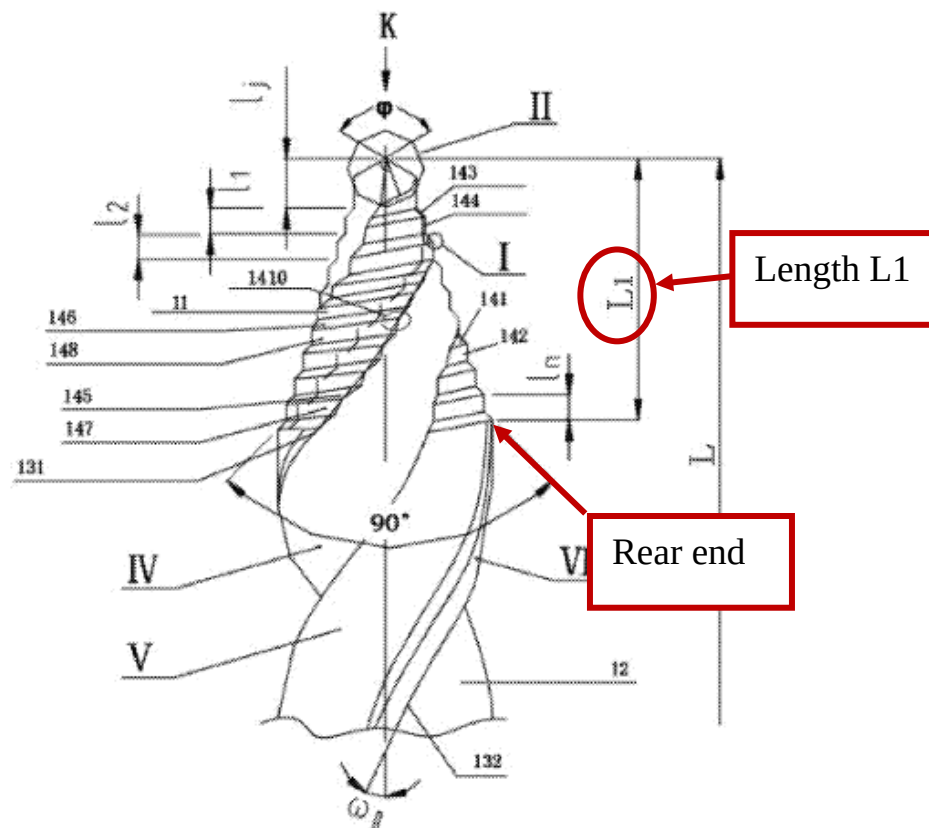
A. "rear end of the cone portion" (Claims 1 and 8)

81. Independent claims 1 and 8 require a plurality of composite cutting

blade groups formed “on a cone portion exterior from a front end of the cone portion to a rear end of the cone portion.”

82. In the Litigation, the parties agreed to construe “rear end of the cone portion” as follows: “the end of the cone portion terminating where the drill stops increasing in diameter and becomes cylindrical.”

83. This construction is consistent with the specification. For example, Figure 3 shows the Length L1 of the cone portion as follows:

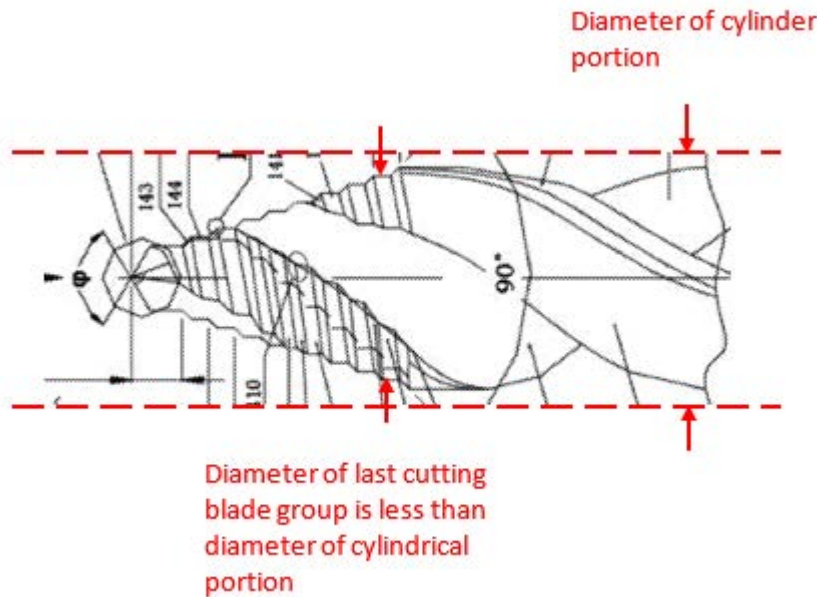


100
FIG. 3

Ex-1001, 7:21-26 (annotations added). As can be seen, the lower line delimiting Length L1 corresponds precisely to the point where the drill stops increasing in diameter and becomes cylindrical.

84. In addition to requiring that the cutting blade groups be formed “on [the] cone portion,” the independent claims also require that “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.” The latter limitation was added during prosecution of the ’583 patent. Ex-1002, 299-302.

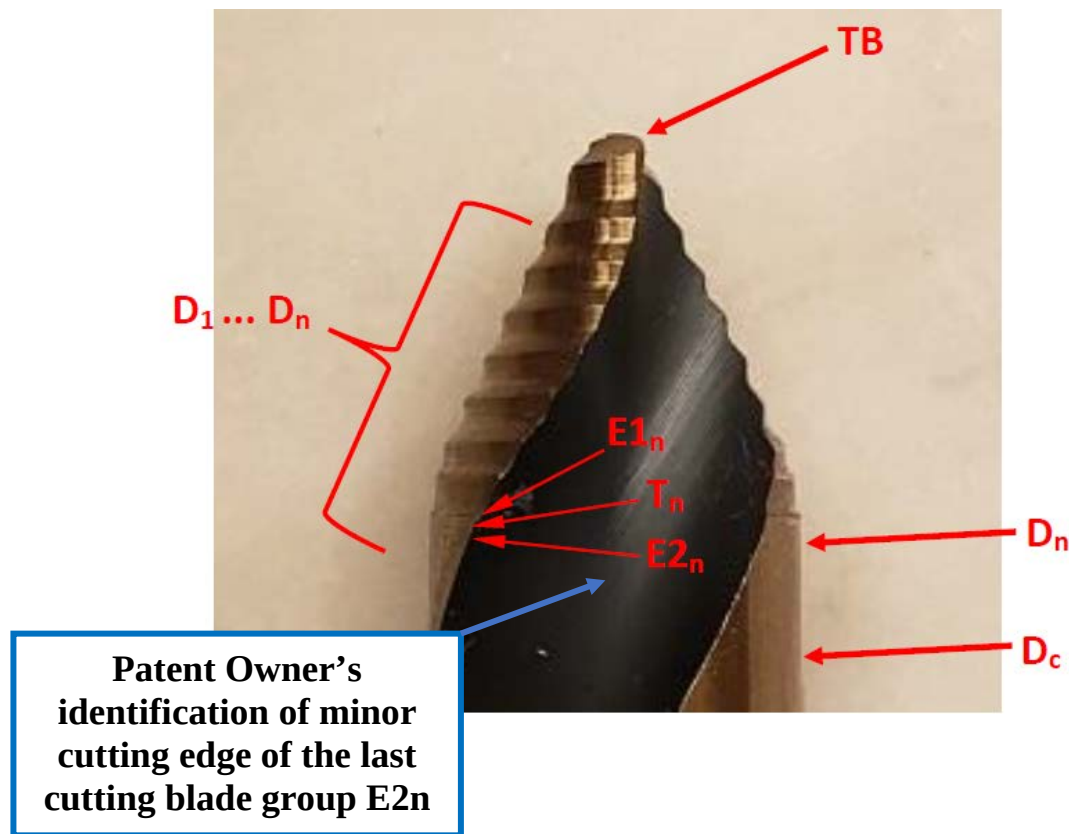
85. The ’583 patent does not disclose any drills that meet both of these claim limitations. In all of the drills disclosed in the ’583 patent, the diameter of the “last” composite cutting blade group (i.e., the one located on the cone portion nearest its rear end) has a diameter that is less than the diameter of the cylindrical portion. This can be seen, for example, in the following annotated representation of Figure 3 of the ’583 Patent:



Ex-1001, Figure 3 (annotations added).⁴

86. Below is an illustration from Patent Owner’s infringement contentions in the Litigation:

⁴ Note that each “composite cutting blade group” is necessarily made up of a conical first step surface that is located above (i.e., closer to the drill tip than) the adjacent cylindrical second step surface. Not only is this shown and described in the specification, it is mandated by the requirement in the claims that the composite cutting blade groups have a “cutting tip” defined by the intersection of the major cutting edge (defined by the intersection of the conical first step surface and the sidewall of the flute) and the minor cutting edge (defined by the intersection of the cylindrical second step surface and the sidewall of the flute).



Ex-1022 (red annotations in original; blue annotation added). As can be seen, Patent Owner's annotations for $E2_n$ (the minor cutting edge of the last cutting blade group) and for D_n (the diameter of the last cutting blade group) point to the cylindrical portion of the drill, not the cone portion. *Id.* This is inconsistent with the requirement that the composite cutting blade groups be formed "on [the] cone portion," which, according to the agreed construction, ends at the location where the drill stops increasing in diameter and becomes cylindrical.

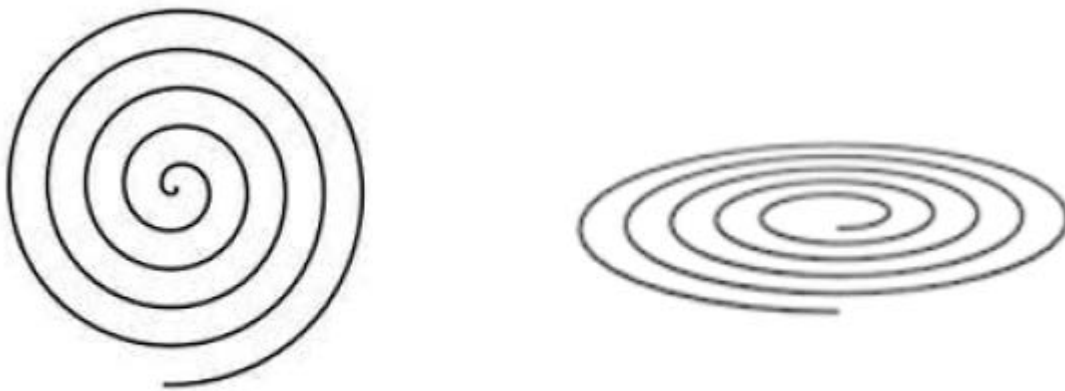
87. Nonetheless, for the purpose of this IPR, I have construed "rear end of the cone portion" consistent with Patent Owner's infringement contentions as permitting an arbitrary length of the adjacent cylindrical portion to be included as

part of the cone portion.

B. Composite Cutting Blade Groups Formed “spirally” on a Cone Portion Exterior (Claims 1 and 8)

88. Independent claims 1 and 8 require a plurality of composite cutting blade groups “formed sequentially and spirally” on a cone portion exterior.

89. In the litigation, Patent Owner has proposed the following construction for “spiral”: “circling around a central axis and gradually receding from it.” Ex-1021, 3. That construction appears to be based on, or at least encompass, one meaning of “spiral” that refers to a two-dimensional shape:

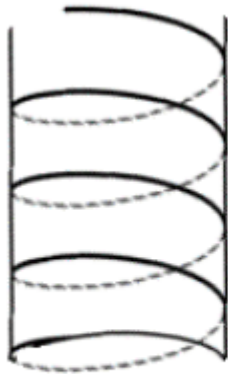


Two dimensional “spiral”

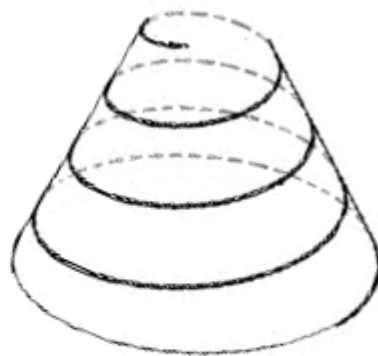
That meaning does not make any sense in the context of the ’583 patent, which does not disclose or describe any structures that would constitute a two-dimensional spiral. Moreover, as discussed below, the specification uses “spiral” to refer to structures that do not “gradually recede from [a central axis].”

90. The term “spiral” may alternatively be used to describe a three-

dimensional structure that is also called a “helix.” Such a helical structure can be at a constant or varying distance from a center axis:



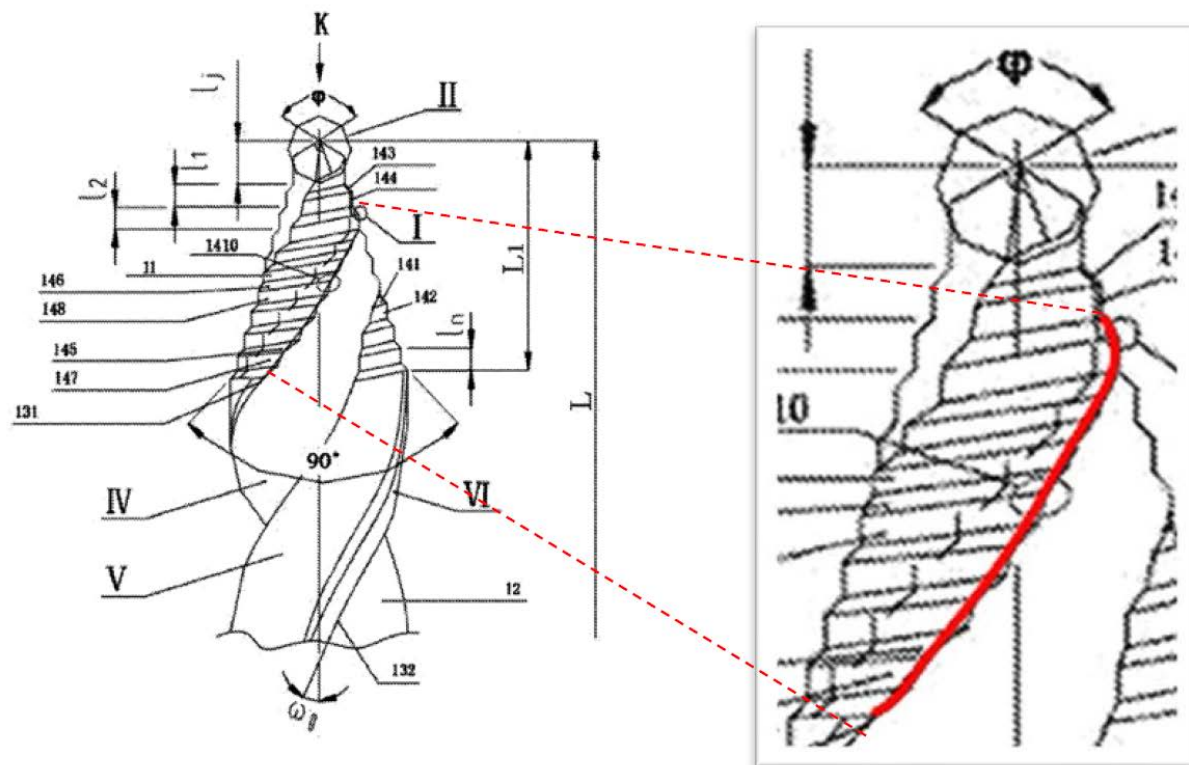
Spiral along constant diameter



Spiral along varying diameter

91. The specification of the '583 patent uses the words “spiral” and “spirally” consistent with this alternative meaning to describe two structures that are in the shape of a helix (albeit neither of which are the composite cutting blade groups). One, there are numerous references in the specification to a “spiral flute.” *E.g.*, Ex-1001, 1:48-55. The spiral flute is identified in the figures as element IV:

6:10-13 (the composite cutting blade groups “conically and spirally extend along the rake face”). The “spiral line” is labeled as element 131 in Figure, and again refers to a helical line around the circumference of the drill, as shown in the annotated and expanded representation of Figure 3 of the '583 Patent provided below:



Ex-1001, Figure 3 (annotations added).

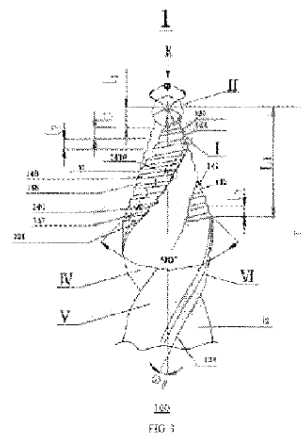
93. The spiral flutes are recited in both independent claims 1 and 8. Ex-1001, 10:7-10; 11:1-4. The feature of cutting tips formed along a spiral line is recited in claims 18 and 22 that were added during reexamination.

94. The specification of the '583 patent does not state that the composite

cutting blade groups are “spirally formed” on the surface of the cone portion, nor does the specification explain what it means for the composite cutting blade groups to be “spirally formed” on the surface of the cone portion.

95. In the *ex parte* reexamination of the '583 patent, Patent Owner pointed solely to Figure 3 to explain what was meant by composite cutting blade groups formed “spirally”:

That is, according to this language in Claim 1, each conical surface and adjacent cylindrical surface is formed spirally on the exterior of the cone portion of the twist drill. This is shown in Figure 3 of Wang, in which the composite cutting blade groups are comprised of conical first step surfaces **141** and cylindrical second step surfaces **142**, which are depicted as spiraling downward from the front end of the cone portion **L₁** to the rear end of the cone portion, as recited in Claim 1.



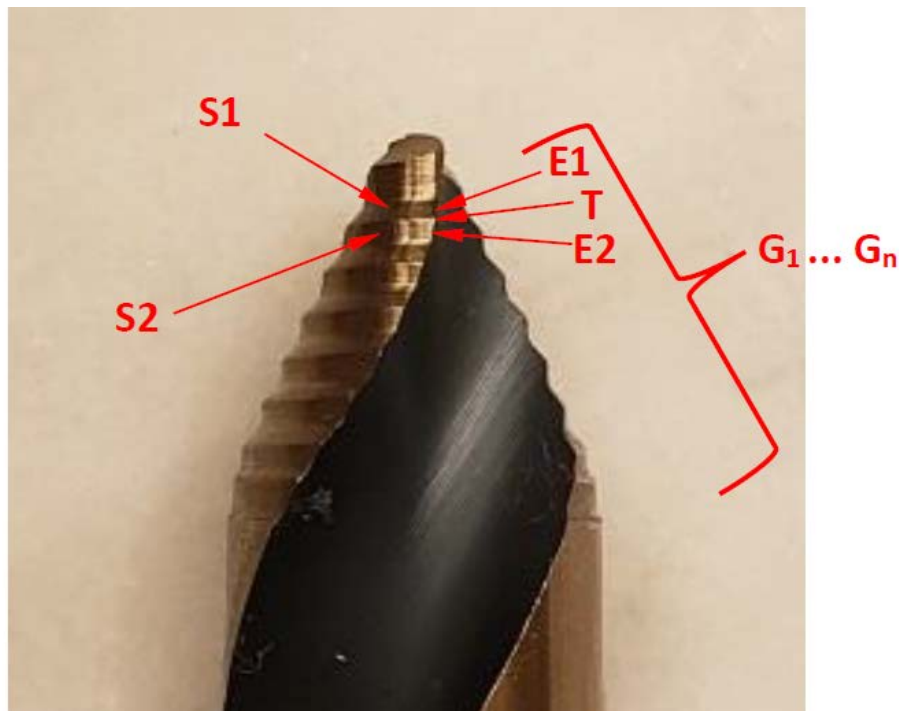
Ex-1003, 510. Patent Owner did not identify any text of the specification as teaching this feature.

96. As discussed above, Patent Owner then distinguished both Sheldon and Zhou by pointing to side views of those references and explaining that the cutting blade groups in those references are oriented “perpendicularly” or “orthogonally” to the longitudinal axis of the drill, not “spirally” as claimed. *See supra* Section VII.C.2. While Patent Owner’s descriptions of both Sheldon and Zhou were incorrect, the Examiner nonetheless accepted Patent Owner’s

representations that Sheldon and Zhou’s cutting blade groups are perpendicular or orthogonal to the drill axis, not “spiral” as claimed, and withdrew the rejections.

Id.

97. In the Litigation, Patent Owner provided the following annotated picture as allegedly showing “spirally formed” cutting blade groups in Petitioner’s accused products:

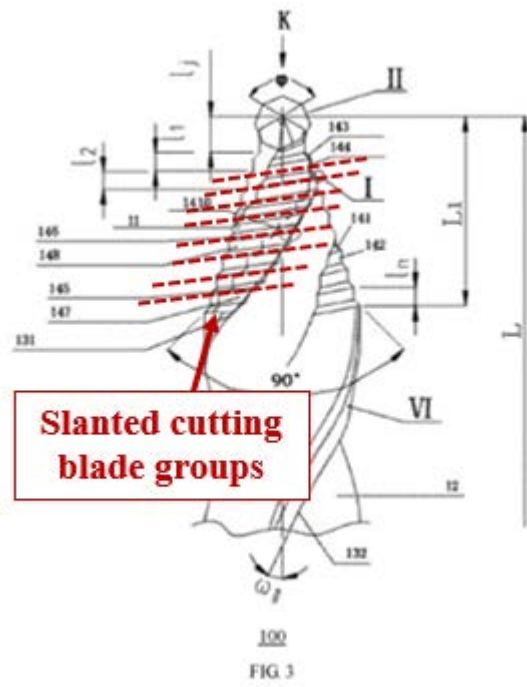


Ex-1022 (annotations in original). The text accompanying this annotated picture states: “[Patent Owner] contends that [the cutting blade groups] are formed ‘spirally’ in that they are more slanted than any conventional step drill and, as a result, are not conducive to being used as a step drill.” I understand that, based on conversations between counsel in the Litigation, Patent Owner’s reference to

“slant” refers to the fact that the conical portions have axial relief (i.e., they angle slightly downward away from the cutting surface in order to prevent rubbing along the flank surface of the conical portions).

98. Patent Owner’s assertion that the accused products are “more slanted than any conventional step drill” is not correct. Step drills come in a variety of shapes, sizes and configurations, and there is no such thing as a “conventional” step drill. Moreover, the amount of axial relief varies widely among step drills and, indeed, relief is a fundamental machining parameter that is changed with all tools and can be material specific.

99. For the purpose of my analysis herein, based on Patent Owner’s infringement contentions as well as their arguments in the reexamination, I interpret the requirement for “spirally formed” composite cutting blade groups to mean that the cutting blade groups are “slanted,” i.e., not perpendicular to the center line axis of the drill when viewed from the side, as shown below in Figure 3:



Ex-1004, Figure 3 (annotation added). I also interpret this term as encompassing “slant” resulting from axial relief of the conical portions of the cutting blade groups.

C. “configured to crush cutting chips into finer chips” (Claims 1 and 8)

100. In the Litigation, Patent Owner has taken the position that the claimed function of “crush[ing] cutting chips into finer chips” means creating cutting chips that are smaller than they would be if the drill did not have composite cutting blade groups. Ex-1021. Patent Owner has further taken the position that this function is the inherent result of having a plurality of composite cutting blade groups, such that any product that has the claimed composite cutting blade groups is inherently “configured to crush cutting chips into finer chips.” *Id.*; see also Ex-1022, 9-10.

For the purpose of my analysis herein, I adopt Patent Owner’s construction of this claim limitation.

D. “wherein, the operation portion is configured to disperse a cutting force on each of the plurality of composite cutting blade groups within a drill hole of a workpiece when at least a portion of the cylinder portion is also within the workpiece” (Claim 14)

101. In the Litigation, Patent Owner has taken the position that the claimed function of “dispers[ing] a cutting force on each of the plurality of composite cutting blade groups within a drill hole of a workpiece when at least a portion of the cylinder portion is also within the workpiece” means that the plurality of major cutting edges and cutting tips each work a region of a workpiece at the same time such that the cutting force is dispersed among them all. Ex-1021, 4-5. Patent Owner has further taken the position that this function is the inherent result of having a cylinder portion having a diameter equal to that of the cylindrical second step surface of the last composite cutting blade group, and a spiral flute running at least partway up the cylinder portion for drilling deep into a relatively thick workpiece, such that any product that has the claimed composite cutting blade groups is inherently “configured to disperse a cutting force on each of the plurality of composite cutting blade groups.” *Id.* For the purpose of my analysis herein, I adopt Patent Owner’s construction of this claim limitation.

X. THE EFFECTIVE FILING DATE OF THE '583 PATENT IS NOVEMBER 28, 2019

102. The '583 patent claims priority to an earlier-filed application.

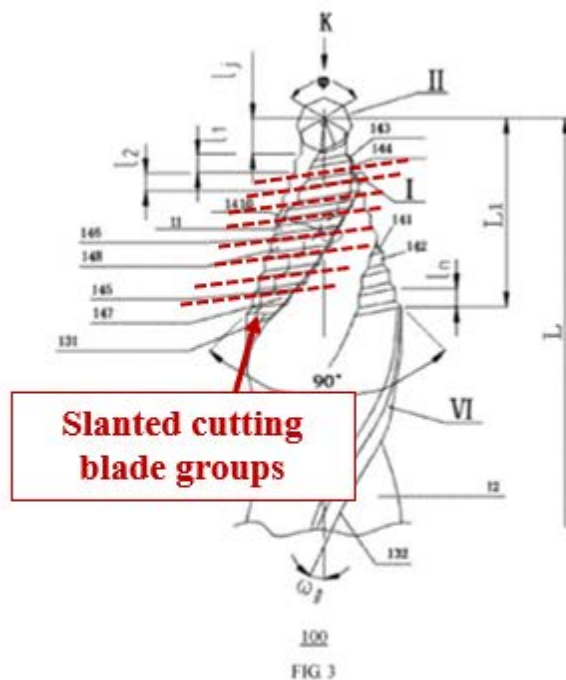
Specifically, the '583 patent states that it is a continuation-in-part application of U.S. Application No. 15/847,900, which was filed on December 19, 2017 (“the '900 application,” Ex-1009), and also to PCT Application PCT/CN2016/073767 filed on February 14, 2016 (“the '767 application,” Ex-1019). I understand that “continuation-in-part” is used to describe a patent application that includes subject matter from an earlier application but also includes new subject matter.

103. In my opinion, the claims of the '583 patent are not entitled to the filing date of these applications because neither the '900 application nor the '767 application provides written description support for the claim element that the composite cutting blade groups are formed “spirally” on the cone portion exterior, as claimed in claims 1 and 8 of the '583 patent. Therefore, the effective filing date of the '583 patent claims is November 28, 2019, the filing date of the '089 application.

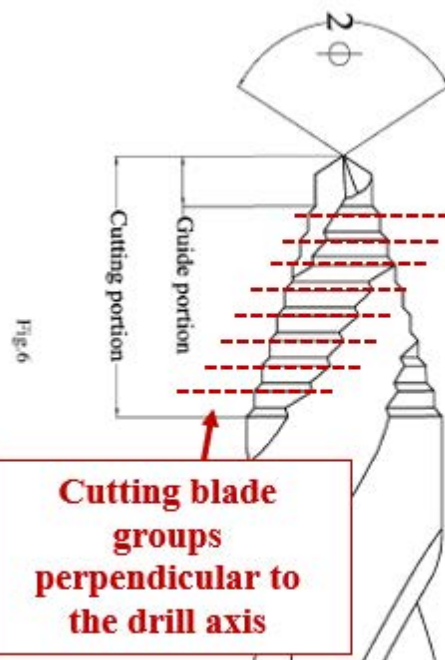
104. The disclosures of the '900 and '767 applications appear to be substantially identical. *Compare* Ex-1009 with Ex-1019. Therefore, in my discussion below, I will only discuss and cite only the '900 application; however, that discussion applies equally to the '767 application.

105. In the *ex parte* reexamination associated with the '583 patent, the only

support that Patent Owner pointed to for describing spirally-formed cutting blade groups was Figure 3 of the '583 patent. Ex-1003, 510. Figure 3 was not, however, present in the '900 application. Unlike Figure 3 of the '583 patent, all of the figures of the '900 application shows the cutting blade groups formed perpendicular to the axis of the drill. Ex-1018, Figures 5-6, 8-11. To illustrate this difference, below is a side-by-side comparison of Figure 3 of the '583 patent and Figure 6 of the '900 application:



'583 Patent, Fig. 3



'900 Application, Fig. 6

As can be seen, the cutting blade groups in Figure 3 of the '583 patent are depicted as being distinctly slanted, while the cutting blade groups in Figure 6 of the '900 application are depicted as perpendicular to the longitudinal axis of the drill.

Figure 6 of the '900 application is representative of the disclosure of the '900

application; in other words, the entire disclosure of the '900 application, including all of the figures, is limited to cutting blade groups that are perpendicular to the longitudinal axis rather than slanted.

106. I understand that in the Litigation, Patent Owner relied on the following disclosure in Wang as providing support for the claimed “spirally formed” cutting blade groups, i.e., cutting blade groups that are slanted when viewed from the side:

“Preferably, connecting lines of the flutes form a spiral structure.”

“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.”

Ex-1009, 3:10-6:35.

107. In my opinion, these sentences do not provide written description support for the “composite cutting blade groups formed . . . spirally on a cone portion exterior.” Specifically, these sentences do not reasonably convey to a POSA that the inventor had in his possession the slanted cutting blade groups that were later shown and claimed in the '583 patent. At best, these sentences are ambiguous. The '900 application provides no explanation as to what “connecting

lines of the flutes” refers to.⁵ Moreover, there are at least two reasonable things that “connecting lines” could be referring to that have nothing to do with the cutting blade groups being slanted as shown in Figure 3 of the ’583 patent.

108. A first possible meaning of the “connecting lines of the flutes” could be the lines along the leading edges of the cutting blade groups. This feature of having the connecting lines at the leading edge of the cutting blade groups form a spiral structure is discussed in the “Summary of the Invention” section of the ’583 patent, which explains that “top ends of flute sidewalls of the spiral flute form a plurality of spiral lines” and that “cutting tips of the composite cutting blade groups are distributed on the spiral lines.” Ex-1001, 1:63–2:5.

109. This understanding of “connecting lines” in the ’900 application also makes particular sense because those connecting lines are depicted as forming a “spiral structure” in the figures of the ’900 application, as illustrated below:

⁵ The ’583 patent and the ’900 application use “flute” to describe different structures. The ’900 application uses “flute” to describe the horizontal grooves separating what the ’583 patent calls “composite cutting blade groups.” Ex-1009, ¶[0035]. The ’583 patent uses “spiral flute” to describe the helical grooves disposed along the length of the drill that are used to remove swarf. Ex-1001, 4:62-65.

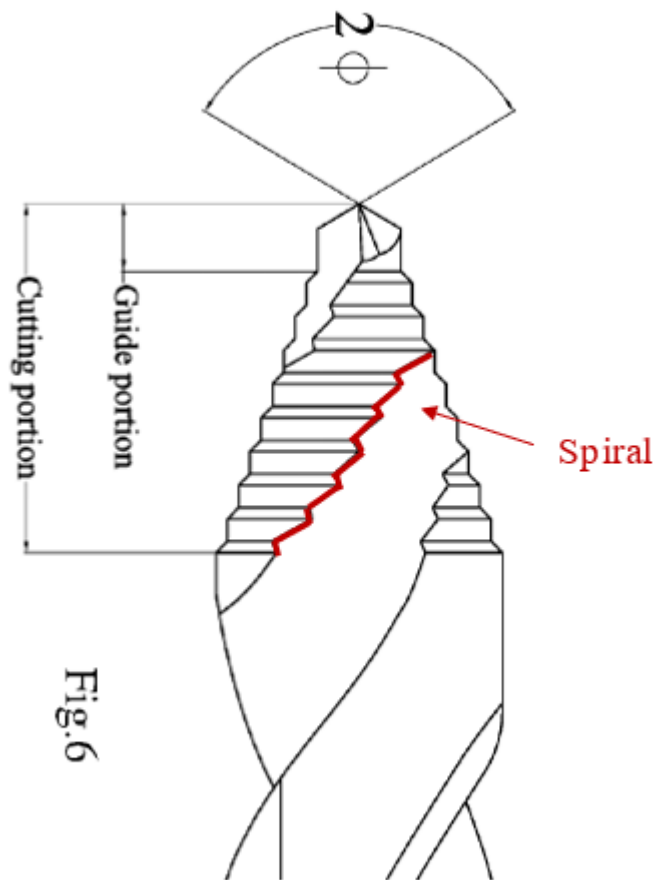


Fig. 6

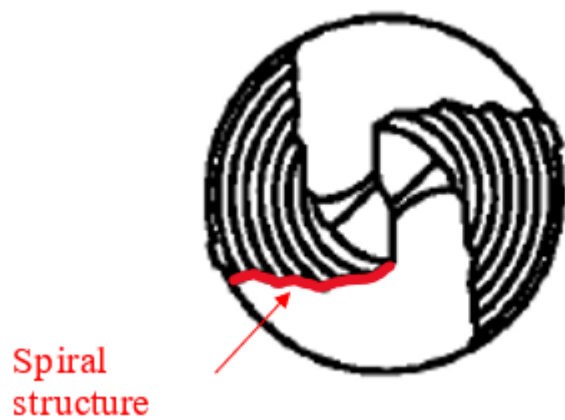


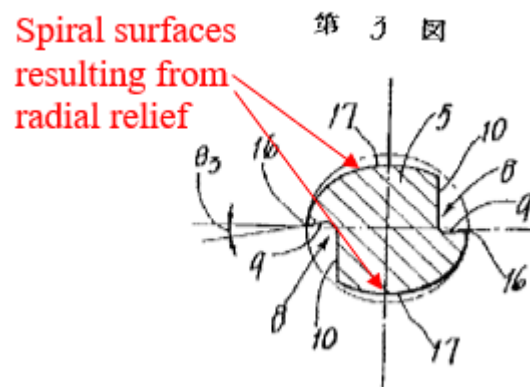
Fig. 7

A POSA trying to decipher what is meant by the ambiguous “connecting lines” sentences would read those sentences in conjunction with the remainder of the specification, including the figures. In doing so, a POSA would conclude that the sentences most likely refer to a feature that is shown in the Figures rather than a

feature that is absent from the figures.

110. A second possible interpretation of “connecting lines of the flutes form a spiral structure” could be that it refers to radial relief along the flank surfaces behind the cutting edges. This is the meaning that was given to this phrase during examination of the ’900 application.

111. Specifically, dependent claim 5 of the '900 application as filed recited this feature, stating: "connecting lines of the flutes form a spiral structure." Ex-1018, 9. In the first Office Action, the Examiner rejected claim 5 as anticipated by Shibata (JP 6301692A), and pointed to Figure 3 of Shibata as showing this feature. Ex-1018, 145-146. Figure 3 of Shibata shows a top sectional view of Shibata's drill:



Ex-1015, Figure 3 (annotations added). As can be seen, the presence of radial relief creates a slight inward spiral when viewed from the top. And in response to the Office Action, the applicant did not dispute that claim 5 read on the radial relief shown in Figure 3 of Shibata. Ex-1018, 201-205.

112. Thus, a POSA reading the '900 application would not conclude that the inventor was in possession of an invention where the cutting blade groups formed “spirally,” i.e., slanted when viewed from the side, as claimed in the independent claims of the '583 patent. Because this feature is recited in both independent claims 1 and 8 of the '583 patent, the effective filing date of all of the claims of the '583 patent is limited to the November 28, 2019 filing date of the '089 application.

XI. OVERVIEW OF THE PRIOR ART

A. Wang: U.S. Patent Application Publication No. 2018/0133808 (Ex-1009)

113. A U.S. Patent Publication No. 2018/0133808 (Wang) is a publication corresponding to the '900 application discussed in the prior section. Wang published on May 17, 2018. This is more than one year before the November 28, 2019 priority date of the '583 patent. Because Wang was published more than 12 months before the effective filing date of the '583 patent, I am informed that it is prior art to the '583 patent.

114. Like the '900 application discussed in the prior section, Wang does not disclose composite cutting blade groups that are formed “spirally” on the cone portion exterior. Other than that feature, however, the drill shown and described in Wang is very similar to that of the '583 patent. Wang describes a twist drill having a cone portion, a cylinder portion, a shank portion, and a spiral flute. *See, e.g.,* Ex-

1009, Figure 5 (annotated by Petitioner), ¶[0031] and ¶¶[0031-39] (generally).

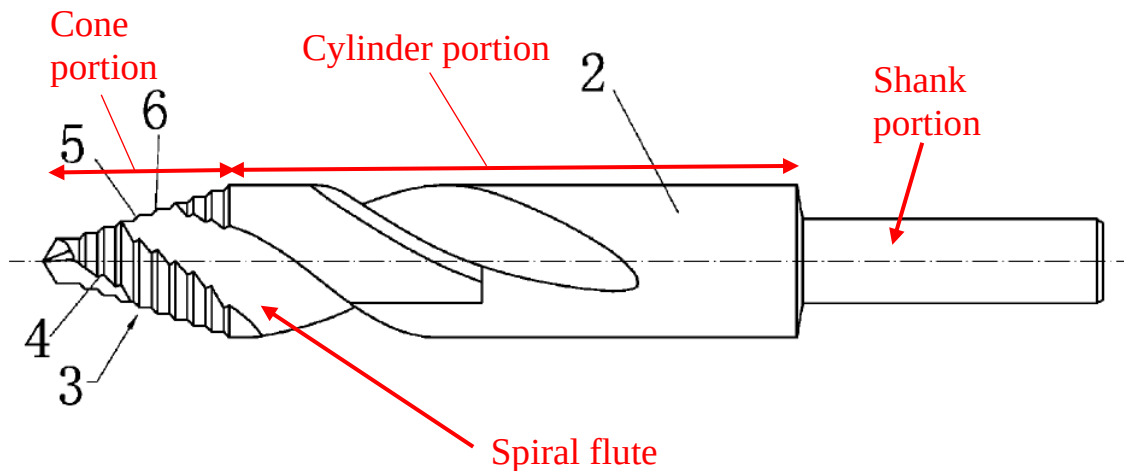
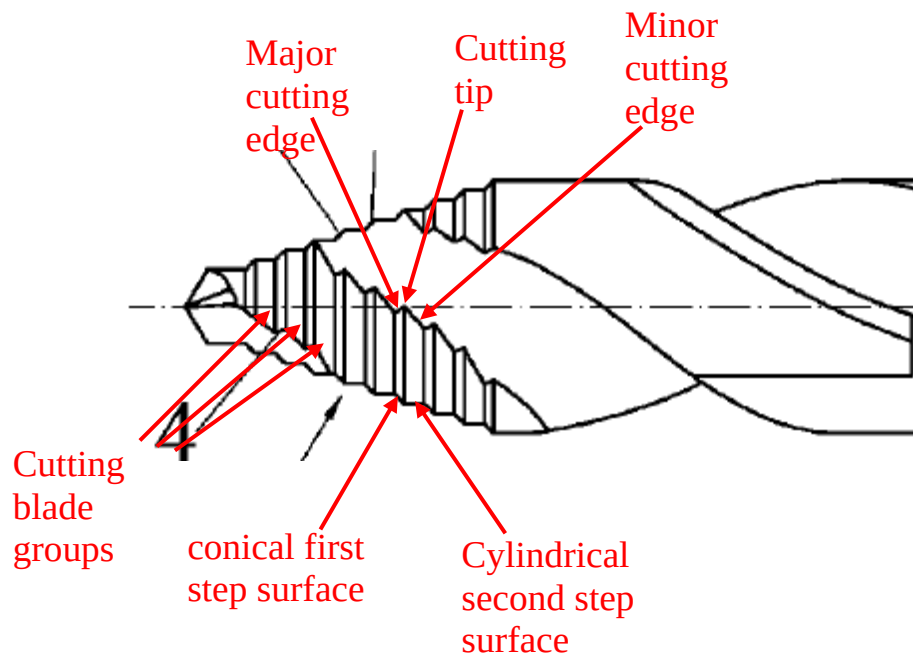
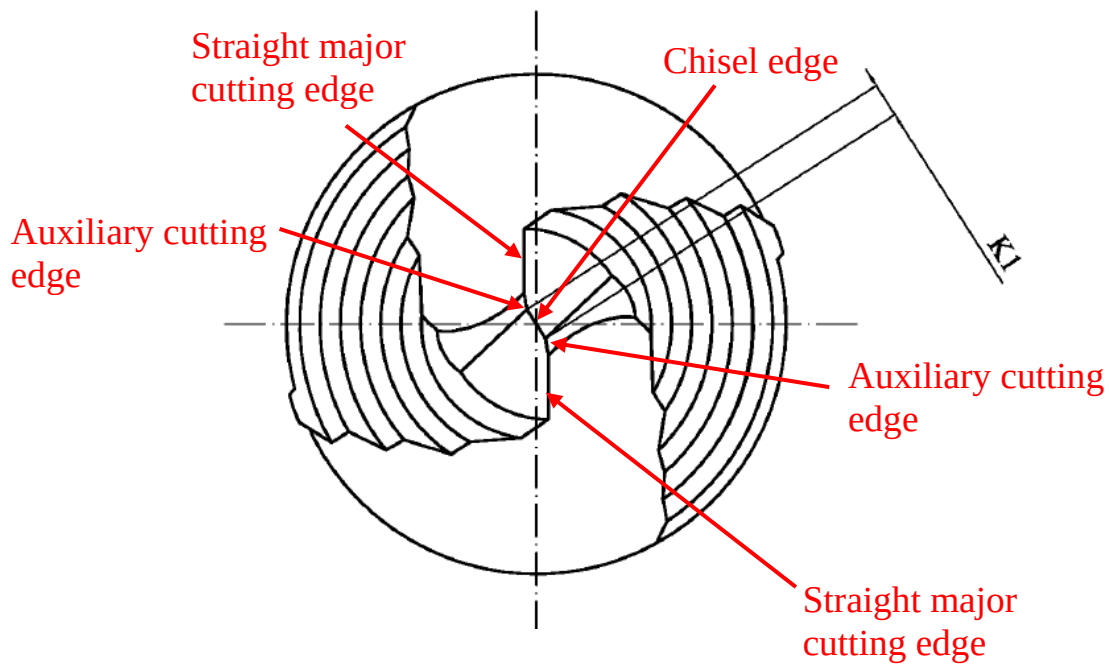


Fig.5

115. The cone portion of Wang's drill has a plurality of composite cutting blade groups (*e.g.*, 5 and 6) that increase in diameter from the front end to a rear end of the cone portion. Ex-1009, ¶[0031-32]. Those composite cutting blade groups each include a conical first step surface, a cylindrical second step surface, a major cutting edge defined by the intersection of the conical first step surface and the sidewall of the spiral flute, a minor cutting edge defined by the intersection of the cylindrical second step and the sidewall of the spiral flute, and a cutting tip defined by the intersection of the major cutting edge. See annotated reproduction of Figure 5 below.



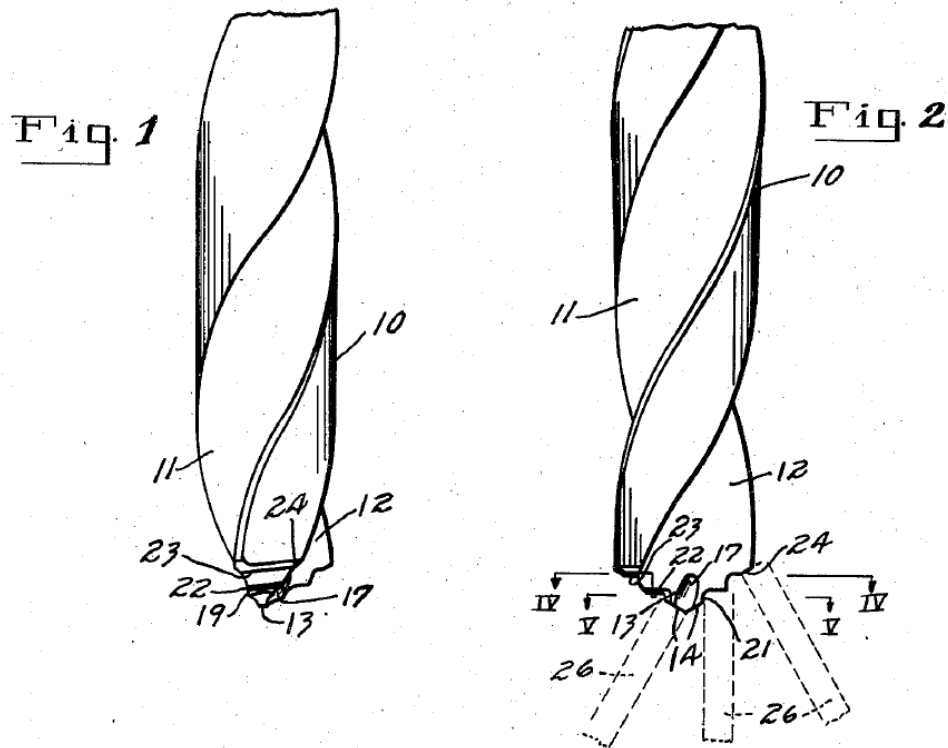
116. Wang's Figure 12 shows a top blade having a chisel edge, two auxiliary cutting edges and two straight major cutting edges. See Ex-1009, Figure 12, annotated below.



B. Bannister: U.S. Patent No. 2,193,186 (Ex-1006)

117. U.S. Patent No. 2,193,186 (“Bannister”) is titled “Twist Drill” and was filed on June 6, 1938 and issued on March 12, 1940. I am informed that Bannister is prior art to the ’583 patent.

118. Bannister discloses a twist drill having a shaft portion and a conical tip, with spiral flutes 11, 12 extending through the shaft portion and tip:



119. The tip of Bannister's drill is stepped so as to form a plurality of cutting edges 22-24. Ex-1006, p.2, 1:74-2:18.⁶ Bannister describes the formation of the cutting edges, noting that they can be normal to the axis of the drill or beveled. *Id.* According to Bannister, beveling the cutting edges produces longer chips and can address problems relating to "short chips [that] are liable to jamb the

⁶ Bannister was published without column numbers. Therefore, I cite to the page number and refer to the left column on any given page as column "1" and the right column of any given page as column "2." Thus, this citation refers to Bannister page 2, left column at line 74 to right column at line 18.

drill in the hole and cause it to break off.” *Id.*, p.2, 1:10-14, 2:7-18. Using this approach, Bannister teaches that grinding/beveling to produce such spiral/axial clearance allows operation in which “each succeeding grinding unit formed by the stepped cutting edges, forms a pilot for the succeeding larger drilling unit, so that holes drilled with my improved drill are perfectly round and straight, and of uniform section.” *Id.*, p.2, 2:49-55.

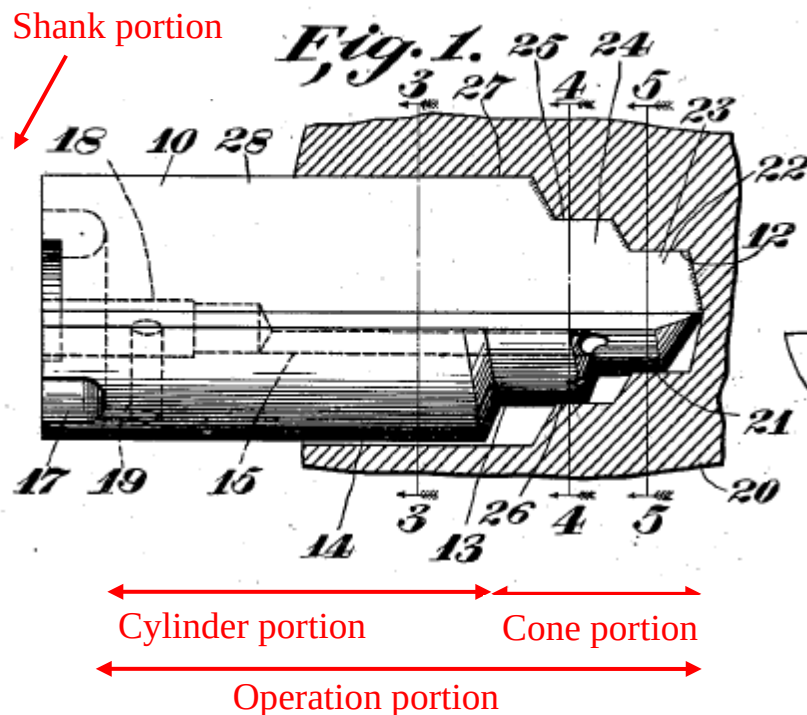
120. Bannister also teaches to provide axial relief to the stepped cutting surfaces, stating that “the plane of the surface behind each [cutting] edge is inclined to the axis of the drill, as shown in Figure 1, in order to provide axial clearance for the drill so that it will feed at the desired rate of speed.” *Id.*, p.2, 1:75-2:4.

C. Welty: U.S. Patent No. 2,276,532 (Ex-1008)

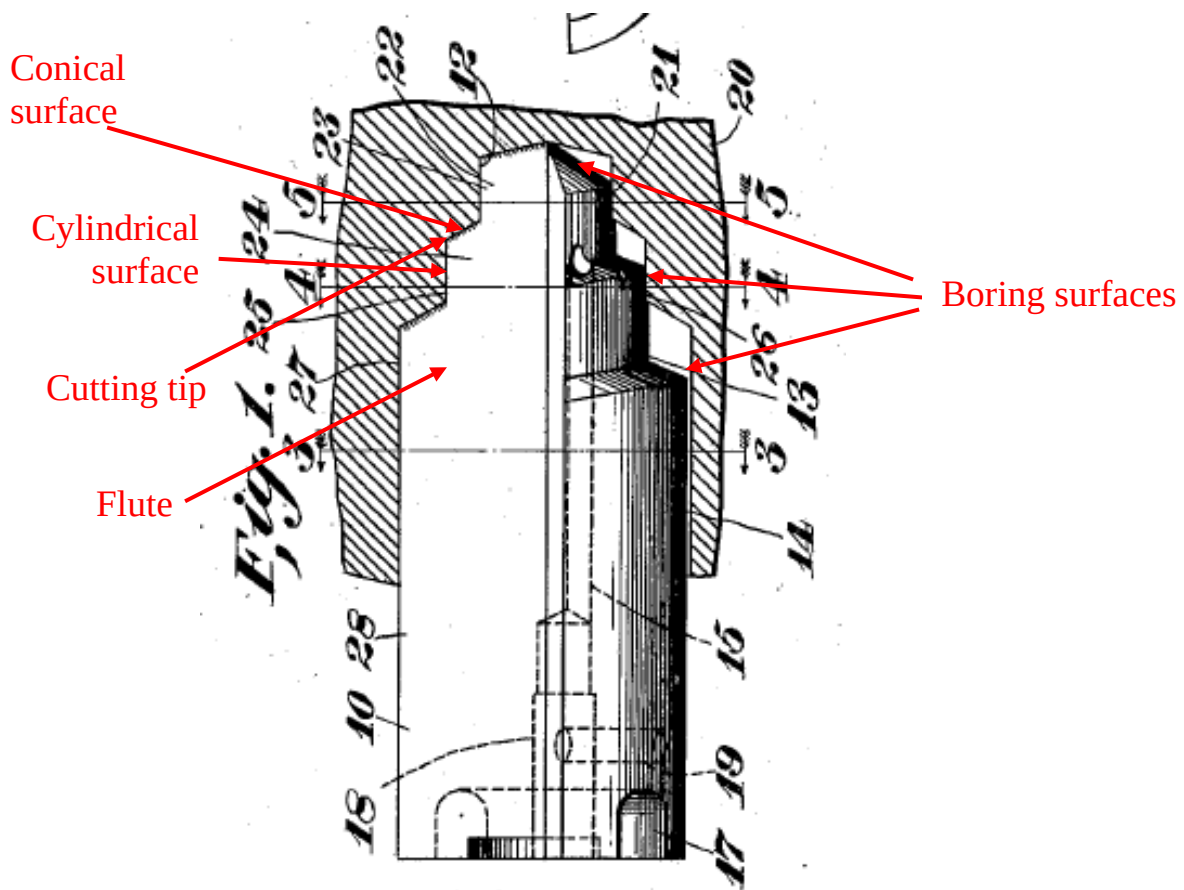
121. U.S. Patent No. 2,276,532 (“Welty”) is titled “Drill” and was filed on May 29, 1940 and published on March 17, 1942. I am informed that Welty is prior art to the ’583 patent.

122. Welty discloses a drill. Figure 1 of Welty (reproduced below) discloses the drill as comprising a cone portion and a cylinder portion axially fixed to the cone portion. Ex-1008, Figure 1. Welty discloses that the drill bit shown in Figure 1 includes a cross groove 17 and holes 18, 19 for receiving means for attaching the drill bit to a shank. Ex-1008, p.1, 1:43-45. Thus, Welty teaches a

shank disposed to the left of the drill. The drill is also “provided with a single flute for removing chips.” Ex-1008, p.1, 1:36-37.



Id., Figure 1 (annotations added). The drill bit has a plurality of steps, called “boring portions” 12, 13 and 14, that “successively increase in diameter from the initial cutting step so that the work may be easily drilled.” Ex-1008, p.1, 1:18-21; *see also id.*, annotated Figure 1. As shown below, Welty’s boring portions each have a conical surface and a cylindrical surface that form a cutting tip at the sidewall of the flute:



Ex-1008, Figure 1 (annotations added). The disclosed drill “requires a much smaller amount of power for its operation” and reduces breakage by only allowing the cutting edge of the body to come into contact with the work. *Id.*, p.1, 1:6-9; see also *id.*, p.1, 2:33 p.2, 1:3. The cutting bits are also arranged at a slight angle and show axial relief. *Id.*, Figure 1. Welty also discloses radial relief. *Id.*, Figures 3-5, p.1, 2:16-2:33.

D. Zhou: Chinese Patent Application Publication No. 103084629 (Ex-1007)

123. Chinese Patent Application Publication No. 103084629 (“Zhou”) is titled “Twist drill with segmented main cutting blades and asymmetric blade

opening height.” Zhou was published on May 8, 2013. I am informed that Zhou is prior art to the ’583 patent.

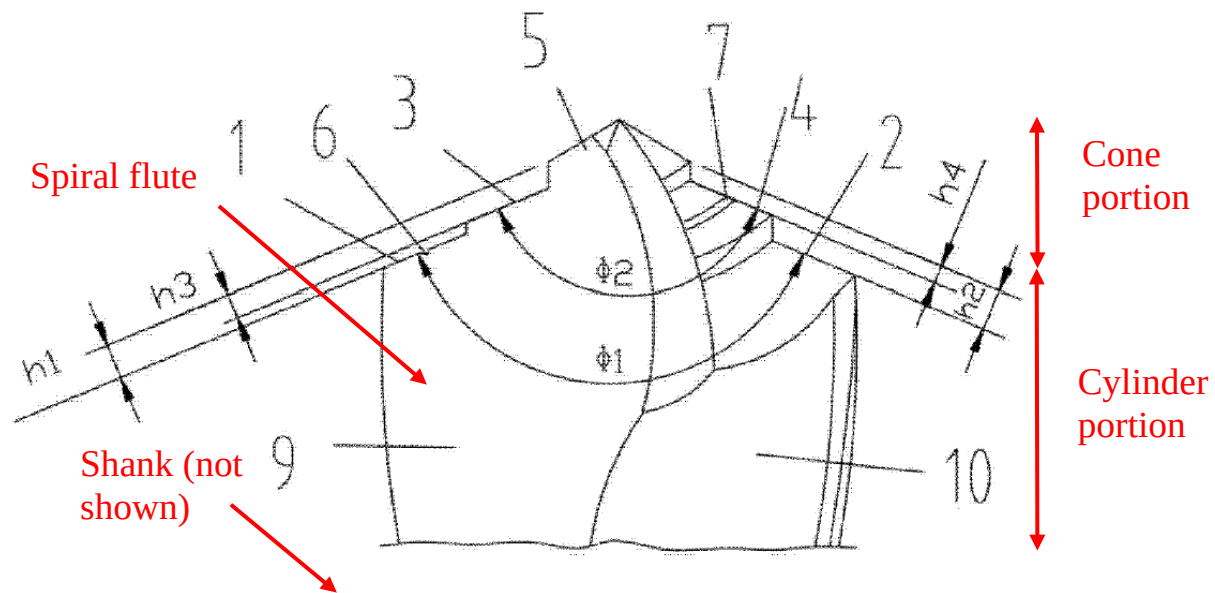
124. Zhou is directed to improvements in the cutting tip of a twist drill. Because the improvement is in the tip, Zhou does not show or describe the entire drill. However, the Background section of Zhou indicates that his improvement is directed to standard twist drills. As Zhou states:

Twist drills were invented over 100 years ago, and are still being used in large volumes throughout the world. World standard twist drills, cross-sharpened twist drills in common use throughout the world at present, and international standards all stipulate that the edge heights of the two main cutting edges of a twist drill should be symmetrical.

Ex-1007, ¶[0002]. Based on this description, and even without it, a POSA would know that various standard features of twist drills, while not shown or expressly discussed, are nonetheless present in the drill and would immediately envisage an entire twist drill including features such as a shank and a spiral flute extending towards the shank end of the drill.

125. Zhou specifically discloses a drill bit having an operation portion (i.e. portion shown at Figure 1) and a shank portion (not shown but necessarily present because the drill bit has to be held in a drilling machine). Ex-1007, Figures 1-6. The operation portion has a cone portion increasing in diameter from the tip towards the shank, and a cylinder portion between and axially fixed to the cone

portion and the shank. *Id.*, Figures 1-6. These elements can be seen in annotated Figure 1 below:



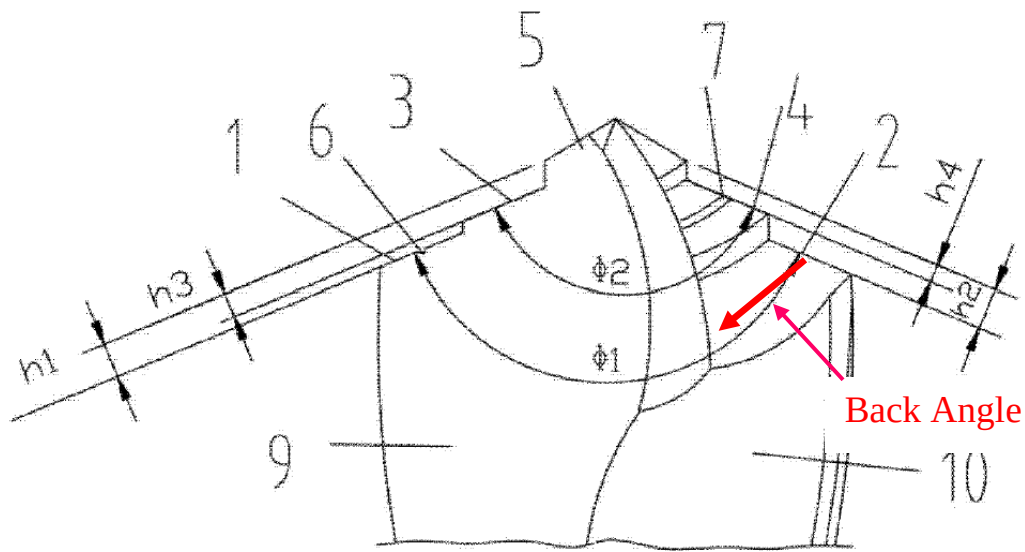
Ex-1007, Figure 1 (annotations added). Two flutes can be seen in the figures and, based on the figures as well as Zhou’s description of his invention being applicable to known standard twist drills, and even without Zhou’s description, a POSA would know that the flutes are necessarily spiral in shape and would immediately envisage such spiral flutes.

126. The cone portion of Zhou’s drill has a plurality of cutting edges 1-5 that form a stepped tip. *Id.*, Figures 1-6, ¶[0024]. The stated novelty of Zhou’s drill is that the cutting edges have “asymmetrical edge heights.” *Id.*, ¶[0014]. Referring to Figure 1, Zhou explains that edge height h1 of “outer protruding edge” 1 is less than edge height h2 of “outer sunken edge” 2, and that edge height

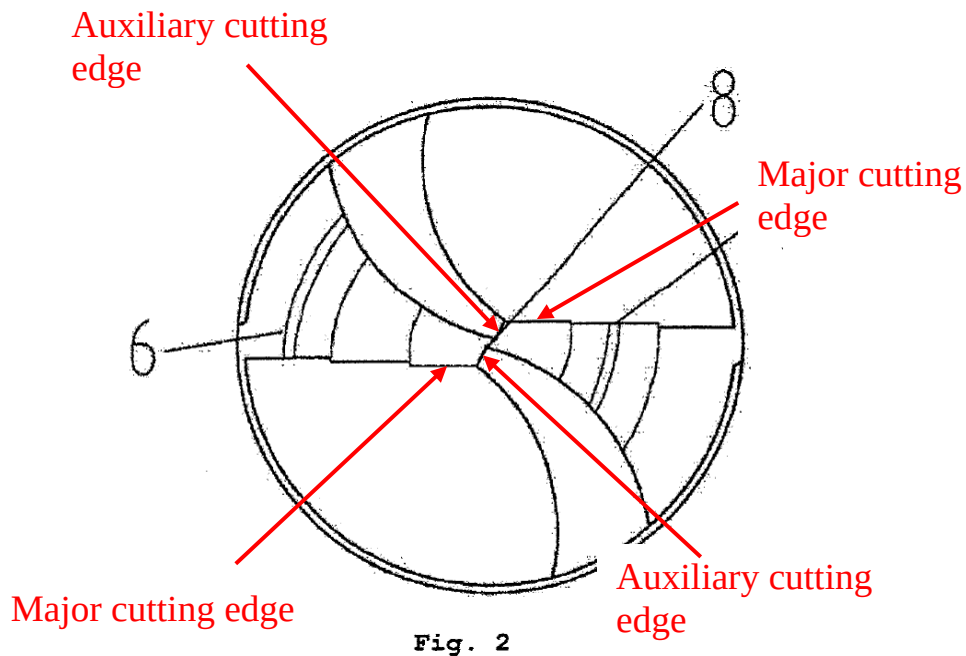
h3 of “inner sunken edge” 3 is greater than edge height h4 of “outer sunken edge”

2. *Id.*, ¶[0024].

127. Zhou states that the cutting edges have a “back angle” of 6° - 18°. *Id.*, ¶[0008]. In the context of the Zhou patent, a POSA would understand that Zhou is using “back angle” to refer to axial relief of the conical surface. That is, it refers to the flank conical surface obliqueness behind the cutting edge to prevent rubbing or burnishing along that surface and improve the efficiency of the cutting. The back angle can be seen in Figure 1:



128. Zhou notes that it is well known to provide a chisel edge at the tip of the drill to improve drilling efficiency. Ex-1007, ¶[0003]. Figure 2 of Zhou shows a top blade made up of such a chisel edge 8, two auxiliary cutting edges and two straight edges:



Ex-1007, Figure 2 (annotations added). This aspect of Zhou is not new or unusual – it is a well-known split point tip design.

129. In larger drill sizes, Zhou employs swarf separation grooves 6-7. See *Id.*, ¶[0011]. However, those grooves are optional and are omitted in smaller drills such as those shown in Figures 3-6.

E. Gentry: U.S. Patent No. 8,029,215 (Ex-1010)

130. U.S. Patent No. 8,029,215 (“Gentry”) is titled “Spiral drill bit and method of forming same.” Gentry issued on October 4, 2011. I am informed that Gentry is prior art to the ’583 patent.

131. Gentry describes a prior art step drill 10 bit having an operation portion (i.e. main body 18) and a shank portion (towards the rear 14).

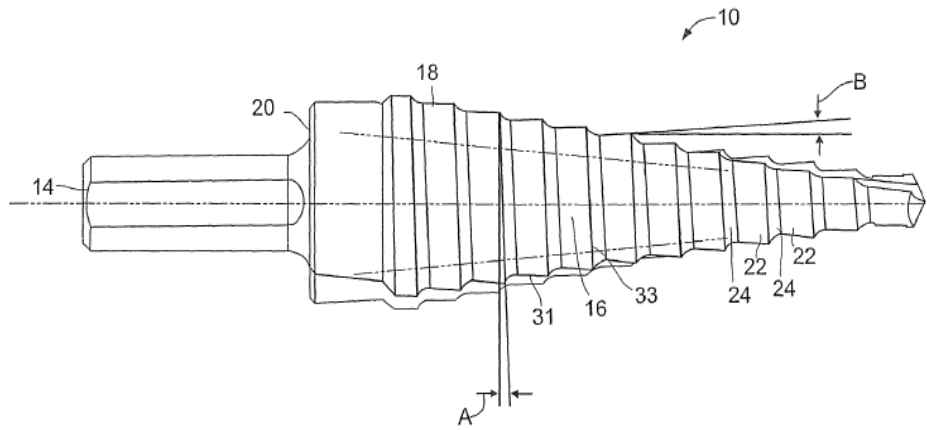


FIG. 1

Ex-1010, Figures 1-3, 1:16-2:49. The main body 18 has steps (cutting surfaces 22 and transition surfaces 24) having cutting edges (31) formed by one or more flutes cut in the drill bit. *Id.* The cutting surfaces 22 are cylindrical and the transition surfaces 24 are conical. *Id.*

132. Gentry describes the known importance of providing axial and radial relief to reduce interference and friction when using stepped drilling surfaces. Ex-1010, 1:52-55. Gentry illustrates axial relief A in Figure 1 (shown above), which is described as “the angle between a plane perpendicular to the axis 16 and the forward edge 33 of the cutting surface 22.” *Id.*, 1:60-62. Gentry describes relief as “necessary.” *Id.*, 2:20-23.

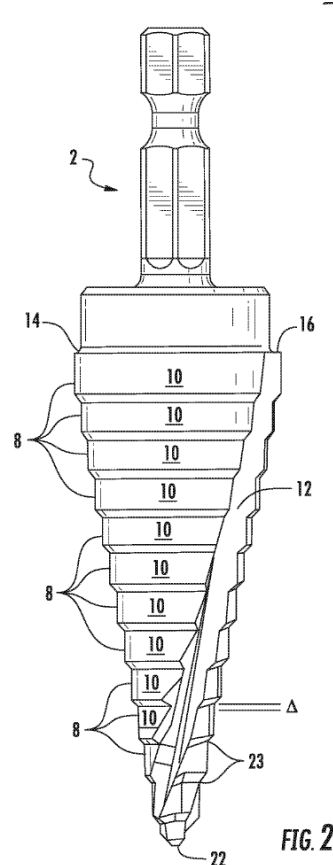
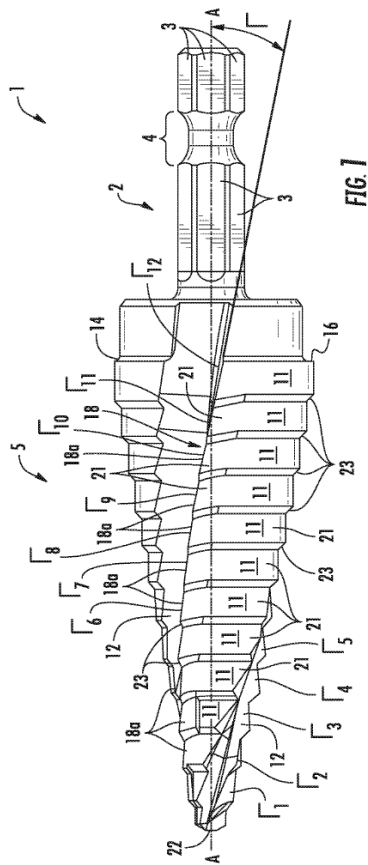
133. The twist drill 10 also has a top blade at front 12. Ex-1010, Figures 1-3, 1:16-2:49. Gentry also discloses step drills having generally the same elements disclosed in the prior art bits discussed above (i.e. at Figures 1-3 and 1:16-2:49), and which also have the various forms of necessary relief, including axial relief.

See generally Ex-1010.

F. Durfee: U.S. Patent No. 10,058,929 (Ex-1011)

134. U.S. Patent No. 10,058,929 (“Durfee”) is titled “Step drill bit with variable helical flute.” Durfee was issued on August 28, 2018 and claims priority to a provisional application filed on November 10, 2015. I have reviewed the provisional application from which Durfee issued (Ex-1011) and it discloses substantially the same subject matter as that shown in the Durfee patent, including the subject matter discussed below. I am informed that Durfee is prior art to the ’583 patent.

135. Durfee describes a step drill bit with a cutting head and steps having cutting edges formed by one or more spiral flutes cut in the drill bit. Ex-1011, Abstract. The spiral flutes 12 are formed helically and extend from the tip end of the drill towards the shank portion:



Ex-1011, Figures 1-6, 3:44-56. Each step 8 is made up of a cylindrical surface (i.e. outer peripheral surfaces 21 of step sections 10, 11) and a conical surface (i.e. transition surfaces 23), with respective cutting edges 18a, 20a formed between the sidewalls of the flutes 12 and the step sections 10, 11. *Id.*, Figures 1-6, 6:33-50 and 8:13-29.

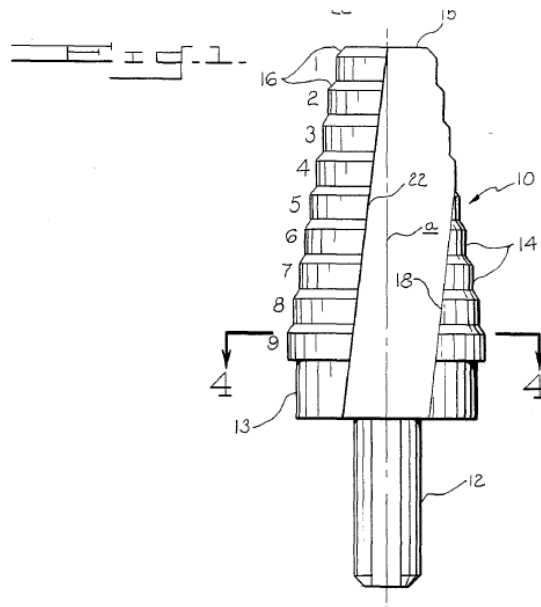
136. Durfee also describes how the steps can have axial and radial relief to reduce interference and friction when using the step drill. Ex-1011, 9:59-10:11, 11:12-12:8. Axial relief can be provided such as through a “helical pitch,” in which the distance between a step surface and the tip 22 continuously increases in

the trailing direction (i.e. as the drill is rotated in the cutting direction) by a distance Δ shown in Figure 2. Ex-1011, Figure 2, 11:27-53. The axial relief can vary between approximately 2 degrees to 15 degrees, with the preferred relief angle being 5 degrees. *Id.*

G. Korb: U.S. Patent No. 4,582,458 (Ex-1012)

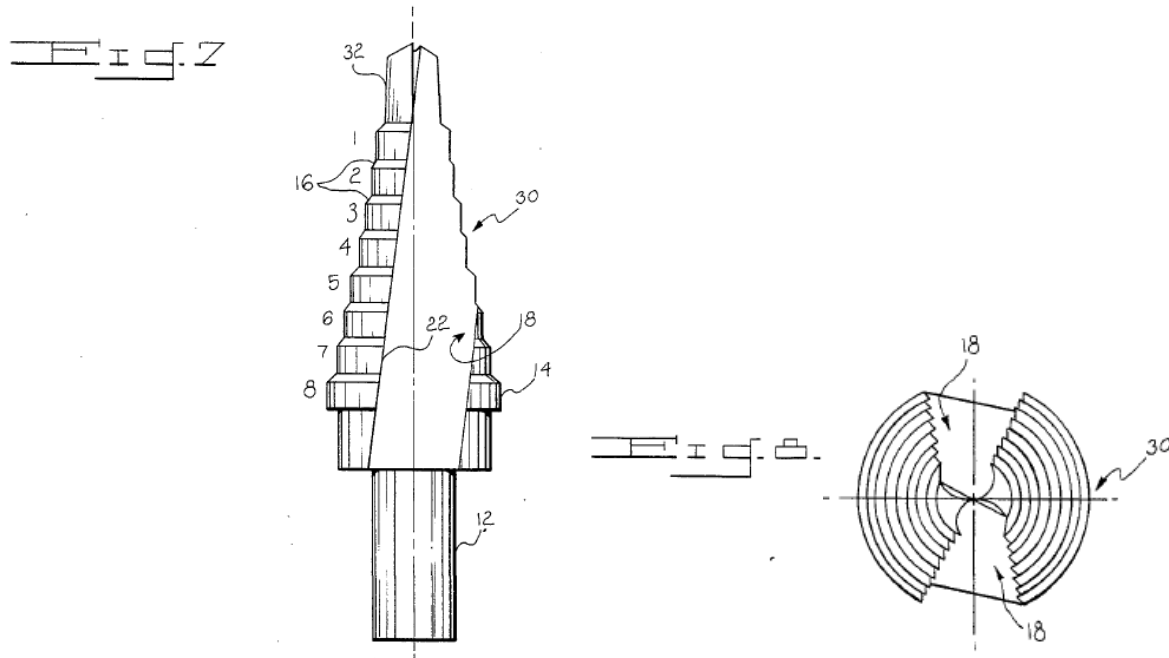
137. U.S. Patent No. 4,582,458 (“Korb”) is titled “Stepped drill construction.” Korb was issued on April 15, 1986. I am informed that Korb is prior art to the ’583 patent.

138. Korb describes a drill bit having steps formed by a series of cylindrical outer surfaces of increasing diameter connected by conical surfaces, as well as at least two flutes. Ex-1012, Abstract. An example of this is shown in Figure 1, reproduced below:



Korb notes that the flutes may be cut “helically about the drill or longitudinally at a fixed angle to the drill axis from about 0 to 15 degrees.” *Id.*, 37-44.

139. Figures 7-8 of Korb shows an alternative embodiment in which a “split tip pilot drill point 32” is added to the tip of the drill:



The split tip pilot drill point is shown as being taller than the other steps when viewed from the side.

XII. OPINION 1: CLAIMS 1, 2, 5, 7, 8, 12-15, 18, 19, AND 22 WOULD HAVE BEEN OBVIOUS BASED ON WANG IN VIEW OF GENTRY, DURFEE, AND/OR THE KNOWLEDGE OF A POSA

A. Independent Claims 1 and 8

1. Elements 1A and 8A: “A twist drill, comprising...” (“the Preamble”)

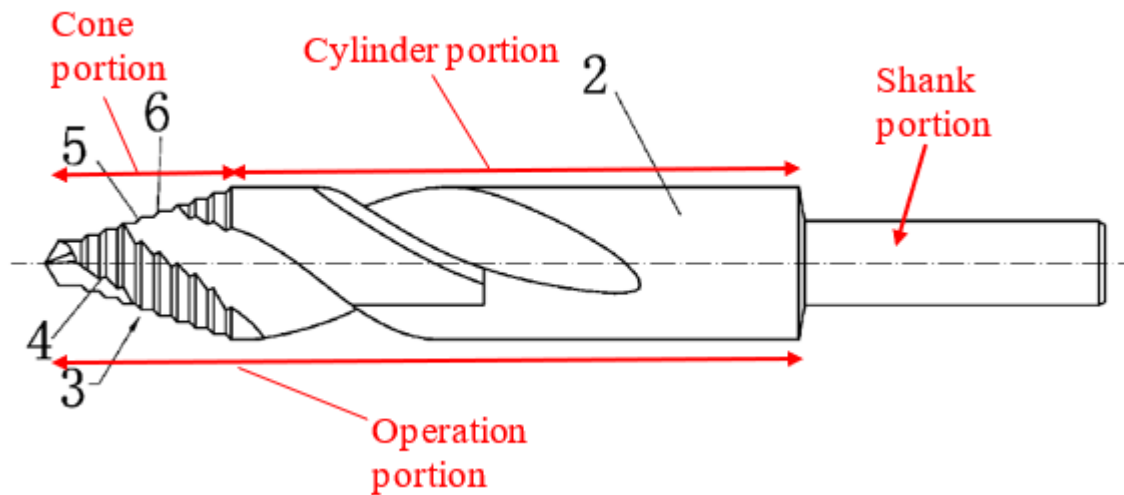
140. I am informed that the preamble of a claim generally is not limiting. I am also informed that this is especially true when the claims define a structurally

complete invention in the claim body and use the preamble only to state a purpose or intended use for the invention, which is the case for claims 1 and 8.

141. However, even assuming the preamble is limiting, Wang teaches a “twist drill.” Wang is titled “Efficient Twist Drill for Layered Drilling,” and refers to a “twist drill,” *see* Ex-1009, Abstract, ¶¶[0006], [0031], [0038], and [0039]. Furthermore, a POSA viewing Wang’s figures would readily understand that Wang teaches twist drills having typical twist drill features such as a spiral flute and a split point tip. *Id.*, Figure 5.

2. Elements 1B and 8B: “an operation portion comprising a cone portion and a cylinder portion axially fixed to the cone portion” (the “Operation Portion Limitation”)

142. Wang discloses a twist drill having an operation portion, i.e., a portion of the drill that cuts, smooths, removes chips from, and otherwise works and interacts with a workpiece. Ex-1009, Figure 5. Wang teaches a drill body 2 which comprises, *inter alia*, an operation portion that has a “cutting portion at a front end and a guide portion at a rear end.” *Id.*, ¶[0031]. Like many twist drills, Wang’s operation portion comprises a cone portion and a cylinder portion fixed axially to the cone portion. Ex-1009, Figure 5. Wang’s “cutting portion at a front end” is a cone portion and the “guide portion at a rear end” is a cylinder portion. *See id.*, Figure 5 (annotated below)



143. More specifically, Wang’s cone portion is the end portion of the drill where the diameter decreases from that of the cylinder portion towards a point at the tip of the drill, thereby forming a generally conically shaped structure. A POSA would understand that as the drill rotates about its longitudinal axis, such as during drilling operations, the cone portion sweeps along a path that is generally conical. That is, it is conical in projection. Wang’s cylinder portion is the middle portion of the drill having a constant maximum diameter and a generally cylindrically shaped structure (with flutes cut into it). A POSA would understand that as the drill rotates about its longitudinal axis, such as during a drilling operation, the cylindrical portion sweeps along a path that is generally cylindrical. That is, it is cylindrical in projection. The cone portion and cylinder portion are “axially fixed” in that they are part of a single, rigid cutting tool. Furthermore, the cone portion is generally coaxial with the cylinder portion, which is necessary for the drill to bore straight and accurate holes.

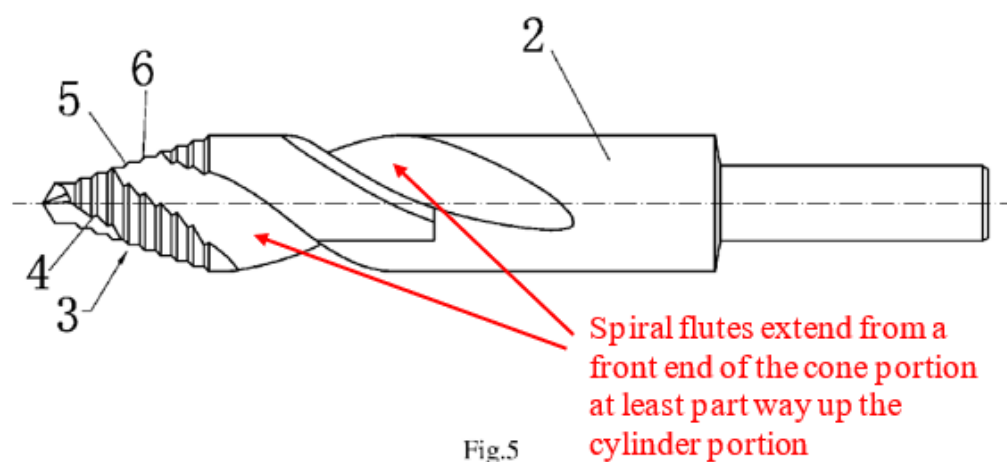
3. Elements 1C and 8C: “a shank portion axially fixed to the cylinder portion opposite the cone portion” (the “Shank Portion Limitation”)

144. Wang discloses a shank portion axially fixed to the cylinder portion opposite the cone portion. Wang states that the drill body includes “a shank portion” that is “connected to the guide portion.” *Id.*, ¶[0031]. As discussed in the previous section, the “guide portion” corresponds to the “cylinder portion” of claim 1. It can be seen from the dashed drill axis depicted on Wang Figure 5 that the shank portion is positioned along the drill axis along with the cylinder portion and cone portion. Ex-1009, Figure 5. It can also be seen that the shank portion is adjacent to the cylinder portion at an axial position that is opposite from the cone portion, which itself is positioned adjacent to the cylinder portion along the drill axis. *Id.* Thus, Wang teaches a shank portion axially fixed to the cylinder portion opposite the cone portion. See Ex-1009, Figure 5 (annotated in the previous section).

4. Elements 1D and 8D: “a spiral flute formed on an exterior surface of the operating portion extending from a front end of the cone portion and at least partway up the cylinder portion, the spiral flute having a sidewall” (the “Spiral Flute Limitation”)

145. Wang’s drill has spiral flutes formed on an exterior surface of the operating portion extending from a front end of the cone portion and at least

partway up the cylinder portion.⁷ The spiral flutes have sidewalls. See Ex-1009, Figure 5 (annotated below).



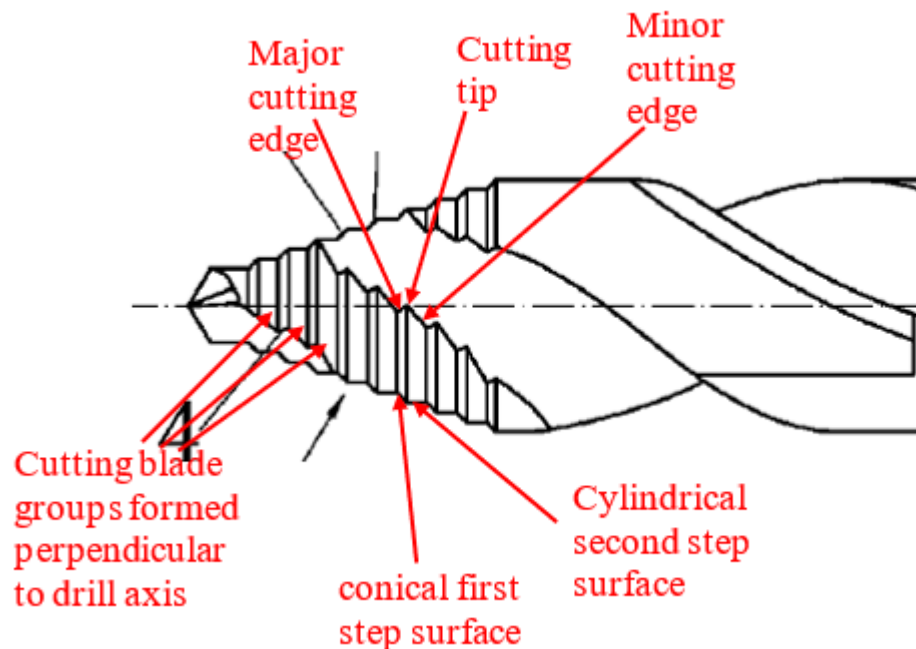
146. Such flutes are generally defined by a recessed surface formed by a cut made into the exterior surface of the body of the drill. The recessed surface geometrically defines the sidewall of the flute. It is readily apparent from Wang

⁷ As previously mentioned, Wang uses “flute” to describe a different part of the drill bit than is considered to be a “flute” in the ’583 patent. Wang uses “flute” to describe the groove formed between adjacent cutting blade groups: “the flutes divide main cutting blades into a plurality of first cutting blades 5 and second cutting blades 6.” *Id.*, ¶[0031]. Nonetheless, Wang’s figures clearly show “flutes” as that term is used in the ’583 patent, i.e., spiral recesses that serve to remove swarf and form cutting edges.

Figure 5 that one end of Wang's spiral flute begins/ends at a front end of the cone portion, i.e., the tip of the drill. Ex-1009, Figure 5. It is also apparent that this spiral flute extends at least partway into the cylinder portion. *Id.*

5. Elements 1E and 8E: “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” (the “Composite Cutting Blade Groups Formed Sequentially and Spirally Limitation”)

147. Wang's twist drill has composite cutting blade groups formed sequentially on a cone portion exterior from a front end of the cone portion to a rear end of the cone portion. The composite cutting blade groups increase in diameter from the tip towards the cylinder portion, as can be seen on the annotated representation of Wang Figure 5 below.



148. Wang does not teach that the cutting blade groups are formed spirally. Instead, Wang teaches that the composite cutting blade groups are formed as steps on the cone portion surface that are perpendicular to the drill axis.

149. It would have been obvious to a POSA to form Wang's cutting blade groups "spirally" as claimed. As I described above with respect to claim construction, the composite cutting blade groups are formed "spirally" if they are slanted relative to the longitudinal axis of the drill, including the slant formed by virtue of the presence of axial relief. It would have been obvious for a POSA to provide axial relief to the cutting blade groups.

150. It was very well known in the art that various types of relief, including axial relief, should be employed in order to prevent rubbing during drilling. Without relief, a large surface area of a drill would rub against the workpiece being cut, causing significant friction. This would require excessive torque to drive the drill, generate excessive heat, limit the service life of the drill, and lead to a poor surface finish on the machined workpiece. The high heat would likely require more exotic and expensive tool materials. Relief reduces the surface area of a drill that contacts a workpiece and reduces these effects. Examples of relief can be seen, for example, in Bannister, which shows a twist drill with steps similar to Wang. Bannister teaches that "the plane of the surface behind each [cutting] edge

is inclined to the axis of the drill, as shown in Figure 1, in order to provide axial clearance for the drill.” Ex-1006, p.2, 1:75-2:4. This can also be seen in Gentry and Durfee, both of which show step drills with a plurality of steps similar to the steps in Wang’s drill, and both of which show and describe axial relief in order to prevent rubbing along the conical flank surfaces of the steps. Gentry teaches that radial relief provides clearance along the axis for the cutting surface of the step drill as the drill bit is rotated. Ex-1010, Figure 1, 1:57-63. Durfee also teaches the inclusion of axial relief on a stepped portion of a drill. Ex-1011, Figure 2, 11:27-53. A POSA would have been motivated in view any of these references to add axial relief to the cutting blade groups of Wang, thereby imparting a slant to Wang’s cutting blade groups which provides clearance between the surface of the drill bit and the workpiece. As described above, this would obtain the known benefit of preventing rubbing along the flank surface would thereby reduce the amount of torque that needs to be applied to the drill bit because the rubbing between the drill surfaces and workpiece surfaces would be reduced.

151. A POSA would have had a reasonable expectation of success in incorporating axial relief into Wang’s cutting blade groups. Again, relief is a routinely employed feature of nearly every drill. Well before the filing of the ’583 patent application, POSAs knew how to incorporate relief into drills so as to improve their performance. Therefore, it would have been obvious to form

Wang's cutting blade groups "spirally" as claimed.

6. Elements 1F and 8F: "a conical first step surface" (the "Conical First Step Limitation")

152. Each composite cutting blade group of Wang's drill has a conical first step surface, as shown on the annotated representation of Figure 5 provided above in relation to Elements 1E and 8E. Wang describes the first cutting blade (formed by the first conical step surface) as being at an angle of 90-140 degrees to the second cutting blade (formed by the second cylindrical step surface) that is parallel to the axis line of the drill bit. *See* Ex-1009, ¶¶[0031-32].

153. Although the conical step surfaces pointed to in Wang Figure 5 above do not form complete cones, a POSA would understand that in the context of the '583 patent, "conical" means "conical" or "frustoconical" barring the void(s) formed by the flute(s) and any changes to the geometry due to axial relief. That is, the surfaces are generally conical or frustoconical in shape. Likewise, when the drill is rotated, the conical first step surfaces would sweep along generally conical or frustoconical paths. That is, they are conical or frustoconical in projection. Thus, a POSA would describe the first step surfaces shown in Wang Figure 5 as conical.

7. Elements 1G and 8G: "a cylindrical second step surface adjacent to the conical first step surface" (the "Cylindrical Second Step Limitation")

154. Each composite cutting blade group of Wang's drill has a cylindrical

second step surface adjacent to the conical first step surface, as shown in the annotated Wang Figure 5 provided above for elements 1E and 8E. Ex-1009, Figure 5. Wang describes the second cutting blade (formed by the second cylindrical step surface) as being parallel to the axis line of the drill bit. *See id.*, ¶¶[0031].

155. Although the cylindrical step surfaces pointed to in Wang Figure 5 above do not form complete cylinders, a POSA would understand that in the context of the '583 patent, “cylindrical” means cylindrical barring the void(s) formed by the flute(s) and any changes to the geometry due to relief, such as radial or diametral relief. That is, the surfaces are generally cylindrical in projection. Likewise, when the drill is rotated, the cylindrical second step surfaces would sweep along a generally cylindrical path. That is, they are cylindrical in projection. Thus, a POSA would describe the second step surfaces shown in Wang Figure 5 as cylindrical.

8. Elements 1H and 8H: “a major cutting edge defined by the intersection of the conical first step surface and the sidewall of the spiral flute” (the “Major Cutting Edge Limitation”)

156. Wang’s drills have a major cutting edge which is defined by the intersection of the conical first step surface and the sidewall of the flute, as shown in the annotated Wang Figure 5 provided above for elements 1E and 8E. Ex-1009, Figure 5. Wang refers to the major cutting edges as “first cutting blades 5.” *See*

id., ¶¶[0031-32].

157. Simply viewing Wang Figure 5 and observing the intersection of the sidewall of the flute and the conical first step surface is sufficient to show that this element is present. But for context, I understand that these edges are “cutting” edges because they are among the edges on the drill that cut a workpiece when Wang’s drill is in operation. I can determine from the figures that, like most drills, when cutting, Wang’s drill is configured to be rotated clockwise when viewed from behind the drill when the tip of the drill is pointed away from the viewer. When rotated accordingly, Wang’s major cutting edges would contact a workpiece and shear off a layer therefrom, thereby forming chips. In other words, Wang’s major cutting edges would shear or cutoff a portion of a workpiece. And although I understand that the term “major” may be an arbitrary label used by the claim drafter, for context, these cutting edges of Wang would perform a significant amount of the cutting work when Wang’s drill is in use. As Wang’s drill would be advanced into a workpiece, these edges would be in contact with the material still present at the annular rings of the cutting edges.

9. Elements 1I and 8I: “a minor cutting edge defined by the intersection of the cylindrical second step and the sidewall of the spiral flute” (the “Minor Cutting Edge Limitation”)

158. Wang’s drills have a minor cutting edge which is defined by the intersection of the cylindrical second step and the sidewall of the flute, which is

shown in the annotations to Wang Figure 5 provided above for elements 1E and 8E. Wang refers to the minor cutting edges as “second cutting blades 6.” See Ex-1009, ¶¶[0031-32].

159. Simply viewing Wang Figure 5 and observing the intersection of the sidewall of the flute and the cylindrical second step surface is sufficient to show that this element is present. But for context, I understand that these edges are “cutting” edges because they are among the edges on the drill that may cut, smooth, or otherwise work a workpiece when Wang’s drill is in operation. As described above for elements 1H and 8H, Wang’s drill is configured to be rotated clockwise when viewed from behind the drill in use. When rotated accordingly, Wang’s minor cutting edges would contact any asperities or other protrusions and cut them off or otherwise improve the hole roundness or smooth the workpiece. And although I understand that the term “minor” may be an arbitrary label used by the claim drafter, for context, these cutting edges of Wang would not remove as much material as the major cutting edges when Wang’s drill is in use. More specifically, the major cutting edges would have already removed the majority of the workpiece by the time the minor cutting edges would enter that portion of the workpiece, so only asperities or errors of form not fully removed by the major cutting edges would be cut by Wang’s minor cutting edges.

10. Element 8I’: “the minor cutting edge being configured to smooth the machined surface of the

workpiece to improve surface quality” (the “Minor Cutting Edge Smoothing Limitation”)

160. Wang’s minor cutting edges are configured to smooth the machined surface of the workpiece to improve the surface quality. This smoothing of the machined surface of a workpiece inherently results from the geometry of the minor cutting edges, which are positioned on the intersection of the flute sidewalls and the cylindrical step surfaces. These edges would therefore sweep in a cylindrical path around a portion of the workpiece first cut by the major cutting edges (as I describe above), thereby smoothing it. This is essentially a shaving operation, where the depth of cut is small and the surface fidelity (shape and surface quality) is high. Shaving on the side flutes has always been a feature of drilling operations.

161. As one example, Wang’s minor cutting edges can simply shear off any material that protrudes into the path of the minor cutting edge as it sweeps along during rotation. They are also inherently capable of smoothing a machined surface through burnishing as they will rub against the machined surface and plastically deform asperities to improve the surface roughness and shape fidelity.

11. Elements 1J and 8J: “a cutting tip defined by the intersection of the major cutting edge, the minor cutting edge, and the sidewall of the spiral flute” (the “Cutting Tip Limitation”)

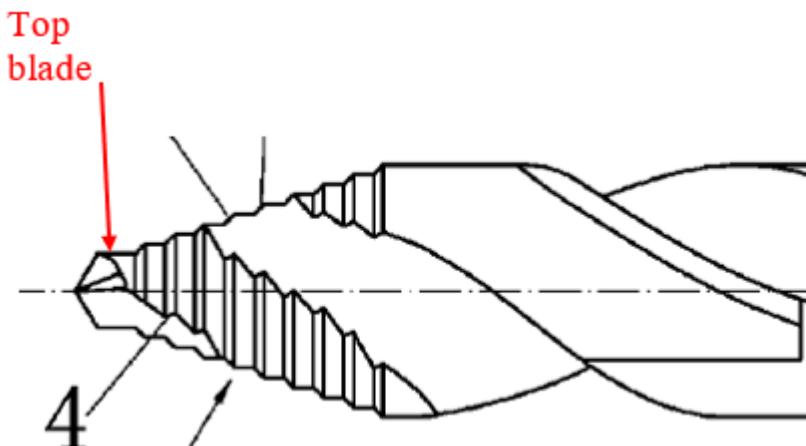
162. Wang’s twist drill has a cutting tip defined by the intersection of the minor cutting edge, the major cutting edge, and the sidewall of the flute, which is

shown in the annotated Wang Figure 5 provided above for elements 1E and 8E.

The intersection between a respective major and minor cutting edge and the sidewall of the spiral flute is a single point, or tip. This single point must be the cutting tip, which the claims contemplate is the single point formed by the respective cutting edges and flute surface.

12. Elements 1K and 8K: “a top blade provided on the front end of the cone portion” (the “Top Blade Limitation”)

163. Wang’s drill has a top blade provided on the front end of the cone portion, as shown in the annotated Wang Figure 5 below.

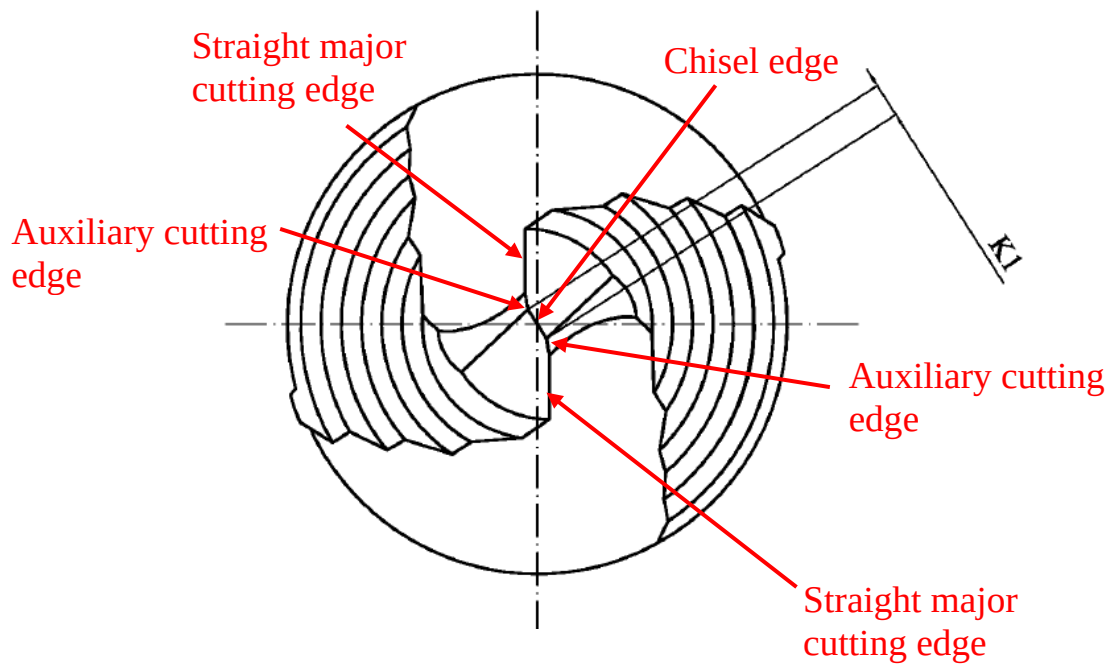


164. Wang does not use the same language as the '583 patent. Instead, Wang refers to the top blade as having a “first cutting blade and a second cutting blade at the foremost end of the drill bit body, the first cutting blade is in contact with the workpiece first.” *Id.*, ¶[0033]. Also, Wang states “[w]hen the drill bit starts to come into contact with the surface of the workpiece, a guide hole is first

drilled by a very small drill point (i.e., the guide portion) of the first section. The small drill point is easy to be positioned and drill the small hole due to a small diameter.” Ex-1009, ¶39. A POSA would understand this to describe the top blade at the front end of the drill bit required by the ’583 patent. Also, the Wang drill is intended to cut material, so it must have a top blade.

13. Element 8K’: “the top blade comprises a chisel edge, two auxiliary cutting edges and two straight major cutting edges, the auxiliary cutting edge is respectively intersected with the straight major cutting edge and the chisel edge” (the “Top Blade Structure Limitation”)

165. Wang’s top blade has a chisel edge, two auxiliary cutting edges, and two straight major cutting edges. Ex-1009, Figure 12. Each of Wang’s auxiliary cutting edges is intersected by a straight major cutting edge of Wang’s top blade and the chisel edge of the top blade. As I described above, these edges can all be seen on Wang Figure 12, which is annotated below to depict the other edges

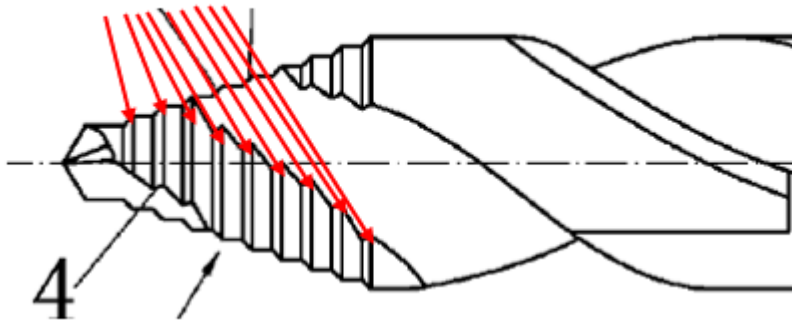


166. A POSA would understand this claim language describes a split point tip, which as I have described above, is a very well-known and standard type of drill tip. Likewise, although Wang doesn't explicitly describe it as such, Wang's top blade is also a split point tip, which a POSA would discern.

14. Elements 1L and 8L: “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” (the “Diameter Increases Sequentially Limitation”)

167. The diameter of each of Wang's composite cutting blade groups increases sequentially from the front end of the cone portion to the rear end of the cone portion. Ex-1009, Figures 5-12, ¶[0036]. This is shown on the annotated Wang Figure 5 below.

Cutting blade groups of
sequentially increasing diameter



168. This claim element does not explicitly refer to a particular diameter, and only states that “a diameter . . . increases” Ex-1001, Claims 1 and 8. A POSA would understand this language to encompass a maximum diameter of each cutting blade group (i.e., the maximum overall diameter of the drill at that axial location), which in Wang, is the diameter d at each of the cutting tips. It is readily apparent from Wang Figure 5 that the diameter at the cutting tips is smaller for cutting blade groups located towards the front of the cone portion (i.e., towards the tip of the drill, or towards the top blade) than it is for cutting blade groups located towards the rear end of the cone portion (i.e., towards the cylinder portion of the drill). Furthermore, Wang states “[a]s shown in FIG. 11...a diameter d of the circular arc between the two opposite second cutting blades is gradually increased to form a step-like structure. For example, from a diameter d_1 between the foremost second cutting blades to a diameter d_n between the last second cutting blades, the diameters show a gradually increasing trend; and the increased size can

be constant or variable.” Ex-1009, ¶[0036].

15. Elements 1M and 8M: “each of the plurality of composite cutting blade groups is configured to crush cutting chips into finer chips and the spiral flute is configured to shunt the finer chips” (the “Configured to Crush Limitation”)

169. As I described above, I have adopted Patent Owner’s construction of “configured to crush cutting chips into finer chips” for the purpose of this analysis. Under this construction, Wang teaches this element. Although Wang does not explicitly describe crushing cutting chips or forming relatively small cutting chips, Wang inherently teaches this element because a POSA would recognize that Wang’s drill is configured to create cutting chips that are smaller than they would be if the drill did not have composite cutting blade groups.

170. If Wang’s drill did not have composite cutting blade groups, a POSA would understand that it would be nothing more than a standard two-blade, split point twist drill such as the exemplar depicted in the Handbook at Figures 9-15, reproduced above in Section VI.A. On such a standard two-bladed twist drill, two major cutting edges (i.e., lips) extending from the split point tip (i.e., top blade) to the outer diameter of the drill would do the majority of the cutting. Each cutting blade would shear chips from a workpiece having a width approximately equal to the length of each respective cutting blade. In Wang, however, the majority of the cutting is distributed among the multiple major cutting blades of each composite

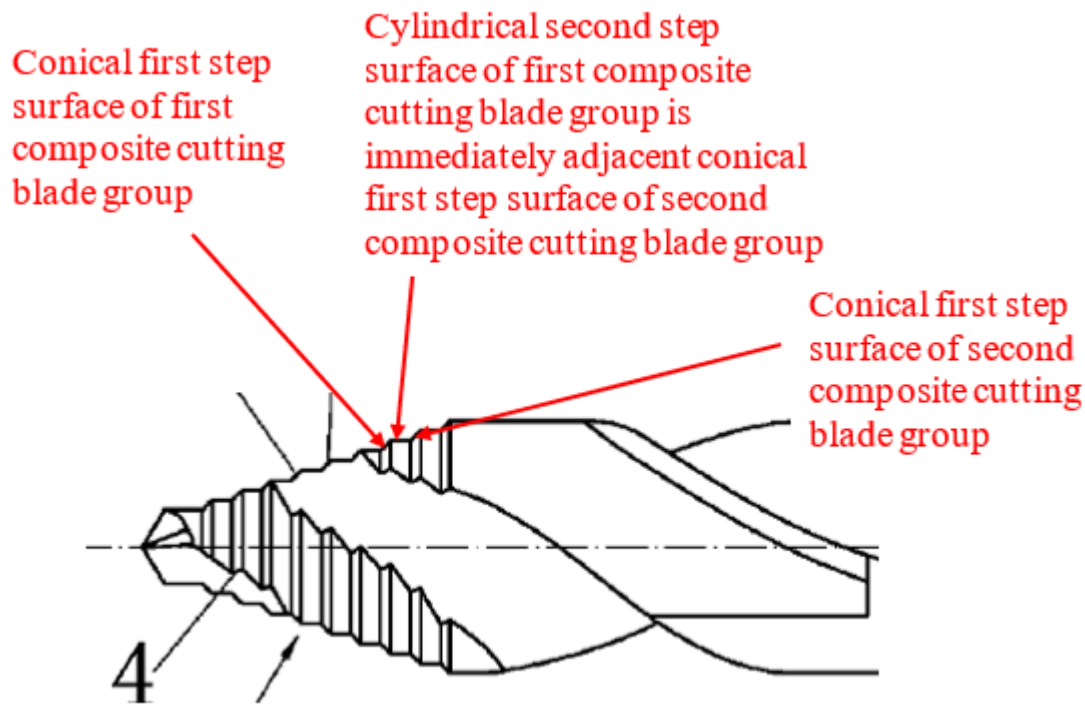
cutting blade group. A POSA would recognize that each composite cutting blade group would shear chips from a workpiece having a width approximately equal to the length of the respective major cutting edge. Thus, instead of relatively large chips having a width approximately equal to the distance from the split point tip (i.e., top blade) to a maximum outer diameter of the drill, Wang would create a greater number of smaller chips having a width approximately equal only to the length of the major cutting edges. Under the construction I have adopted for this claim language, a POSA would recognize that Wang's composite cutting blade groups meet this claim limitation.

171. Wang also teaches a spiral flute configured to shunt the finer chips. First, as explained above, Wang's drills are configured to create "finer chips." The flutes of Wang's drills are configured to shunt the chips formed by the operation of the drill. Although Wang does not explicitly describe this feature, a POSA would recognize that it is an inherent property of Wang's flutes. Indeed, shunting, also known as evacuating, cutting chips is one of the primary purposes served by flutes on a twist drill. The flute necessarily and inherently provides a passageway for chips to be transported out from where they are cut and exit the workpiece. The shape of a flute, in this case a helical flute, lifts the chips away from the workpiece and towards the shank of the drill by way of pressure from the cutting surfaces and previously generated chips. A POSA would recognize that the helical flutes shown

on Wang's Figures 5-12 serve the same purpose as flutes on other twist drills: evacuating, or shunting, chips (also known as swarf) from the hole being drilled.

16. Elements 1N and 8N: “wherein at least one cylindrical second step surface is immediately adjacent to a conical first step surface of a next composite cutting blade group” (the “Immediately Adjacent Limitation”)

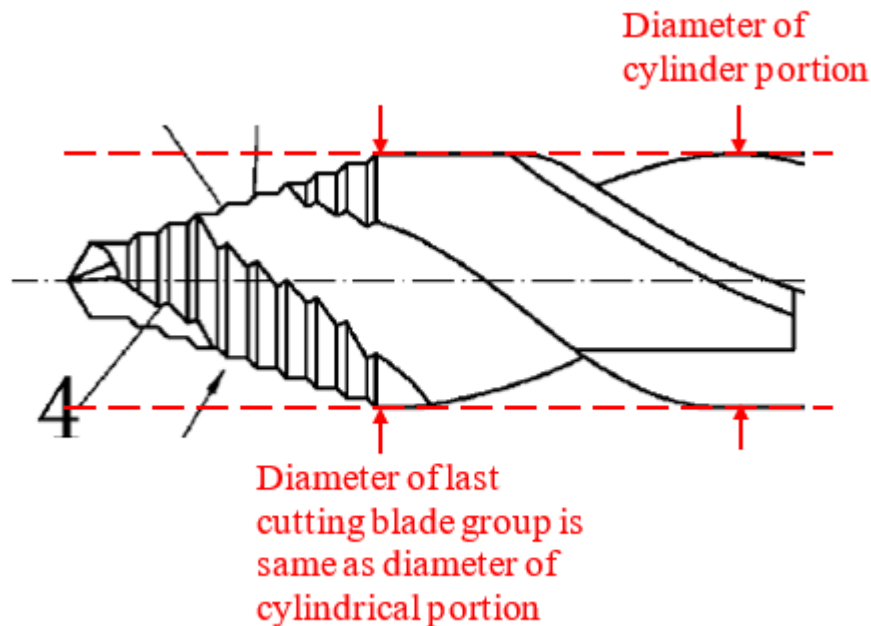
172. Wang's drill has at least one cylindrical second step surface of a first composite cutting blade group that is immediately adjacent to a conical first step surface of a next, second composite cutting blade group. Ex-1009, Figures 5-12, ¶[0031] (“[C]onnecting lines of the first cutting blades 5 and 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. Meanwhile, a cross section of the entire flank surface 3 is also a step-like structure.”). This is shown on the annotated version of Wang Figure 3 provided below.



17. Elements 1O and 8O: “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” (the “Diameter Is Equal Limitation”)

173. As I explained above with respect to claim construction, I have adopted a construction in which an arbitrary length of the cylindrical portion, although not actually part of the “cone portion,” can be included as part of the last composite cutting blade group. *See supra* Section IX.A. Using this interpretation, the diameter of the last composite cutting blade group which is located at the rear end of the cone portion in Wang and immediately adjacent to the cylinder portion is equal to the cylinder portion diameter. This can be seen in the annotated Wang

Figure 5, below.



18. Claims 1 and 8: Conclusion

174. As I have explained, Wang, in combination with Gentry, Durfee, and/or the knowledge of a POSA, discloses all of the elements of claims 1 and 8. Therefore these claims would have been obvious.

B. Dependent Claim 2

175. Dependent claim 2 adds the same limitation as set forth in element 8I' of claim 8 ("the minor cutting edge is configured to smooth the machined surface of the workpiece to improve surface quality") to claim 1, on which it depends. For the reasons I discussed above in connection with element 8I', Wang also discloses the limitation of claim 2 and it would have been obvious.

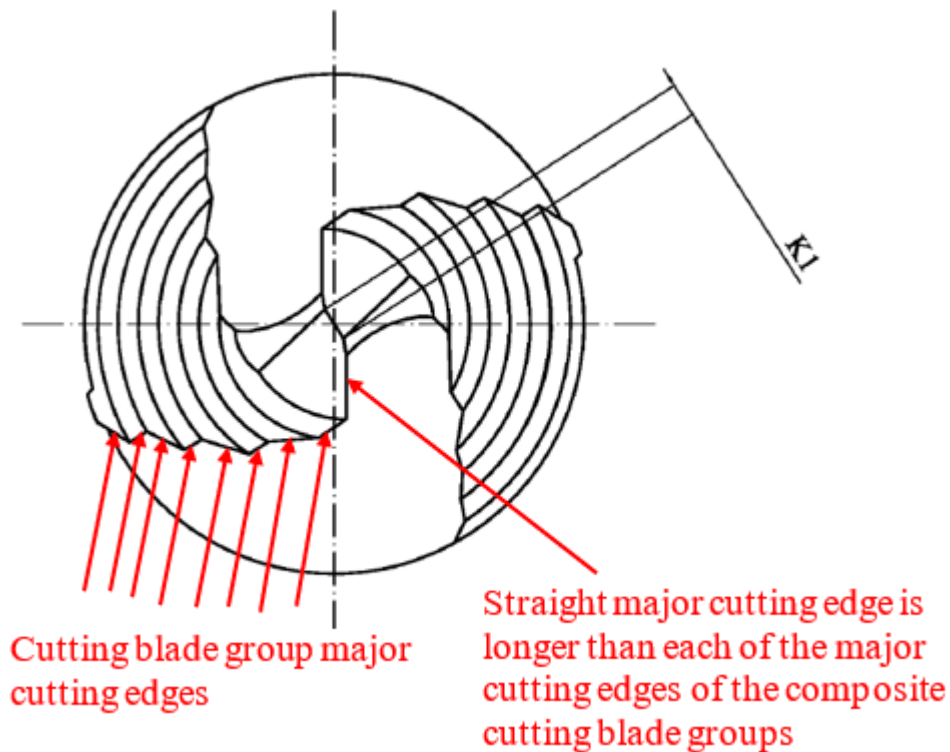
C. Dependent Claim 5

176. Dependent claim 5 adds the same limitation as set forth in element 8K' of claim 8 (“the top blade comprises a chisel edge, two auxiliary cutting edges and two straight major cutting edges, the auxiliary cutting edge is respectively intersected with the straight major cutting edge and the chisel edge”) to claim 1, on which it depends. For the reasons I discussed above in connection with element 8K', Wang also discloses the limitation of claim 5 and it would have been obvious.

D. Dependent Claims 7 and 12

177. Dependent claims 7 and 12 depend from claims 1 and 8, respectively, and add the further limitation “*wherein, 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.*” Ex-1001, Claims 7, 12.

178. Wang includes a top blade that has a straight major cutting edge. As Wang shows in Figures 5-12, the 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. *See, e.g.,* Ex-1009, Figure 12 (annotated below).



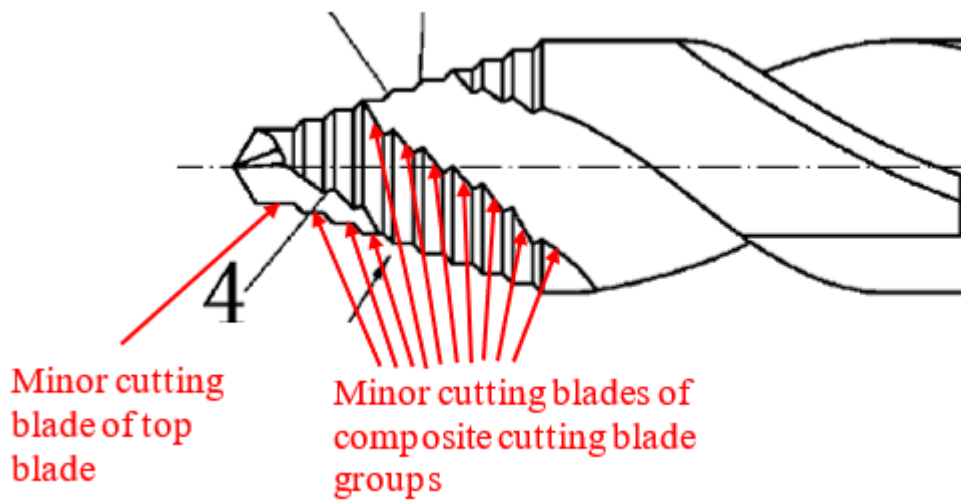
Thus, Wang teaches the limitations of these claims and they would have been obvious.

E. Dependent Claim 13

179. Dependent claim 13 depends from claim 8 and adds the further 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.*” Ex-1001, Claim 13.

180. Wang discloses a top blade having a straight minor cutting edge with a length that is greater than the length of the minor cutting edges of the plurality of composite cutting blade groups. In other words, Wang teaches a drill where the step height of the top blade is greater than the step height of any of the composite

cutting blade groups. See Ex-1009, Figure 5 (annotated below).



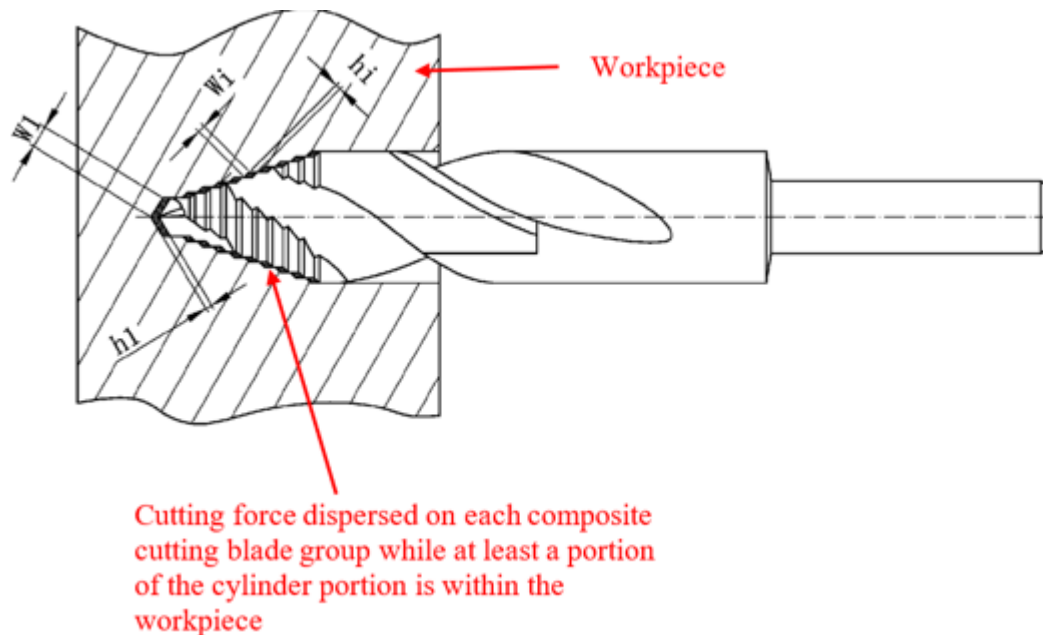
181. Thus, Wang teaches the limitations of this claim, and the claim would have been obvious.

F. Dependent Claim 14

182. Claim 14 depends from claim 8 and adds the further limitation “wherein, the operation portion is configured to disperse a cutting force on each of the plurality of composite cutting blade groups within a drill hole of a workpiece when at least a portion of the cylinder portion is also within the workpiece.” Ex-1001, Claim 14.

183. Wang’s operating portion is configured to disperse a cutting force across its composite cutting blade groups when, during drilling, the drill is sufficiently inserted into a drill hole of a workpiece so that at least a portion of the cylinder portion is within that drill hole. Wang does not explicitly describe this

trait, but a POSA would understand that the dispersal of cutting force during drilling is the inherent result of having a plurality of composite cutting blade groups, because each cutting blade group will engage the workpiece and apply at least some force to the workpiece. Because the total cutting force applied to the drill bit includes portions attributable to each composite cutting blade group, it can be said that the cutting force is “dispersed,” as claimed. Thus, under the construction of this Term (*see supra* Section IX.D) Wang inherently teaches this limitation because its drills have a plurality of composite cutting blade groups that are configured to simultaneously engage a workpiece during operation, thereby dispersing a cutting force, as is shown in the annotated version of Wang Figure 9 below.



184. Wang teaches the benefits of this arrangement: “[i]n the gradual

drilling and hole expanding processes, compared with the one process continuous cutting of a conventional twist drill, the cutting resistance is reduced, and the feeding is easy and fast. *Id.*, ¶[0039]. Thus, Wang teaches the limitations of claim 14 and it would have been obvious.

G. Dependent Claims 15 and 19

185. Claims 15 and 19 depend from claims 1 and 8, and add the further limitation “*wherein the cylinder portion is longer than the cone portion.*” Ex-1001, Claims 15, 19. Wang’s twist drill has a cylinder portion that is longer than the cone portion, as seen in annotated Wang Figure 5 below.

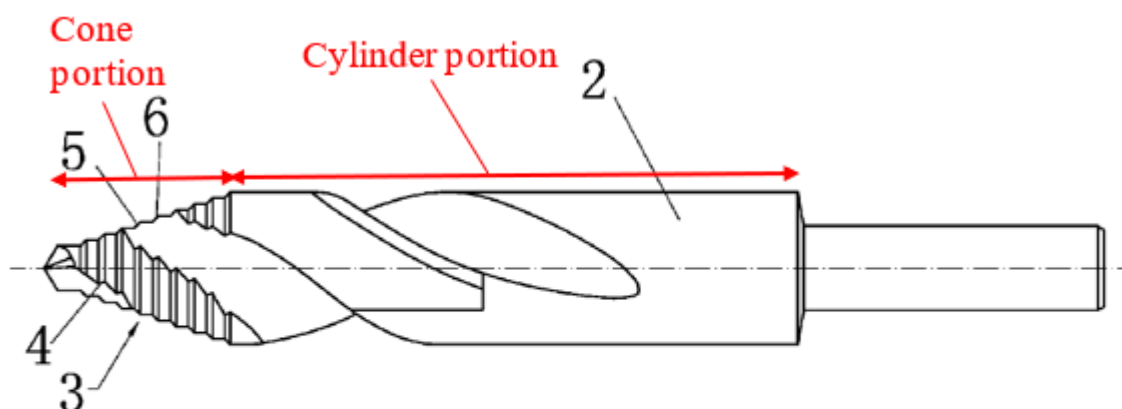


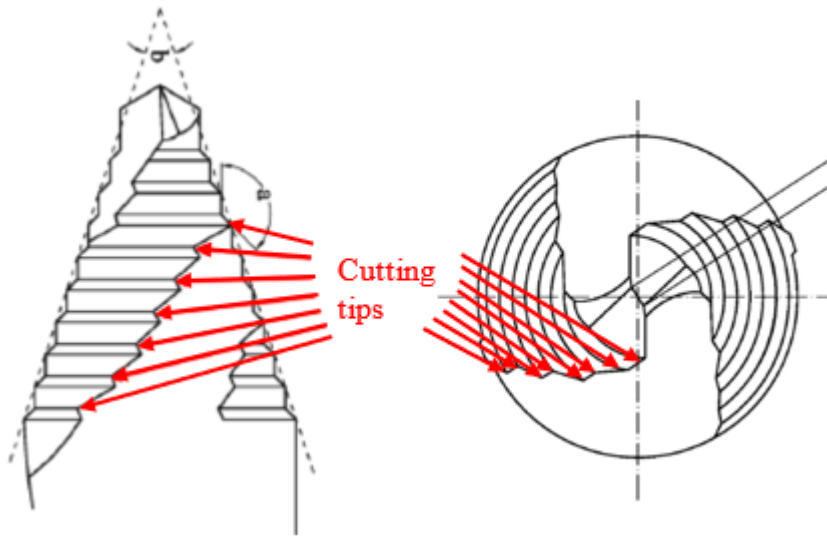
Fig.5

186. Thus, Wang teaches the limitations of these claims and they would have been obvious.

H. Dependent Claims 18 and 22

187. Claims 18 and 22 depend from claims 1 and 8, and add the further

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.” Ex-1001, Claims 18 and 22. Wang’s cutting tips are formed at the edges of the spiral flutes, and so the cutting tips are formed spirally on the cone portion. See, e.g., Ex-1009, Figures 7 and 8 (annotated below).



188. Thus, Wang teaches the limitations of these claims and they would have been obvious.

XIII. OPINION 2: CLAIMS 1, 2, 5, 7, 8, 12, 14, 15, and 19 WOULD HAVE BEEN OBVIOUS BASED ON BANNISTER IN VIEW OF ZHOU OR WELTY, AND/OR THE KNOWLEDGE OF A POSA

A. Independent Claims 1 and 8

1. Elements 1A and 8A: Preamble

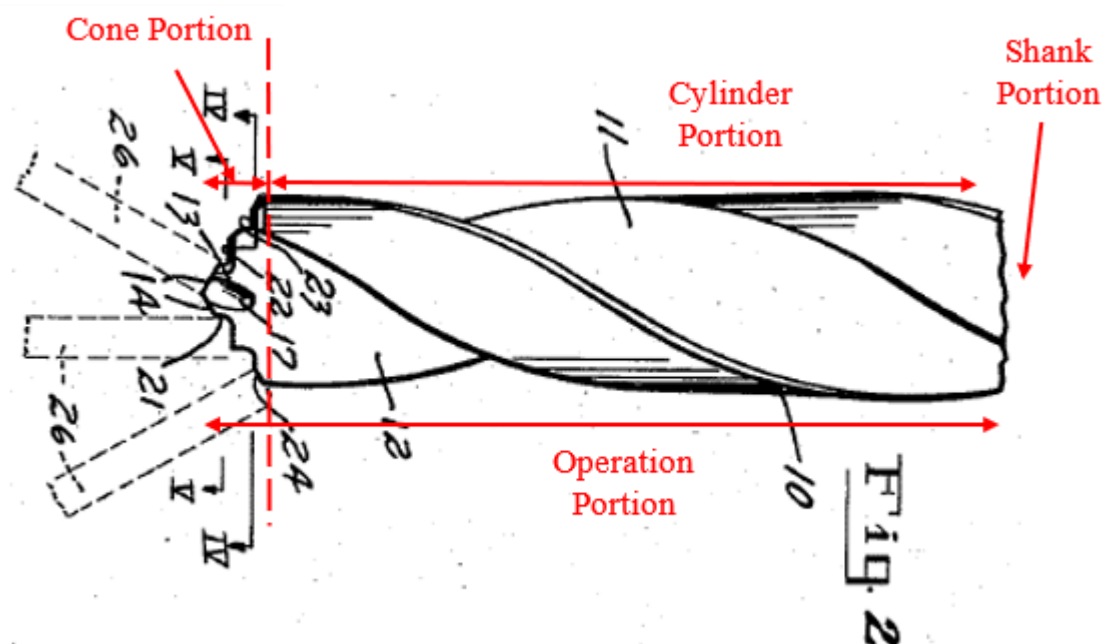
189. Even assuming the preamble is limiting, Bannister discloses this limitation. Bannister is titled “Twist drill.” Bannister is generally directed to twist

drills, and the opening sentence of the patent states: “[m]y invention relates to metal working twist drills.” See Ex-1006, p.1, 1:1-2.

2. Elements 1B and 8B: the Operation Portion Limitation

190. Bannister discloses a twist drill having an operation portion, i.e., a portion of the drill that cuts, smooths, removes chips from, and otherwise works and interacts with a workpiece. Ex-1006, Figures 1-2; p.1, 1:1–p.2, 1:31; p.2, 1:32 – p.3, 1:11. Like many twist drills, the operation portion of Bannister’s drill comprises a cone portion and a cylinder portion axially fixed to the cone portion.

Id. For example, see Petitioner’s annotations to Bannister Figure 2 below:



191. More specifically, Bannister’s cone portion is the end portion of the drill where the diameter increases from that of the cylinder portion towards a point at the tip of the drill, thereby forming a generally conically shaped structure. A

POSA would understand that as the drill rotates about its longitudinal axis, such as during drilling operation with a constant axial feed rate, the cone portion sweeps along a path that is generally conical. That is, it is conical in projection.

Bannister's cylinder portion is the middle portion of the drill having a constant maximum diameter and a generally cylindrically shaped structure. A POSA would understand that as the drill rotates about its longitudinal axis, such as during a drilling operation, the cylindrical portion sweeps along a path that is generally cylindrical. That is, it is cylindrical in projection. Although it is not explicitly described in Bannister, it is apparent from the figures and necessarily true the cone portion and cylinder portion are formed from a single unitary piece and so are "axially fixed" to one another. Furthermore, the cone portion is generally coaxial with the cylinder portion, which is necessary for the drill to bore straight and accurate holes. These portions are "fixed" in that they are necessarily rigidly connected so that the cone portion can be driven by torque transmitted from the cylinder portion (which itself is driven by a shank), allowing it to cut a workpiece.

192. Thus, Bannister discloses this limitation.

3. Elements 1C and 8C: the Shank Portion Limitation

193. Bannister discloses a shank portion axially fixed to the cylinder portion opposite the cone portion. Although Bannister does not explicitly describe or depict a shank portion, this is inherent in Bannister's disclosure as a shank is a

standard twist drill feature that is necessary for Bannister's twist drill to function. Likewise, it is inherent and necessary that the shank portion of Bannister is axially fixed to the cylinder portion opposite the cone portion. The location of Bannister's shank portion is shown on the annotated version of Bannister Figure 2 provided above for elements 1B and 8B.

194. Bannister's Figures only depict a distal end of the drill (i.e., an end toward the tip of the drill) and do not show the full extent of the cylinder and the shank portions (see annotated representation of Figure 2 above). The break line on Bannister's Figure 2 shows where a proximal end of the drill would extend. A POSA would understand from Figure 2 that this unshown portion of the drill would include the full length of the cylinder portion (i.e. a continuation of the cylinder portion that is visible) and a shank portion. A shank portion, or shank, would necessarily be present because it provides the structure necessary for the drill to couple to a drilling machine, such as the chuck of a drill press or hand drill. All twist drills have shanks, which are necessary to couple to a machine and thereby render the twist drill usable.

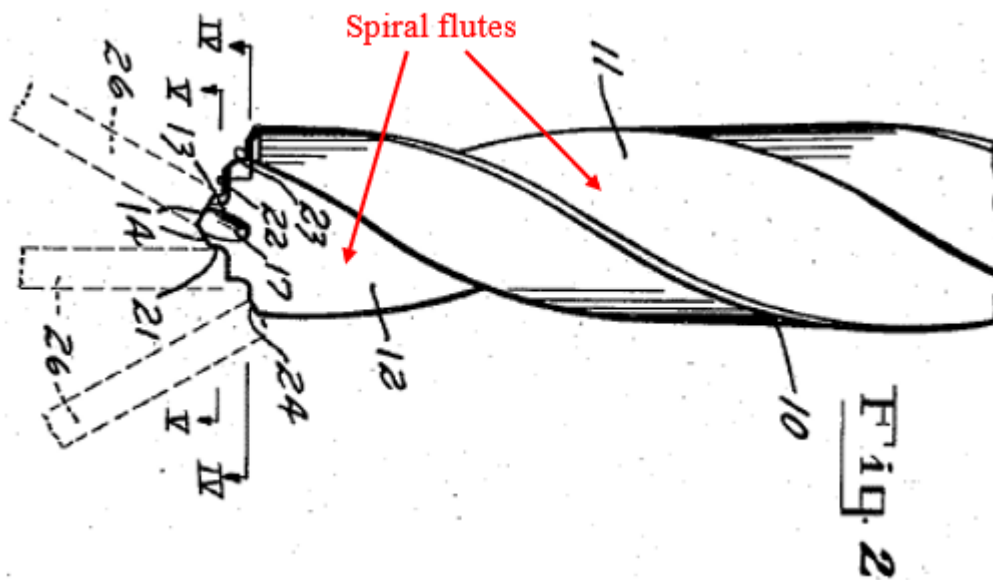
195. Although not shown in Bannister's Figures, it is inherent that the shank portion is axially fixed to the cylinder portion and an end opposite from the cone portion. First, it is necessary that the shank portion is axially fixed to the cylinder portion. The shank needs to be positioned along the axis of rotation in

order to drive the drill by torque transmitted from a drilling machine. The shank needs to be coaxial with the cylinder portion, or else the cylinder portion and cone portion affixed thereto would be radially offset from the axis of rotation and “wobble” during operation. Second, the cylinder portion has only two ends, one affixed to the cone portion and one affixed to the shank portion. These portions are “fixed” in that they are necessarily rigidly connected so that cylinder portion can be driven by torque transmitted from the shank portion, which in turn transmits the torque to the cone portion to cut a workpiece.

196. Thus, a POSA would understand that a shank inherently would be present on Bannister’s drill but out of view where the break line is drawn in Bannister’s Figures 1 and 2. Moreover, to the extent a shank portion is not inherently disclosed in Bannister, it would have been obvious to have a shank portion for the obvious and necessary purpose of attaching it to a drill chuck.

4. Elements 1D and 8D: the Spiral Flute Limitation

197. Bannister’s drill has spiral flutes (e.g. main flutes 11 and 12) formed on an exterior surface of the operating portion, extending from a front end of the cone portion and at least partway up the cylinder portion. See Ex-1006, Figure 2 (annotated below); p.1, 1:1 – p.2, 1:31; p.2, 1:32 – p.3, 1:11. The flutes have sidewalls. *Id.*, Figures 1-2.

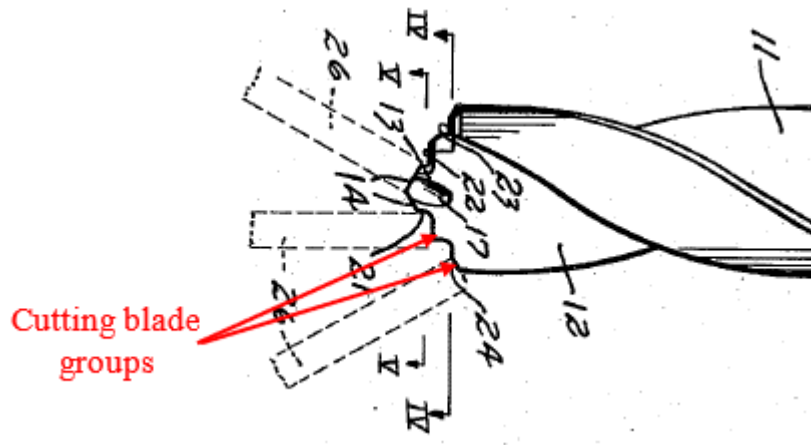


198. Such flutes are generally defined by a recessed surface formed by a cut made into the exterior surface of the body of the drill. The recessed surface geometrically defines the sidewall of the flute. It is readily apparent from Bannister Figure 2 that one end of Bannister’s spiral flute begins/ends at a front end of the cone portion, i.e., the tip of the drill. Ex-1006, Figure 2. It is also apparent that this spiral flute extends at least partway into the cylinder portion. *Id.*, Figure 2.

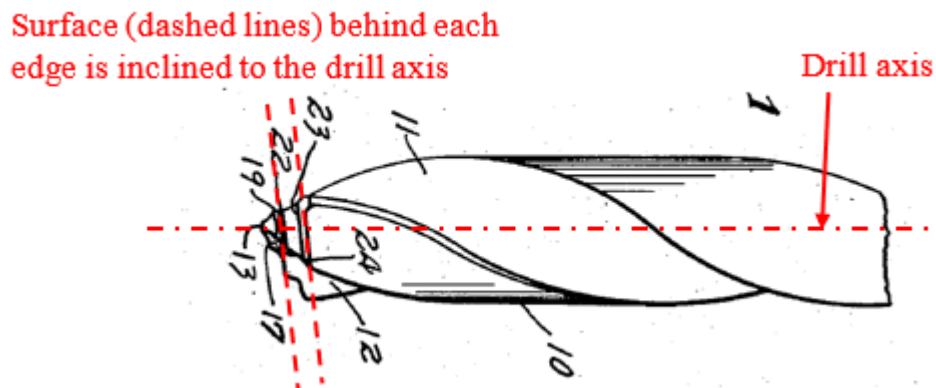
5. Elements 1E and 8E: the Composite Cutting Blade Groups Formed Sequentially and Spirally Limitation

199. Bannister’s twist drill has composite cutting blade groups formed sequentially on a cone portion exterior from a front end of the cone portion to a rear end of the cone portion. Bannister states: the “drill is next ground...with a series, or plurality of steps, of cutting edges 22 and 23, which are normal to the

main axis of the drill 10...The last cutting edge 24 of the drill...is preferably bevelled.” Ex-1006, p.2, 1:72-2:6. The composite cutting blade groups increase in diameter from the tip towards the cylinder portion, as can be seen on the annotated representation of Bannister Figure 2 below.



200. As I described above with respect to claim construction, the composite cutting blade groups are formed “spirally” if they are slanted relative to the longitudinal axis of the drill, and includes the slant formed by virtue of the presence of axial relief. Bannister teaches that the composite cutting blade groups have axial relief. See Ex-1006, Figure 1 (annotated below) and p.2, 1:75 – 2:4 (“the plane of the surface behind each edge is inclined to the axis of the drill, as shown in FIG. 1, in order to provide axial clearance for the drill so that it will feed at the desired rate of speed.”).



Thus, Bannister teaches this limitation.

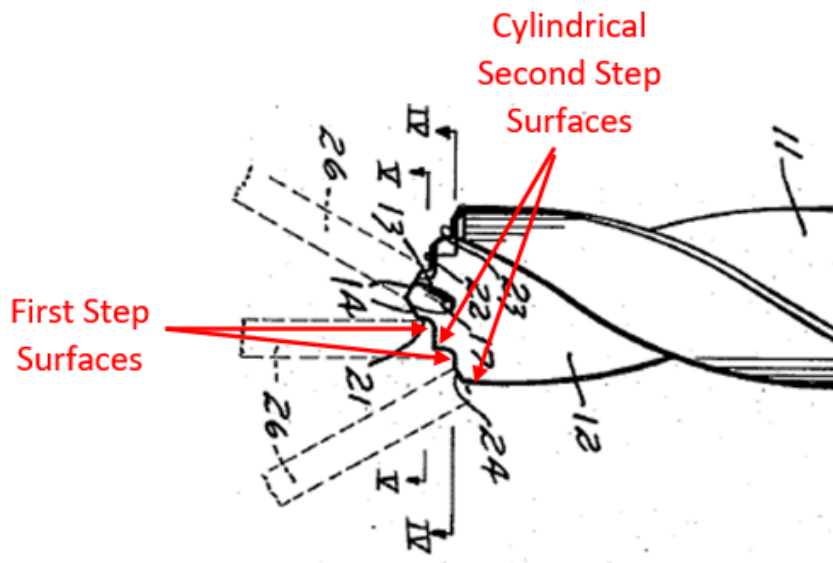
201. Moreover, even if Bannister was found not to disclose this limitation, it would have been obvious to add axial relief to Bannister's drill, thus meeting this limitation. It was very well known in the art that various types of relief, including axial relief, should be employed in order to prevent rubbing during drilling.

Without relief, a large surface area of a drill would rub against the workpiece being cut, causing significant friction. This would require excessive torque to drive the drill, generate excessive heat, limit the service life of the drill, and lead to a poor surface finish on the machined workpiece. The high heat would likely require more exotic and expensive tool materials. Relief reduces the surface area of a drill that contacts a workpiece and reduces these effects. Examples of relief can be seen, for example, in Welty which shows a step drill with a plurality of steps similar to the steps in Bannister's drill, and which shows and describes axial relief that prevents rubbing along the conical flank surfaces of the steps. Ex-1008, Figure 1. Other examples of axial relief being taught in the prior art include Ex.

1007, ¶[0008]; Ex-1010, Figure 1, 1:60-62 and 2:20-23; and Ex-1011, Figure 2, 11:27-53, as described above in Section XI. A POSA would have been motivated to add axial relief to the cutting blade groups of Bannister, thereby imparting a slant to Bannister's cutting blade groups, in order to obtain the known benefit of preventing rubbing along the flank surface. A POSA would also have a reasonable expectation of success in doing so, as axial relief is a common, standard feature in the drilling art.

6. Elements 1F and 8F: the Conical First Step Surface Limitation

202. Each composite cutting blade group of Bannister's drill has a first step surface, as shown on the annotated representation of Figure 5. However, Bannister's twist drill does not have conical step surfaces, but instead has cutting edges 22, 23 that are normal to the axis of the drill. See Ex-1006, Figure 2, p.2, 1:72-75. This is shown on the annotated representation of Bannister Figure 2 provided below.



203. However, Bannister does teach that the last cutting edge 24 can be bevelled.⁸ *Id.*, p.2, 2:4-6. Moreover, conical first step surfaces were well known in similar prior art drills with stepped tips, such as those shown in Zhou and Welty. A POSA would know that conical first step surfaces such as those shown in Zhou and Welty have advantages such as reduced drilling axial resistance and torque (because the major cutting edge more gradually engages the workpiece) and more accurate and round drilling holes. Also, a POSA would understand that a cutting edge wears more slowly when the cutting force is applied over a longer distance to cut the same amount of material, i.e. when the cutting edge is angled relative to the

⁸ The bevel results from the angle of the grinding wheel 26 on the last cutting edge 24, shown in Figure 2.

drill axis, rather than orthogonal to the drill axis. Furthermore, cylindrical conical surfaces aid in centering the drill and reducing torque because only the top-most portion of the cylindrical surface cuts into the workpiece when initially plunged into the workpiece, whereas the entirety of a horizontal cutting surface cuts into the workpiece when initially entering the workpiece. Additionally, a POSA would reasonably expect that the use of conical step surfaces would be successful in providing an efficient drill tip, as cylindrical surfaces were widely used on stepped drill surfaces e.g., Ex-1007, Figures 1-3; Ex-1008, Figure 1; Ex-1011, Figures 1-2; Ex-1012, Figures 1, 7 and 2:26-36.

7. Elements 1G and 8G: the Cylindrical Second Step Surface Limitation

204. Each composite cutting blade group of Bannister's drill has a cylindrical second step surface adjacent to the first step surface. Ex-1006, Figures 1-2, p.1, 1:1 – p.2, 1:31; p.2, 1:32 – p.3, 1:11. This can be seen in the annotated representation of Bannister Figure 2 provided above for elements 1F and 8F.

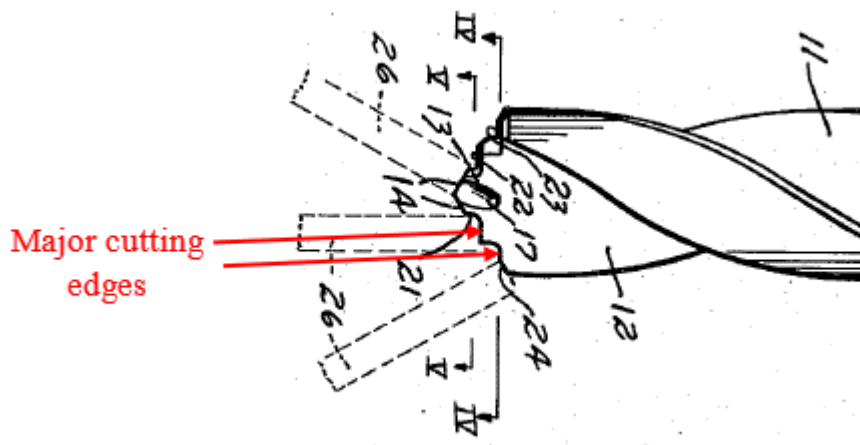
205. Although the cylindrical step surfaces pointed to in Bannister Figure 2 above do not form complete cylinders, a POSA would understand that in the context of the '583 patent, "cylindrical" means cylindrical barring the void(s) formed by the flute(s) and any changes to the geometry due to relief, such as radial or diametral relief. That is, the surfaces are generally cylindrical in shape. Likewise, when the drill is rotated, the cylindrical second step surfaces would

sweep along a generally cylindrical path. That is, they are cylindrical in projection. Thus, a POSA would describe the second step surfaces shown in Bannister Figure 2 as cylindrical.

206. Thus, as modified to have a conical first step surface (Element 1F), the composite cutting blade groups each have a cylindrical second step surface adjacent to a conical first step surface. Other references discussed above with reference to elements 1F and 8F as showing conical first step surfaces also have adjacent cylindrical second step surfaces. *See, e.g.*, Ex-1007, Figures 1-3; Ex-1011, Figures 1-2; Ex-1012, Figures 1, 7 and 2:26-36.

8. Elements 1H and 8H: the Major Cutting Edge Limitation

207. Bannister's drills have a major cutting edge which is defined by the intersection of the first step surface and the sidewall of the flute, as shown in the annotated representation of Bannister Figure 2 below. *See* Ex-1006, Figures 1-2; p.1, 1:1 – p.2, 1:31; p.2, 1:32 – p.3, 1:11.



208. Specifically, Bannister states “The central grinding unit 13 and each succeeding grinding unit formed by the stepped cutting edges, forms a pilot for the succeeding larger drilling unit” Ex-1006, p.2, 2:49-52.

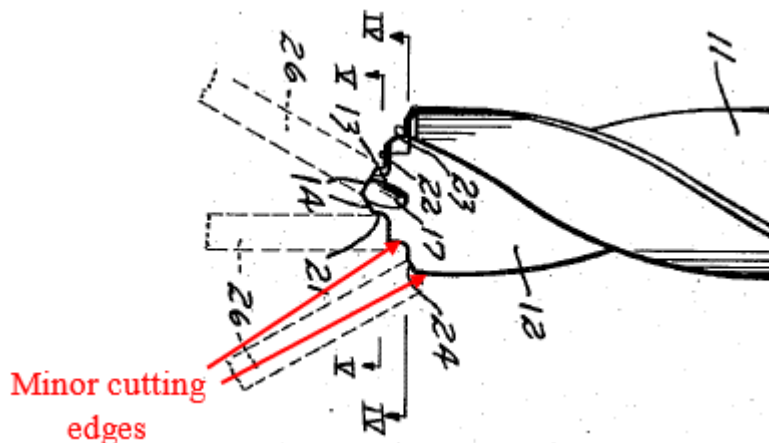
209. Simply viewing Bannister Figure 2 and observing the intersection of the sidewall of the flute and the conical first step surface is sufficient to show that this element is present. But for context, I understand that these edges are “cutting” edges because they are among the edges on the drill that cut a workpiece when Bannister’s drill is in operation. I can determine from the figures that, like most drills, when cutting, Bannister’s drill is configured to be rotated clockwise when viewed from behind the drill when the tip of the drill is pointed away from the viewer. When rotated accordingly, Bannister’s major cutting edges would contact a workpiece and shear off a layer therefrom, thereby forming chips. In other words, Bannister’s major cutting edges would shear or cut off a portion of a workpiece. And although I understand that the term “major” may be an arbitrary label used by the claim drafter, for context, these cutting edges of Bannister would perform a significant amount of the cutting work and material removal when Bannister’s drill is in use. As Bannister’s drill would be advanced into a workpiece, these edges would be in contact with the material still present at the annular rings of the cutting edges.

210. Thus, as modified to make the first step surface conical (see Elements

1F and 8F), Bannister meets this limitation. Other references discussed above with reference to elements 1F and 8F as showing conical first step surfaces also have major cutting edges defined by conical first step surfaces and a spiral flute. *See, e.g.,* Ex-1007, Figures 1-3; and Ex-1008, Figure 1; Ex-1011, Figures 1-2; Ex-1012, Figures 1, 7 and 2:26-36.

9. Elements 1I and 8I: the Minor Cutting Edge Limitation

211. Bannister's drills have a minor cutting edge which is defined by the intersection of the cylindrical second step and the sidewall of the flute, which is shown in the annotated representation of Bannister Figures 2, below. *See* Ex-1006, Figures 1-2; p.1, 1:1 - p.2, 1:31; p.2, 1:32 – p.3, 1:11.



212. Simply viewing Bannister Figure 2 and observing the intersection of the sidewall of the flute and the cylindrical second step surface is sufficient to show that this element is present. But for context, I understand that these edges are “cutting” edges because they are among the edges on the drill that may cut,

smooth, or otherwise work a workpiece when Bannister's drill is in operation. As described above for elements 1H and 8H, Bannister's drill is configured to be rotated clockwise when viewed from behind the drill in use. When rotated accordingly, Bannister's minor cutting edges would contact any asperities or other protrusions and cut them off or otherwise improve the hole roundness or smooth the workpiece. And although I understand that the term "minor" may be an arbitrary label used by the claim drafter, for context, these cutting edges of Bannister would not remove as much material as the major cutting edges when Bannister's drill is in use. More specifically, the major cutting edges would have already removed the majority of the workpiece by the time the minor cutting edges would enter that portion of the workpiece, so only asperities or errors of form not fully removed by the major cutting edges would be cut by Bannister's minor cutting edges.

213. Other references discussed above with reference to elements 1F and 8F as showing conical first step surfaces also have minor cutting edges defined by cylindrical second step surfaces and the sidewalls of a spiral flute. *See, e.g.*, Ex-1007, Figures 1-3; Ex-1011, Figures 1-2; Ex-1012, Figures 1, 7 and 2:26-36.

10. Element 8I': the Minor Cutting Edge Smoothing Limitation

214. Bannister's minor cutting edges are configured to smooth the machined surface of the workpiece to improve the surface quality. This smoothing

of the machined surface of a workpiece inherently results from the geometry of the minor cutting edges, which are positioned on the intersection of the flute sidewalls and the cylindrical step surfaces. Ex-1006, Figures 1-2. These edges would therefore sweep in a cylindrical path around a portion of the workpiece first cut by the major cutting edges (as I describe above), thereby smoothing it. This is essentially a shaving operation, where the depth of cut is small and the surface fidelity (shape and surface quality) is high. Shaving on the side flutes has always been a feature of drilling operations.

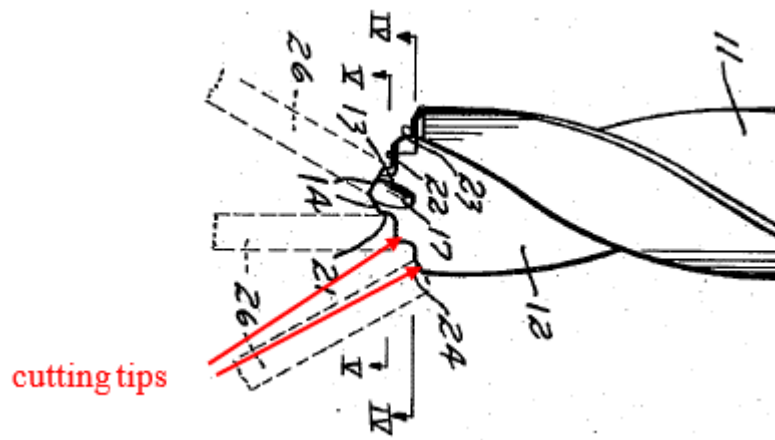
215. As one example, Bannister's minor cutting edges can simply shear off any material that protrudes into the path of the minor cutting edge as it sweeps along during rotation. They are also inherently capable of smoothing a machined surface through burnishing as they will rub against the machined surface and plastically deform asperities to improve the surface roughness and shape fidelity.

216. Thus, Bannister inherently discloses this element.

11. Elements 1J and 8J: the Cutting Tip Limitation

217. Bannister's twist drill has a cutting tip defined by the intersection of the minor cutting edge, the major cutting edge, and the sidewall of the flute, which is shown in the annotated representation of Bannister Figure 2 provided below. Ex-1006, Figures 1-2, p.1, 1:1 - p.2, 1:31; p.2, 1:32 – p.3, 1:11. The intersection between a respective major and minor cutting edge and the sidewall of the spiral

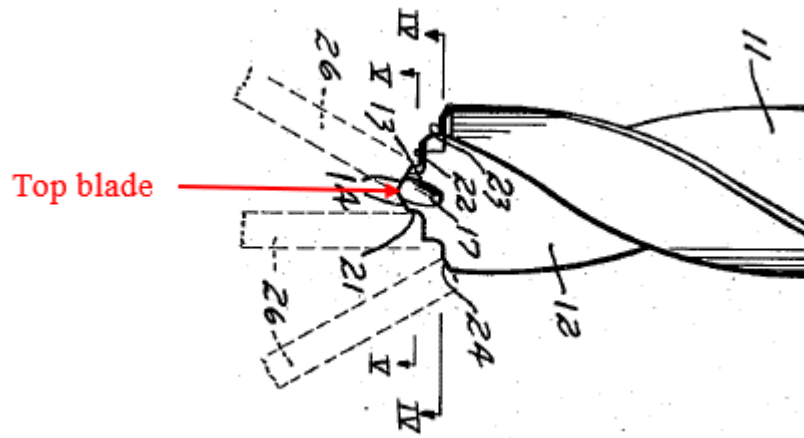
flute is a cutting point or tip.



218. Thus, as modified to make the first step surface conical (see Element 1F), Bannister meets this limitation. Other references discussed above with reference to elements 1F and 8F as showing conical first step surfaces also have cutting tips defined by the intersection of the minor cutting edge, a major cutting edge and the sidewall of the spiral flute. See, e.g., Ex-1007, Figures 1-3; Ex-1008, Figure 1.; Ex-1011, Figures 1-2; Ex-1012, Figures 1, 7 and 2:26-36.

12. Elements 1K and 8K: the Top Blade Limitation

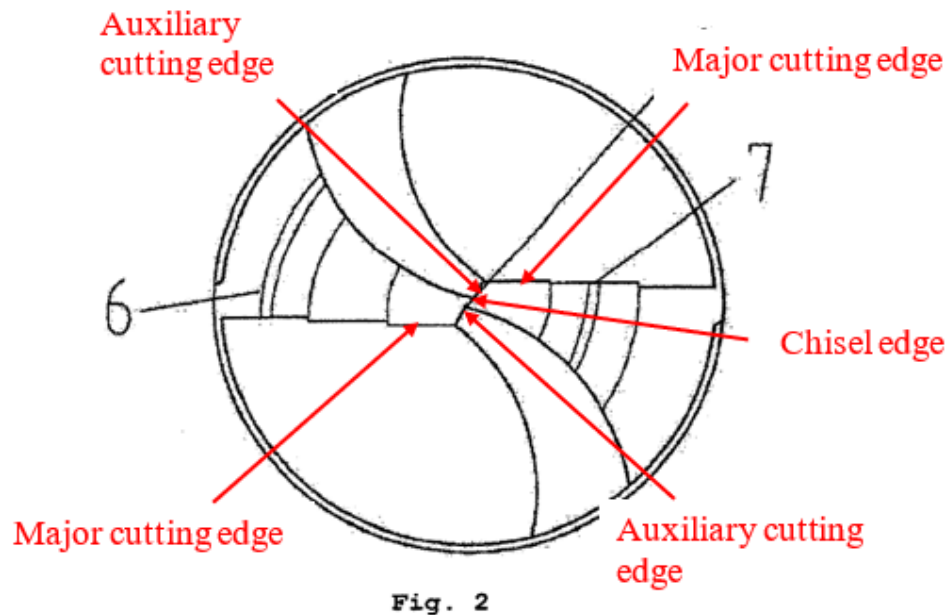
219. Bannister's drill has a top blade provided on the front end of the cone portion. Specifically, Bannister refers to "a central drilling unit 13 having bevelled cutting edges 14, and provided with auxiliary flutes 17 and 18 which merge into the main flutes 11 and 12," which can be seen on the annotated representation of Bannister Figure 2 provided below. Ex-1006, Figure 2, p.2, 1:49-53. Thus, Bannister discloses this limitation.



13. Element 8K': the Top Blade Structure Limitation

220. Claim 8 specifies that the top blade “*comprises a chisel edge, two auxiliary cutting edges and two straight major cutting edges, the auxiliary cutting edge is respectively intersected with the straight major cutting edge and the chisel edge.*” Ex-1001, Claim 8. A POSA would understand this claim language describes a split point tip, which as I have described above, is a very well-known and standard type of drill tip. The ubiquity of split point tips in the art is unquestionable, and examples include those shown in Ex-1023, 5-10, 17, 19-20, 24; Ex-1024 (noting that “#3: Standard 135° Split Points”); Ex-1025, 15-17. One example of a reference teaching a split point tip is Zhou, which shows a top blade that comprises a chisel edge, two auxiliary cutting edges and two straight major cutting edges. Ex-1007, Figure 2; *see also id.*, ¶[0024] (“The chisel edge is ground by a cross-sharpening method”). The auxiliary cutting edge is also respectively intersected with the straight major cutting edge and the chisel edge. Ex-1007,

Figure 2 (annotated, below).

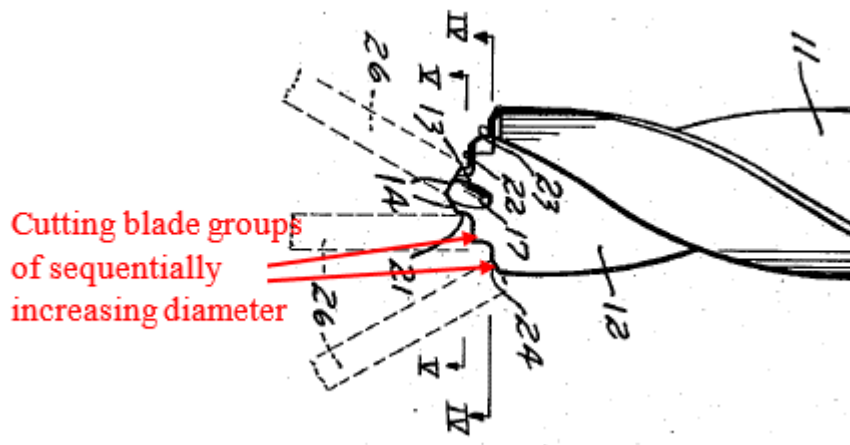


221. It was known that this type of point provides fast penetration into the workpiece and accurate starting. *See e.g.*, Ex-1023, 6. Such designs were well known and were widely used. A POSA would have been motivated to provide Bannister's drill with the well-known split point tip for the advantages of accurate starting and fast penetration in order to further Bannister's objective of drilling straight and round holes, Ex-1006, p.2, 2:49-56, and would have had a reasonable expectation of success in doing so, as it was a widely-use feature that POSAs routinely designed into twist drills.

222. Therefore, claim 8 would have been obvious for the same reason as claim 1, plus the additional teaching of a split point tip as provided by Zhou.

14. Elements 1L and 8L: the Diameter Increases Sequentially Limitation

223. The diameter of each of Bannister's composite cutting blade groups increases sequentially from the front end of the cone portion to the rear end of the cone portion. Ex-1006, Figure 1-3 (annotated below); p.1, 1:1 - p.2, 1:31; p.2, 1:32 – p.3, 1:11. This is shown on the annotated representation of Bannister Figure 2, below.



224. This claim element does not explicitly refer to a particular diameter, and only states that “a diameter . . . increases” Ex-1001, Claims 1 and 8. A POSA would understand this language to encompass a maximum diameter of each cutting blade group (i.e., the maximum overall diameter of the drill at that axial location), which in Bannister, is the diameter at each of the cutting cylindrical second step surfaces. It is readily apparent from Bannister Figure 2 that the diameter at the cylindrical second step surfaces is smaller for cutting blade groups located towards the front of the cone portion (i.e., towards the tip of the drill, or

towards the top blade) than it is for cutting blade groups located towards the rear end of the cone portion (i.e., towards the cylinder portion of the drill).

225. Thus, Bannister discloses this limitation.

15. Elements 1M and 8M: the Configured to Crush Limitation

226. As I described above, I have adopted Patent Owner’s construction of “configured to crush cutting chips into finer chips” for the purpose of this analysis. Under this construction, Bannister teaches this element. Although Bannister does not explicitly describe crushing cutting chips or forming relatively small cutting chips, Bannister inherently teaches this element because a POSA would recognize that Bannister’s drill is configured to create cutting chips that are smaller than they would be if the drill did not have composite cutting blade groups.

227. If Bannister’s drill did not have composite cutting blade groups, a POSA would understand that it would be nothing more than a standard two-blade, split point twist drill such as the exemplar depicted in the Handbook at Figure 9-15, reproduced above in Section VI.A. On such a standard two-bladed twist drill, two major cutting edges (i.e., lips) extending from the split point tip (i.e., top blade) to the outer diameter of the drill would do the majority of the cutting. Each cutting blade would shear chips from a workpiece having a width approximately equal to the length of each respective cutting blade. In Bannister, however, the majority of the cutting is distributed among the multiple major cutting blades of

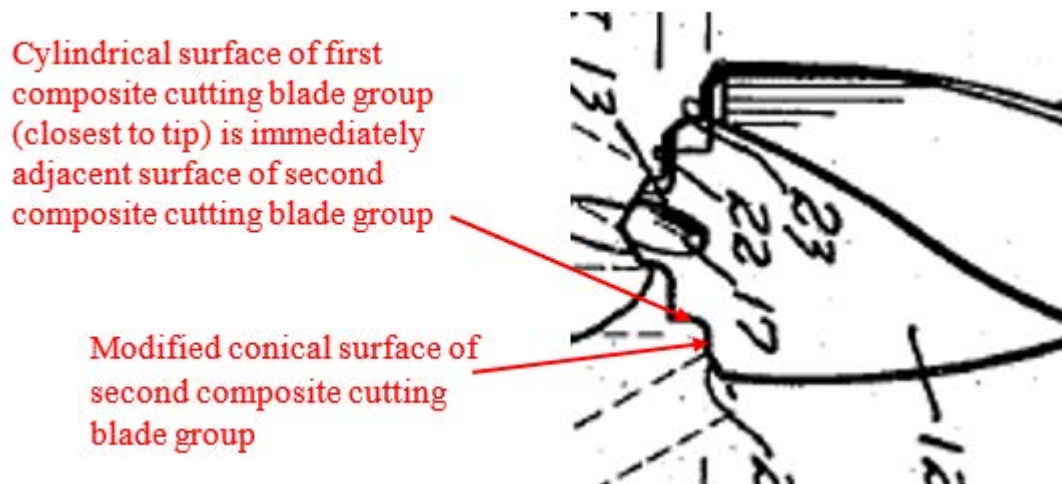
each composite cutting blade group. A POSA would recognize that each composite cutting blade group would shear chips from a workpiece having a width approximately equal to the length of the respective major cutting edge. Thus, instead of relatively large chips having a width approximately equal to the distance from the split point tip (i.e., top blade) to a maximum outer diameter of the drill, Bannister would create a greater number of smaller chips having a width approximately equal only to the length of the major cutting edges. Under the construction I have adopted for this claim language, a POSA would recognize that Bannister's composite cutting blade groups meet this claim limitation.

228. Bannister also teaches a spiral flute configured to shunt the finer chips. First, as explained above, Bannister's drills are configured to create "finer chips." The flutes (11 and 12 shown in Figures 1-2) of Bannister's drills are configured to shunt the chips formed by the operation of the drill. Ex-1006, Figures 1-3; p.1, 1:1 - p.2, 1:31; p.2, 1:32 – p.3, 1:11. Bannister specifically describes that "[t]he chips from the small drill unit are carried up the auxiliary flutes into the main flutes and thence off with the chips from the other drill units." *Id.*, p.1, 2:54 – p.2, 1:2. Indeed, shunting, also known as evacuating, cutting chips is one of the primary purposes served by flutes on a twist drill. The flute provides a passageway for chips to be transported out from where they are cut and exit the workpiece. The shape of a flute, in this case a helical flute, lifts the chips away

from the workpiece and towards the shank of the drill by way of pressure from the cutting surfaces and previously generated chips.

16. Elements 1N and 8N: the Immediately Adjacent Limitation

229. As modified according to Elements 1F and 8F, Bannister's drill has at least one cylindrical second step surface of a first composite cutting blade group that is immediately adjacent to a conical first step surface of a next, second composite cutting blade group. Ex-1006, Figures 1-3; p.1, 1:1 - p.2, 1:31; p.2, 1:32 – p.3, 1:11. This is shown on the annotated version of Bannister Figure 2 provided below.

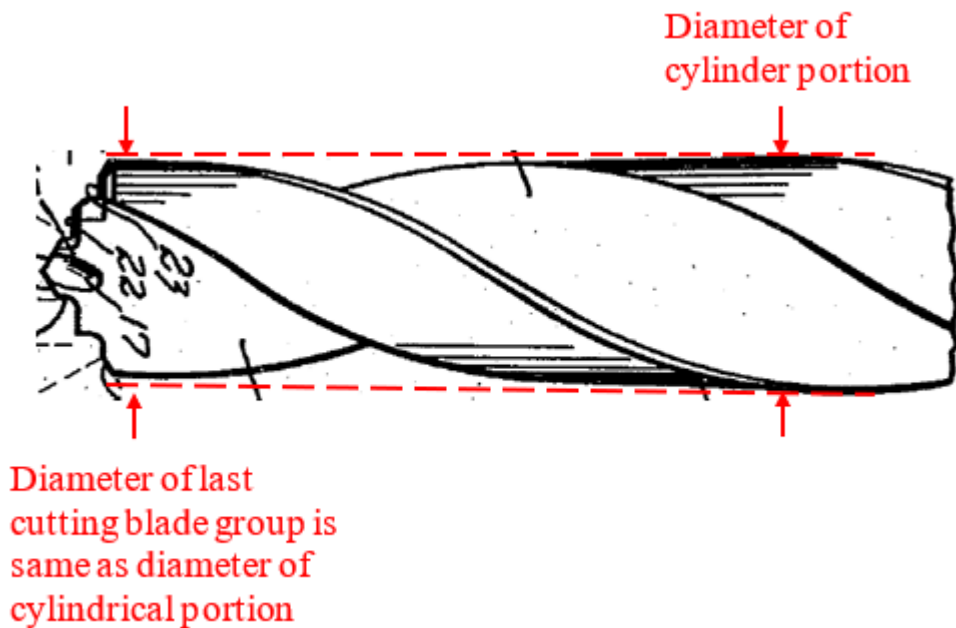


230. Thus, as modified to make the first step surface conical, Bannister meets this limitation.

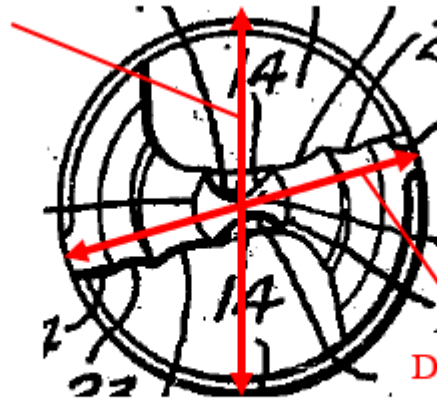
17. Elements 1O and 8O: the Diameter Is Equal Limitation

231. As I explained above with respect to claim construction, I have

adopted a construction in which an arbitrary length of the cylindrical portion, although not actually part of the “cone portion,” can be included as part of the last composite cutting blade group. *See supra* Section IX.A. Using this interpretation, the diameter of the last composite cutting blade group which is located at the rear end of the cone portion in Bannister and immediately adjacent to the cylinder portion is equal to the cylinder portion diameter. This can be seen in Petitioner’s annotations to Bannister’s Figures 2 and 3 below:



Diameter of cylindrical
portion



Diameter of last
cutting blade group is
same as diameter of
cylindrical portion

18. Claims 1 and 8: Conclusion

232. As I have explained, claims 1 and 8 would have been obvious based on Bannister in view of Zhou, and/or Welty and/or the knowledge of those skilled in the art.

B. Dependent Claim 2

233. Dependent claim 2 adds the same limitation as element 8I' of claim 8 (“the minor cutting edge is configured to smooth the machined surface of the workpiece to improve surface quality”) to claim 1, on which it depends. For the reasons I discussed above in connection with element 8I', claim 2 also would have been obvious based on Bannister in view of Zhou and/or Welty and/or the knowledge of those skilled in the art.

C. Dependent Claim 5

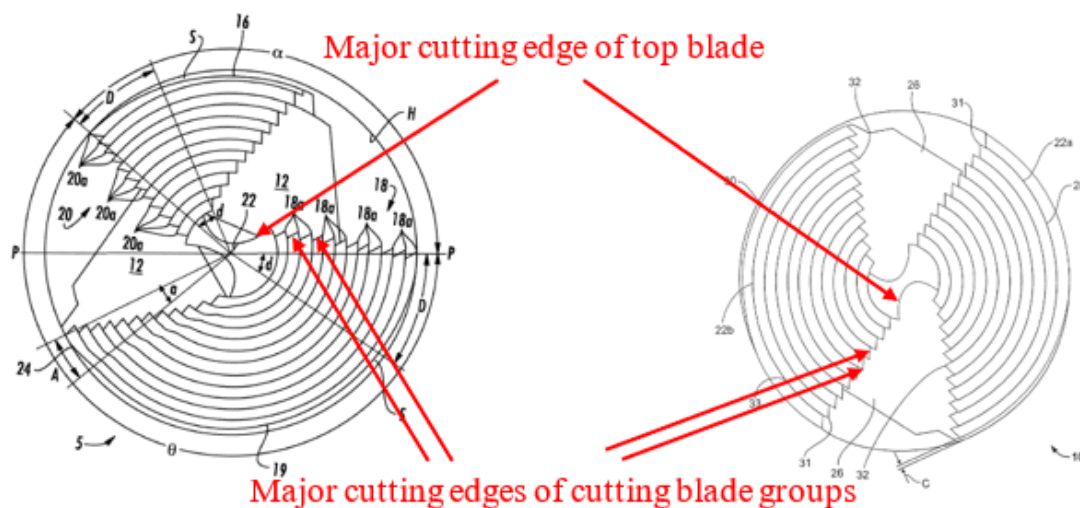
234. Dependent claim 5 adds the same limitation as element 8K' of claim 8 (“the top blade comprises a chisel edge, two auxiliary cutting edges and two straight major cutting edges, the auxiliary cutting edge is respectively intersected with the straight major cutting edge and the chisel edge”) to claim 1, on which it depends. For the reasons discussed above in connection with element 8K', claim 5 is also obvious over Bannister in view of Zhou and/or Welty, and/or the knowledge of those skilled in the art.

D. Dependent Claims 7 and 12

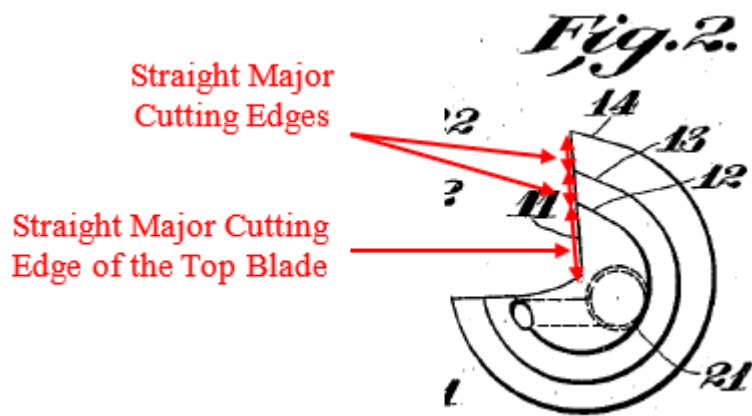
235. Claims 7 and 12 each recite “*wherein, a straight major cutting edge length of the top blade is greater than each of the major cutting edges of the plurality of composite cutting blade groups.*” Ex-1001, Claims 7, 12.

236. Bannister does not expressly teach a drill having a top blade with a straight major cutting edge having a length that is greater than each of the major cutting edges of the composite cutting blade groups. However, it would be obvious for a POSA to modify Bannister to have this feature. Doing so would be a matter of routine engineering choice. It is among a limited number of known design options for the top blade: having a top blade with major cutting edges that are longer than, shorter than, or the same length as the major cutting edges of the composite cutting blade groups. From these limited three choices, the claimed

configuration is known in the art. The prior art is replete with examples of similar drill having a top blade having straight major cutting edges that are longer than the major cutting edges of the composite cutting blade groups. For example, both Gentry and Durfee are configured in this way, as shown on the annotated representations of Gentry Figure 2 and Durfee Figure 4 provided below.



See Ex-1010, Figure 2; Ex-1011, Figure 4. Similarly, Welty teaches a drill having a top blade with a straight major cutting edge having a length that is greater than each of the major cutting edges of the composite cutting blade groups, as shown on the annotated representation of Welty Figure 2 provided below.



Having longer top blade major cutting edges that are longer also takes advantage of longer life, thus reducing the frequency with which the top blade would need to be sharpened.

237. Modifying Bannister in this way would be consistent with Bannister's disclosure. Bannister contemplates that the smallest drill unit (i.e., top blade) may set diameter regardless of the overall diameter of the drill. Ex-1006, p.2, 2:20-31. Therefore, as additional steps are added to accommodate larger drill diameters, having a top blade that is relatively large relative to an increasing number of steps would be a natural consequence of adding additional steps. Moreover, Bannister explicitly states that "While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various changes and modifications." *Id.*, p.3, 1:3-7. Such a modification would enhance Bannister's drill without deviating from Bannister's invention. A POSA would expect success in forming a top blade that is longer than the cutting blade

groups, since it is a simple mechanical modification that was common and routine in the art.

238. Thus, claims 7 and 12 also would have been obvious in view of Bannister and other prior art for these reasons.

E. Dependent Claim 14

239. Claims 14 depends from claim 8, and adds the further limitation *“wherein, the operation portion is configured to disperse a cutting force on each of the plurality of composite cutting blade groups within a drill hole of a workpiece when at least a portion of the cylinder portion is also within the workpiece.”*

240. Bannister’s operating portion is configured to disperse a cutting force across its composite cutting blade groups when, during drilling, the drill is sufficiently inserted into a drill hole of a workpiece so that at least a portion of the cylinder portion is within that drill hole. Bannister does not explicitly describe this trait, but a POSA would understand that the dispersal of cutting force during drilling is the inherent result of having a plurality of composite cutting blade groups, because each cutting blade group will engage the workpiece and apply at least some force to the workpiece. Because the total cutting force includes portions attributable to each composite cutting blade group, it can be said that the cutting force is “dispersed,” as claimed. Furthermore, Bannister states objects of the invention include “the provision of such a drill which shall be operable with

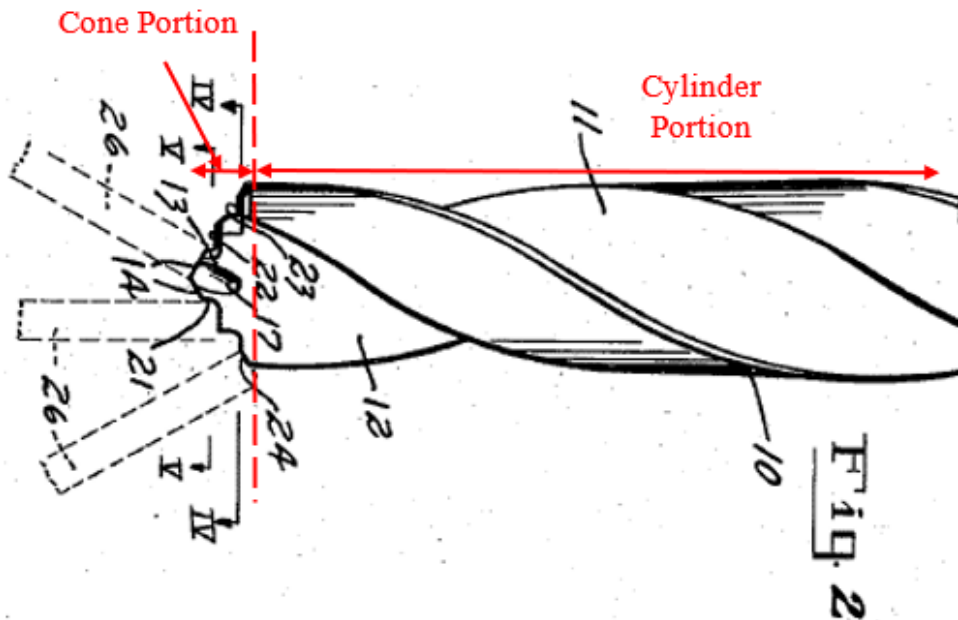
much less power than twist drills as heretofore formed; which shall generate less heat in cutting; which shall be readily started into the material to be drilled; which shall be effective to drill large holes in one operation; and which shall be effective to clear the hole from being drilled of chips as they are formed..” Ex-1006, p.1, 1: 2-11. Thus, under the construction of this Term (*see* Section IX.D, above) Bannister thus inherently teaches this limitation because its drills have a plurality of composite cutting blade groups that are configured to simultaneously engage a workpiece during operation, thereby dispersing a cutting force.

241. Thus, dependent claim 14 would have been obvious in view of Bannister and other prior art for these reasons.

F. Dependent Claims 15 and 19

242. Claims 15 and 19 depend from claims 8 and 1, respectively, and add the further limitation “*wherein the cylinder portion is longer than the cone portion.*” Ex-1001, Claims 15, 19.

243. Bannister’s twist drill has a cylinder portion that is longer than the cone portion, as seen in the annotated representation of Bannister, Figure 2, below.



244. Thus, dependent claims 15 and 19 would have been obvious in view of Bannister and other prior art for these reasons.

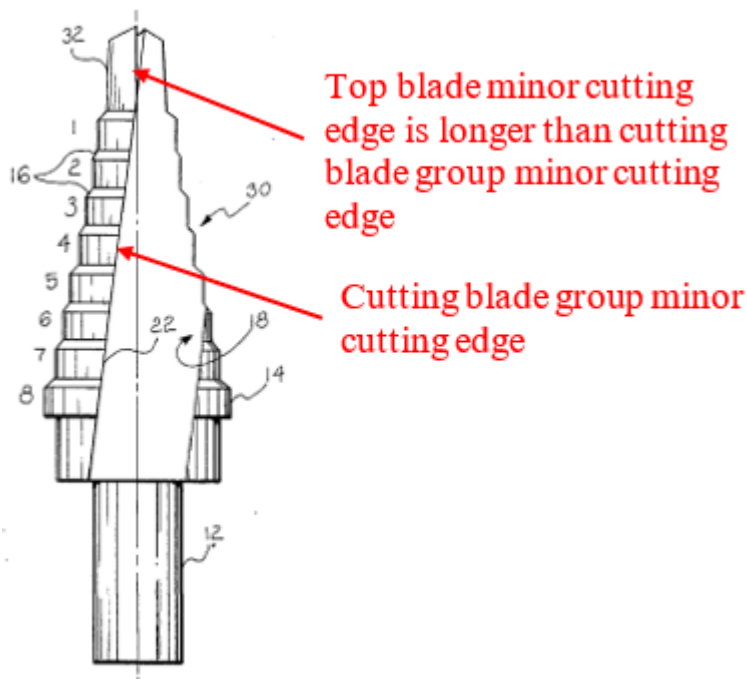
XIV. GROUND 3: CLAIMS 13, 18 AND 22 WOULD HAVE BEEN OBVIOUS BASED ON BANNISTER IN VIEW OF ZHOU OR WELTY AND THE KNOWLEDGE OF A POSA, AND FURTHER IN VIEW KORB

A. Dependent Claim 13

245. Dependent claim 13 depends from claim 8 and adds the further 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.*” Ex-1001, Claim 13.

246. Bannister does not expressly teach a drill having a top blade with a straight minor cutting edge having a length that is greater than each of the minor cutting edges of the composite cutting blade groups. However, this is a matter

routine engineering choice. It is among a limited number of known design of options for the top blade: having a top blade that is taller than, shorter than, or the same height as the step height of the composite cutting blade groups. From these limited three choices, the claimed configuration is known in the art. An example of a drill with a top blade taller than the subsequent steps is shown in Korb. Korb's drill has a top blade with a minor cutting edge that is longer than each of the minor cutting edges of the composite cutting blade groups. See Ex-1012, Figure 7, annotated below.



247. A POSA would have known that such a taller top blade would have the advantage of creating a deeper pilot hole to act as a guide for the drill before the cutting blade groups reach a workpiece during operation, and that such a

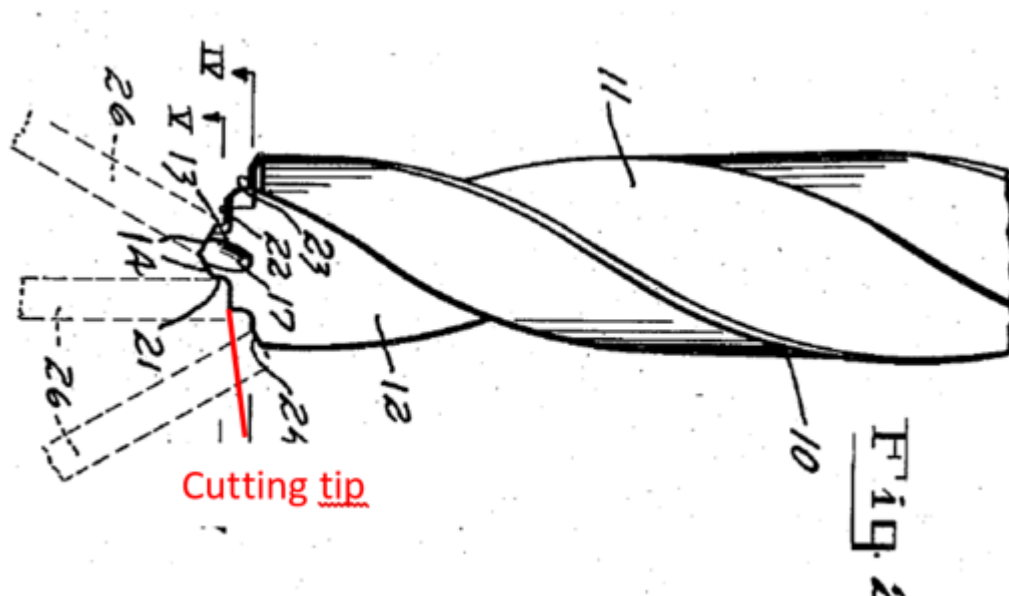
configuration would provide increased stability and a straighter, more accurate, and more circular hole. A deeper top blade enhances a drill's ability to resist moments tending to move the drill away from the desired hole centerline. This configuration would additionally provide for an initial drilling force that is relatively small. See Ex-1006, p.1, 1:1-11. Thus, a POSA would have been motivated to modify Bannister to provide for such a taller top blade and would have had a reasonable expectation of success of doing so. It therefore would have been obvious to a POSA to incorporate a top blade having a relatively long straight minor cutting edge in order to provide Bannister's drill with these benefits.

248. Thus, claim 13 would have been obvious in view of Bannister and other prior art for these reasons.

B. Dependent Claims 18 and 22

249. Claims 18 and 22 depend from claims 8 and 1, respectively, and add the further 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.*" Ex-1001, Claims 18 and 22.

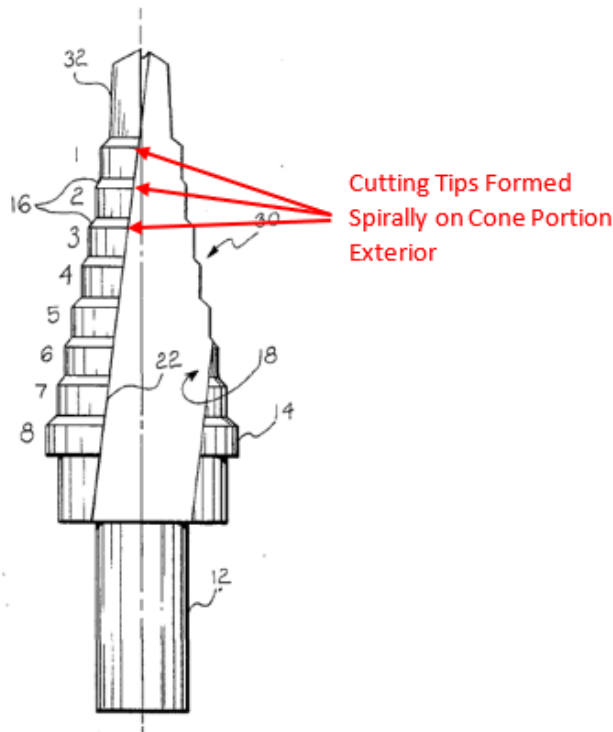
250. Bannister shows a twist drill with a pair of cutting tips between the front tip and the shoulder leading to the cylinder portion, as shown on the annotated representation of Bannister Figure 2 provided below.



251. The cutting tips shown on Bannister’s drill appear to be formed along a straight line. However, Bannister does not limit the disclosure to this arrangement and emphasizes that the drill may include multiple steps: “[w]hile I have illustrated a plurality of steps or drilling units, the number will be governed largely by the size of the drill. For example, with drills less than one inch diameter, I preferably grind the point with the central drilling unit one pair of cutting edges. As the diameter of the drill increases, the number of drill units may be increased.” Ex-1006, p.2, 2:70 – p.3, 1:2. Thus, it would have been obvious to modify Bannister’s drill to have the claimed configuration.

252. It was well known in the art that cutting tips could be formed spirally on a cone portion exterior from a front end of the cone portion to a rear end. There are numerous examples of this in the prior art including Gentry, Durfee, and Korb. See, e.g., Ex-1010, Figures 1-2; Ex-1011, Figures 1-6, 1:33-39, 3:57-6:32; Ex-

1012, Figures 1, 2 and 7, 1:33-35, 2:37-44. These can be seen on the annotated representation of Korb Figure 7 provided below.



253. Cutting tips that are formed spirally are the natural result of having a flute on a cone portion of a stepped drill when the flute is cut at any angle other than parallel to the axis of a drill (i.e., perfectly vertical). This is a consequence of having the cutting tips be formed where the steps meet the side wall of the flute. As an example, having the cutting tips formed spirally on the cone portion is an inherent result of maintaining the spiral shape of the flute side walls all the way to the tip of the drill. A POSA would have known that maintaining the spiral shape of the flute side walls was desirable since it helps to lift chips, or swarf, away from the cutting surface and evacuate it from the hole being cut. Thus, a POSA would

have been motivated to modify Bannister's flute to have the side walls maintain their spiral shape (resulting in the cutting tips also formed spirally) in order to obtain the known benefits of spiral flute side walls on a drill. Moreover, a POSA would have had a reasonable expectation of success in doing so, since the mechanics and manufacturing techniques of drills are well understood and predictable. Moreover, Korb suggests equivalency between a flute cut helically, and a flute cut at about zero degrees to the drill axis: "[t]he flutes may be cut helically about the drill or longitudinally at a fixed angle to the drill axis from about 0 to 15 degrees." *Id.*, 2:41-43. Korb's Figures 7-8 shows cutting tips arranged linearly along the side of a linear flute. However, had the flute been helical, as Korb clearly suggests can be the case, then the cutting tips on would be arranged spirally, rather than linearly. Such an arrangement was well known.

254. It would have been obvious to one of ordinary skill to Bannister so that the cutting tips of the modified drill would be formed spirally (such as by having the spiral flutes extend spirally all the way up Bannister's cone portion) because spiral flutes are known to provide efficient removal of swarf. Also, since spiral flutes were so well known, a POSA making such a modification would have reasonably expected success.

255. Thus, claims 18 and 22 would have been obvious in view of Bannister and other prior art for these reasons.

XV. CONCLUSION

256. In signing this declaration, I understand that the declaration will be filed as evidence in the contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in this case and that that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

257. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Date: 1/13/2023

By: 
Steven R. Schmid