FILED
U.S. DISTRICT COURT

2005 APR -1 P 4: 17

DISTRICT OF UTAH
ORIGINAL
DEPUTY CLERK

Richard D. Burbidge (0492)
Jefferson W. Gross (8339)
Robert J. Shelby (8319)
BURBIDGE & MITCHELL
215 South State Street, Suite 920
Salt Lake City, Utah 84111
Telephone: (801) 355-6677
Facsimile: (801) 355-2341

Attorneys for Plaintiff U.S. Synthetic Corporation

IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF UTAH, CENTRAL DIVISION

U.S. SYNTHETIC CORPORATION, a Delaware corporation, Plaintiff, v. REEDHYCALOG, LTD., a United Kingdom company, Defendant.	)	**AMENDED COMPLAINT** **DEMAND FOR JURY TRIAL** Civil No. 2:05CV00247 Judge Dale A. Kimball

Plaintiff U.S. Synthetic Corporation ("USS") alleges as follows:

PARTIES, JURISDICTION AND VENUE

1. USS is a corporation incorporated under the laws of the State of Delaware with its principal place of business located in Utah County, State of Utah. USS is a citizen of the State of Utah. USS is engaged in the business of manufacturing and

2

distributing various products employing synthetic diamonds. Most of its products are components for drill bits.

2. Defendant ReedHycalog, Ltd. ("RHL") is a United Kingdom company that is registered to do business in the State of Utah. RHL is a wholly owned subsidiary of Grant Prideco, Inc., and describes itself as a "global leader in drill bit technology." RHL regularly and continuously conducts business in the State of Utah, and regularly maintains a business office in Provo, Utah. RHL manufactures PDC Inserts and drill bits.

3. This court has jurisdiction of this matter pursuant to 28 U.S.C. §§1331, 1332(a)(2) and 1338(a).

4. This is an action for declaratory judgment of invalidity and/or unenforceability of RHL's patents and of non-infringement by USS of patents held by RHL. This action is brought pursuant to 28 U.S.C. §§2201 and 2202 and Rule 57, Federal Rules of Civil Procedure.

5. Venue is proper in this district pursuant to 28 U.S.C. §1391(b) and (c).

GENERAL ALLEGATIONS

6. USS manufactures synthetic polycrystalline diamond compacts ("PDC Inserts"). PDC Inserts are then used by drill bit manufacturers as "cutters" or "teeth" for

drill bits in the oil and gas industry. Customers of USS require that PDC Inserts be manufactured to exacting technical requirements.

7. A now well known technological advance for PDC Inserts is the process of "leaching." Leaching involves the application of chemicals to the diamond cutting surface of the PDC Insert in order to remove other materials, usually cobalt, from the diamond surface and to some prescribed depth. Leaching can result in a PDC Insert being less susceptible to failure from thermal/mechanical loading.

8. RHL manufactures drill bits which contain, as components, PDC Inserts, which are also manufactured by RHL. As such, RHL is a direct competitor with many of USS's customers and an indirect competitor with USS itself.

9. Beginning with a provisional application filed with the Patent and Trademark Office (the "PTO") on September 20, 2000, RHL's predecessor in interest, Camco International, Ltd. ("Camco") and RHL, pursued a family of related patents concerning PDC Inserts and the cutting surfaces thereon. As a result of this and subsequent applications, the following U.S. Patents were eventually issued: U.S. Patent No. 6,544,308 issued April 8, 2003; U.S. Patent No. 6,562,462 issued May 13, 2003; U.S. Patent No. 6,585,064 issued July 1, 2003; U.S. Patent No. 6,589,640 issued July 8, 2003; U.S. Patent No. 6,592,985 issued July 15, 2003; U.S. Patent No. 6,601,662 issued August

5, 2003; U.S. Patent No. 6,739,214 issued May 25, 2004; U.S. Patent No. 6,749,033 issued July 15, 2004; U.S. Patent No. 6,797,326 issued September 28, 2004; U.S. Patent No. 6,861,098 issued March 1, 2005; and U.S. Patent No. 6,861,137 issued March 1, 2005 (hereinafter collectively referred to as "RHL's Patents" or "the Patents"). The named inventors of the Patents are Nigel Griffin and Peter Hughes. RHL is the assignee of all the Patents.

Prosecution of the '985 Patent

10. On July 13, 2001, and in pursuit of the Patents, RHL's predecessor-in-interest, Camco, filed Application No. 09/682,042 (the "'042 Application"), which application eventually led to the issuance of Patent No. 6,592,985 (the '985 Patent). In the course of prosecution of the '985 Patent, Camco disclosed to the examiner Japanese Patent No. 59-219500, issued to Sumitomo Electric Industries Co., Ltd. (the "Sumitomo Patent") as relevant prior art. A copy of the Sumitomo Patent (translated into English) is attached hereto as Exhibit "A".

11. On December 4, 2001, the PTO issued its first office action indicating that all claims in the '042 Application were subject to restriction. Thereafter, and on December 18, 2001, Camco cancelled claims 1-8, 11-13, 14-30, 33, 39-49, 52-62, 65-66, 69-76, 79-86, 89-102 and 105-111.

12. On February 27, 2002, the PTO issued its second office action on the '042 Application rejecting all claims (which the Applicant had not cancelled) as being anticipated by, *inter alia*, the Sumitomo Patent.

13. On June 19, 2002, Camco, by and through its patent lawyer Jeffery E. Daly, responded to the rejection of the '042 Application by adding additional claims 112-128, abandoning all previously asserted claims, and by remarking on the prior art, including the Sumitomo Patent, as follows:

> *In order to clearly distinguish the claims of the present invention from the coating shown in the prior art,* new independent claims 112, 118, 122 and 126 include the limitation that *the portion of the body that is free of catalyzing material extends to a depth of at least about 0.1 mm from the working surface.*
>
> Keshavan et al. (5,370,195) generally relates to layers of diamond, including transition layers, bonded to non-planar cemented tungsten carbide substrates. [The Sumitomo Patent] is generally drawn to a polycrystalline diamond member and is similar in many respect to Oles '149 at the intermediate step prior to the CVD coding.
>
> None of Karner et al., (5,897,942), Mensa-Wilmot et al. (5,833,021), Keshavan et al. (5,370,195), Cho et al. (5,011,514), [the Sumitomo Patent] or W09232204 individually show or describe the specific limitations of new independent claims 112 and 122. *Specifically, all the references are silent about the nature of the catalyzing*

> *material that remains in the regions of the body that are substantially free of the catalyzing material.*
>
> Regarding new claims 118 and 126, none of the above references disclose a polycrystalline diamond element that has a substantially higher volume density of the bonded diamond crystals in the region of the body substantially free of the catalyzing material then elsewhere in the body. (Emphasis added.)

14. On August 27, 2002, the PTO gave notice to Camco that certain claims in the ‘042 Application had been allowed. On October 25, 2002, the PTO issued its notice of allowance. The ‘985 Patent issued on July 15, 2003.

Prosecution of the ‘308 Patent

15. On August 30, 2001, and in pursuit of the Patents, Camco filed Application No. 09/682,419 (the "‘419 Application"), which application eventually led to the issuance of Patent No. 6,544,308 (the ‘308 Patent). In the course of prosecution of the ‘308 Patent, Camco disclosed to the examiner the Sumitomo Patent as relevant prior art.

16. On November 5, 2001, the PTO issued its first office action indicating that all claims in the ‘419 Application were subject to restriction. Thereafter, and on November 15, 2001, Camco cancelled claims 1-25 and 31-50.

17. On December 6, 2001, the PTO issued its second office action on the '419 Application rejecting all claims (which the Applicant had not cancelled) as being indefinite, and/or anticipated by, *inter alia*, the Sumitomo Patent.

18. On December 19, 2001, Camco, by and through its patent lawyer Jeffery E. Daly, responded to the rejection of the '419Application by adding additional claims 51 and 52, and amending claim 26.

19. On February 27, 2002, the PTO issued a third office action rejecting all pending claims as being anticipated by, *inter alia*, the Sumitomo Patent.

20. On June 11, 2002, Camco, by and through its patent lawyer Jeffery E. Daly, responded to the rejection of the '419 Application by further amending claim 26.

21. On August 27, 2002, the PTO issued a fourth and final office action rejecting all the pending claims as being anticipated by, *inter alia*, the Sumitomo Patent.

22. On September 12, 2002, Camco, by and through its patent lawyer Jeffery E. Daly, responded to the rejection of the '419 Application by again amending claim 26, amending claim 52, and by remarking on the prior art, including the Sumitomo Patent, as follows:

> Applicants believe that the Office did not consider the limitations of dependent claim 52 when maintaining this rejection. Claim 52, as filed, limited the thickness of the

> diamond cutting element devoid of binder to at least 0.1 mm. This limitation was not addressed in previous actions by the Office in light of the prior art, and *none of the prior art discloses this claimed thickness.*
>
> Applicants believe this limitation, if added to claim 26, would make claim 26 allowable. Accordingly, claim 26 has been amended now to indicate that the first interstitial region extends beneath the cutting surface at least about 0.1 mm.
>
> Claim 52 has been amended now to claim a narrower range of the thickness of the first interstitial region to between about 0.2 mm and about 0.3 mm.
>
> Applicants believe that claim 26 as amended now puts the application in a better condition for allowance, and therefore respectfully request that the Office enter the amendment and allow claim 26.
>
> Because claims 27-30, 51, and amended claim 52 depend from allowable base claim 26, Applicants believe that these claims are also allowable, and therefore respectfully request allowance of claims 27-30 and 51-52. (Emphasis added.)

23. On December 24, 2002, the PTO issued its notice of allowance for the '419 Application. The '308 Patent issued on April 8, 2003.

Prosecution of the '462 Patent

24. On December 20, 2001, and in pursuit of the Patents, Camco filed Application No. 09/683,386 (the "'386 Application"), which application eventually led to the issuance of Patent No. 6,562,462 (the '462 Patent). In the course of prosecution of

the '462 Patent, Camco disclosed to the examiner the Sumitomo Patent as relevant prior art.

25. On May 6, 2002, the PTO issued its first office action indicating that all claims in the '386 Application were subject to restriction. Thereafter, and on May 16, 2002, Camco cancelled claims 10-12, 22-24, and 35-38, and amended claims 1, 28, and 39.

26. On June 3, 2002, the PTO issued its second office action on the '386 Application rejecting all claims (which the Applicant had not cancelled) as being anticipated by, *inter alia*, the Sumitomo Patent.

27. On October 15, 2002, Camco, by and through its patent lawyer Jeffery E. Daly, responded to the rejection of the '386 Application by cancelling claims 2, 3, 14, 15, 29, and 30, by amending claims 1, 4, 16, 28, and 31, and by remarking on the prior art, including the Sumitomo Patent, as follows:

> *In order to clearly distinguish the claims of the present invention from the coatings shown in the prior art,* claims 1 and 28 have been amended now to include the limitation that *the portion of the body that is substantially free of catalyzing material extends to a depth of at least about 0.1 mm from the working surface.*
>
> Keshavan et al. (5,370,195) generally relates to layers of diamond, including transition layers, bonded to non-planar

> cemented tungsten carbide substrates. [The Sumitomo Patent] is generally drawn to a polycrystalline diamond member and is similar in many respect to Oles '149 at the intermediate step prior to the CVD coding.
>
> None of Karner et al., (5,897,942), Mensa-Wilmot et al. (5,833,021), Keshavan et al. (5,370,195), Cho et al. (5,011,514), [the Sumitomo Patent] or W09232204 individually show or describe, nor fairly teach to one skilled in the art, the specific limitations of amended claims 1 and 28, and previously amended claim 39. *Specifically, all the references are silent about the claimed PDC element having a portion of the PCD body that is substantially free of catalyzing material extending to a depth of at least 0.1 mm from the working surface in addition to the other claimed limitations.* (Emphasis added.)

28. On December 31, 2002, the PTO issued its notice of allowance for the '386 Application. The '462 Patent issued on May 13, 2003.

Additional Background Allegations

29. Camco's representations to the PTO about the Sumitomo Patent were misleading and false. In particular, contrary to Camco's representations, Camco and its patent lawyer, Mr. Daly, knew that the Sumitomo Patent described an embodiment of a PDC Insert having a leach depth in excess of 0.1 mm. Likewise, Camco and its patent lawyer, Mr. Daley, knew that the Sumitomo Patent is not silent about the nature of catalyzing materials that remains in the area leached from the diamond surface. Camco's

and its patent lawyers' misrepresentations about the Sumitomo Patent were deliberately made in order to deceive the PTO so that the '308 Patent, the '462 Patent and the '985 Patent would issue. The misrepresentations of the Sumitomo Patent were plainly material because they concerned the very limitation which Camco claimed distinguished its inventions over the prior art.

30. While Camco claimed that its "inventions" were novel over prior art because the portion of the PDC Insert free of catalyzing material (i.e., the leach depth) exceeded 0.1mm, Camco had previously purchased from USS PDC Inserts which had been leached to a depth in excess of 0.1 mm. Beginning in or around January, 1990, USS sold a PDC Insert known as the Terracut to RHL's predecessor-in-interest, Camco. These Terracut products bore product names TC100, TC120, TC123, TC220, TC223 and TC 524. Indeed, some of the sales were procured by Terry Mathias, one of the named inventors of the '622 Patent. The Terracut products anticipate the Patents.

31. The '908 Patent and the '137 Patent do not contain the limitation that the leach depth for the PDC Insert exceed 0.1mm. Instead, the '908 Patent and the '137 Patent claim a temperature gradient between the surface of the PDC Insert and at the depth of the leaching. No one skilled in the art knows how to measure such a temperature gradient described in the '908 Patent and/or the '137 Patent.

32. The independent claims of the '662 Patent lack the limitation that the leach depth for the PDC Insert exceed 0.1mm. Instead, the '662 Patent claims that the impact strength for the portion of the diamond crystals which had been leached is the same as for the diamond crystals which have not been leached. No one skilled in the art knows how to accomplish such a limitation.

33. As a result of the Patents, USS has undertaken, at great expense, measures to ensure that it does not infringe the Patents. For example, USS now employs extensive measurement and quality control procedures to ensure that its PDC Inserts are not leached at a depth of 0.1 mm or greater. Moreover, avoidance of infringement of some of the Patents puts USS at a competitive disadvantage; for example, leaching PDC Inserts at a depth greater than 0.1 mm can result in a more stable component for drill bits.

FIRST CLAIM FOR RELIEF
(Declaratory Relief for Invalidity/Unenforceability of the Patents)

34. By this reference, USS incorporates all preceding paragraphs of this Complaint as if set forth in full herein.

35. An actual and present controversy exists between USS and RHL with respect to the validity, scope and enforceability of the Patents. USS has incurred and

continues to incur significant expense to ensure that its PDC Inserts have a leach depth less than 0.1mm. In addition, USS is at a competitive disadvantage in the marketplace by avoiding infringement of the Patents. USS seeks to have the Patents declared invalid so that, *inter alia*, it may manufacture and sell PDC Inserts with leach depths in excess of 0.1 mm.

36. Camco's misrepresentations about the Sumitomo Patent were material and related to the prosecution of all the Patents.

37. USS is entitled to a judgment declaring:

a. The Patents are invalid under the provisions of 35 U.S.C. § 101, *et seq*., including, without limitation, Sections 101, 102, 103, 112 and 115.

b. The Patents are unenforceable based upon RHL's predecessor's fraud on, and inequitable conduct before, the PTO.

38. Unless a declaratory judgment issues determining that the Patents are invalid and unenforceable, USS will be irreparably injured by, in avoiding infringement of the Patents, incurring expenses and losing sales.

SECOND CLAIM FOR RELIEF
(Declaratory Relief for Non-Infringement of Patents)

39. By this reference, USS incorporates all preceding paragraphs of this Complaint as if set forth in full herein.

40. RHL has asserted that USS's products infringe one or more of RHL's Patents and has stated it intends to file a patent infringement action against USS. RHL's conduct has created the reasonable apprehension by USS that RHL will file suit against USS for patent infringement of RHL's Patents based upon USS's manufacturing and distribution of its products.

41. An actual controversy between the parties has arisen and does now exist as to whether the devices manufactured and distributed by USS infringe RHL's Patents. This controversy is ripe for determination by this court.

42. USS is entitled to judgment declaring that none of its products infringe the Patents and that USS has not induced or contributed to infringement of the Patents.

43. USS has suffered or will suffer irreparable damage and harm unless the court adjudicates the controversy between the parties and issues a declaratory judgment of non-infringement.

PRAYER

WHEREFORE, USS prays for Judgment as follows:

1. On the First Claim for Relief, for declaratory judgment that the Patents are invalid and/or unenforceable;

2. On the Second Claim for Relief, for a declaratory judgment that USS has not and does not infringe any of the Patents;

3. For costs of suit incurred herein; and

4. For such other relief as the Court deems just and proper.

DEMAND FOR JURY TRIAL

Plaintiff demands a trial by jury of all matters that may be tried to a jury.

DATED this 31st day of March, 2005.

BURBIDGE & MITCHELL

Jefferson W. Gross
Attorneys for Plaintiff US Synthetic Corporation

P:\DKapinos\DKapinos\DKapinos\MyFiles\US Synthetics\Pleadings\AmendedComplaint.wpd

(19) Japan Patent Office (JP)
(11) Japanese Unexamined Patent Application Publication
(12) Public Patent Information (A) S59 – 219500

(51) Int. Cl.[3]	ID. No.	Internal Filing. No.	(43) Publication Date: December 10th, 1984
C 25 F 5/00		7011 – 4K	
B 22 F 3/24		6441 – 4K	

Number of Inventions: 2
Examination Request: Not Filed
(Total Pages: 4)

(54) Title of the Invention: DIAMOND SINTERING AND PROCESSING METHOD

(21) Application No.: S58 – 91691
(22) Application Filed: May 24, 1983

(72) Inventor: Shuji YATSU
c/o Itami Works
Sumitomo Electric Industries Co., Ltd.
1 – 1 – 1 Koyakita, Itami City

(72) Inventor: Tetsuo NAKAI
Sumitomo Electric Industries Co., Ltd.
1 – 1 – 1 Koyakita, Itami City

(71) Applicant: Sumitomo Electric Industries Co., Ltd.
5 – 15 Kitahama, Higashi-ku, Osaka

(74) Patent Representative Patent Attorney: Tetsuji JODAI

Specification

1. Title of the Invention: DIAMOND SINTERING AND PROCESSING METHOD

2. Patent Claims

(1) A sintered diamond layer made from diamond and a ferrous metal binder phase is joined to a base material made from an ultra-hard alloy during high-pressure sintering, forming a hybrid sintered object. The majority of a ferrous metal binder phase that is already contained in the surface layer section at least 0.2 mm from the surface layer of the diamond sintered layer is removed electrolytically.

(2) A method of processing sintered diamond objects with the following characteristics. A composite sintered diamond object is made by joining an ultra-hard alloy base material with a layer of a sintered diamond object that is made from a ferrous metal binder phase and diamond that is sintered under high pressure. Only the sintered diamond layer is immersed in acid or an electrolytic solution until the ferrous metals in the surface layer of the sintered diamond object have been dissolved.

3. Detailed Description of the Invention

(a) Technical Fields

This invention pertains to sintered diamonds, which are produced under ultra-high pressure and high temperatures and are used in machine tools and tools for digging and drilling through rock. In particular, it pertains to the marked improvement of such tools.

Prior Art and Problems

Diamond sintered objects produced by sintering diamond powder with metal as a binder under stable, ultra-high pressure and high temperature are among the most rigid of all diamond tool materials. Like monocrystalline diamond, there is no low-stress damage brought on by cleavage, so they are used in a wide variety of tools including machine tools, wire-drawing dies, dressers and rock cutting tools. Depending upon the use, these sintered diamond objects have all sorts of structures and shapes, but generally, there is a layer of sintered diamond like the one shown in Figure 1, which is bonded to a highly rigid base material such as an ultra-hard alloy for use in machine tools, dressers and rock cutting tools. Sintered objects with this sort of structure are known and have been described in JSP S46-005204, for example, where a sintered diamond is joined directly to a WC base, ultra-hard alloy material or JSP S54-045313 and JSP S56-00506, where the sintered diamond layer is joined to an ultra-hard alloy material through an intermediate binder layer. Currently, sintered diamond layers of this sort now often use a ferrous metal such as Co as a binder for the diamond granules. When synthesizing diamond from graphite, ferrous metal is used as a solvent and during sintering under ultra-high pressure, part of the diamond powder melts and, it is believed that this has the effect of causing the diamond granules to sinter into each other. These ferrous metals may be mixed with the diamond powder before sintering or, as in JSP S46-005204, the base material WC-Co lubricating binder may be placed in the diamond powder during sintering. Sintered diamond of this sort has superior wear resistance and exhibits superior performance in uses where monocrystalline diamond has traditionally been used. At the same time, however, there are significant limitations on the heat resistance. In the atmosphere, a diamond's surface turns to graphite at temperatures of 900° C or more. In a vacuum or in inert gas, graphite does not form easily even around 1400° C. In the conventional sintered diamond described above, inferior tool performance is seen at around 750° C. Naturally this means that when the tip of the machine tool or cutting tool reaches a high temperature during use, a decline in performance will be seen. It is believed that the reason that conventional sintered diamond degrades at a level of temperature than simple diamond is that there is a significant difference between the thermal expansion coefficients of the ferrous metal binder and the diamond. During heating, the amount of thermal stress in the sintered object increases and the structure breaks down. Additionally, ferrous metals have the effect of promoting the conversion of diamond into graphite. As a means of improving the heat resistance of sintered diamond, sintered objects have been created that are not bound to ultra-hard alloy base materials, which are then immersed in aqua regia or similar substance and heat treated. This dissolves the metal binder phase in the sintered object (JSP S53 – 114589). This is said to allow the sintered diamond to withstand temperatures of up to 1200° C. However, the metal binder phase escapes, leaving cavities in the sintered material, which degrades the strength of the sintered material. The result is a material which lacks sufficient hardness as a tool. With this method, there are also considerable binding limitations, which makes a strong bond between the sintered diamond and the tool difficult.

(b)

The purpose of this invention is to provide a new sintered diamond material that resolves the deficiencies of this sort of conventional sintered material. For instance, when using sintered diamond as a cutting tool, the part that becomes hottest is the tip of the tool that comes into contact with the material being worked. The temperature slope acid of this section is considerable and as one moves away from the point of contact of the material being worked, the temperature drops quickly. Therefore, improving the heat resistance of just the surface portion of a disk-shaped sintered object like the one in Figure 2, would offer a significant improvement in the performance of such a tool. This invention is based on this point. It is a composite sintered diamond layer, from which the binder phase has been removed from the surface layer. In this composite, the sintered diamond layer is joined to the ultra-hard alloy base material during ultra-high pressure sintering of diamond and a ferrous metal binder phase as shown in Figure 2. The thermal resistance of tools made using this process is improved considerably. Additionally, there is binder phase inside the sintered diamond, so there is less loss of strength in the sintered object overall. Again, because there are no interior cavities, the thermal conductivity does not decline, which is effective in dispersing the heat that is generated at the tip of the tool. In the sintered objects of this invention, the thickness of the sintered diamond layer is normally 0.3 ~ 5 mm and this is joined to the ultra-hard alloy base material during ultra-high pressure sintering. The majority of the ferrous metal binder phase is removed from an area that is at least 0.2 mm of the surface layer of the sintered diamond layer. In the production of the sintered objects of this invention, methods described in JSP S46-005204, S54-045313 and S56-055506 which are mentioned above, could be used. Using these methods, composite sintered objects that join a diamond layer that is 0.3 ~ 5 mm to an ultra-hard alloy base can be obtained. In order to remove the ferrous metal binder phase from the sintered diamond surface layers of these sintered composites, electrolytic removal may be employed by placing a spongy material containing an aqueous hydrochloric acid solution on the surface of the sintered object and applying a DC voltage. Using this sort of method, the binder phase can be removed from just the surface layer of the sintered diamond object without having the acid cause any damage to the ultra-hard alloy that serves as the base material.

(c) Effect of the Invention

This invention makes it possible to improve significantly, the performance limit of insufficient heat resistance found in conventional composite sintered diamond used in tools, without damaging its strength. The following are the embodiments.

Embodiment 1

We made a sintered composite having the structure shown in Figure 1 by joining a sintered diamond object that was 26 mm in diameter and 1 mm thick with a base material that was made of WC-10% Co that was 2.5 mm thick. The sintered diamond object contained diamond particles having a granularity averaging 5 u that was 90% by volume and the remainder consisted of a Co binder phase. The surface of the sintered diamond layer in this sintered object was placed in contact with a plastic sponge containing hydrochloric acid water. Ten volts DC was applied between the ultra-hard alloy base and an electrode that had been placed below the sponge and left for 2 hours. Then the power was shut off and the sintered object was cut into many triangular pieces using electrical discharge machining. The cut surfaces were polished and examined, revealing that nearly all of the metal Co binder phase in an area 0.5 mm from the surface of the sintered diamond object had been removed electrolytically. We then ran alumina ceramic cutting tests by applying wax to another ultra-hard alloy metal base plate. For comparison, the same sort of unprocessed, composite sintered object was created using a tool of the same shape. The cutting tests were run under the following conditions: a 0.15 mm cut was made at a cutting speed of 60 m/minute and a feed of 0.02 mm/revolution while applying an aqueous cutting agent. With the sintered object of this invention, we were able to cut for 50 minutes until the relief wear land of the tool reached 0.4 mm, while the same relief wear land was attained after 10 minutes with the comparison sintered object.

Sent by: HYCALOG 713 934 6609; 05/15/02 14:09; JetFax #660;Page 9/11

Embodiment 2

In the same manner as Embodiment 1, we produced a core bit that was 46 mm in diameter using 4 of the sintered objects of this invention that were 8 mm in diameter with a 2.5 mm diamond sintered ultra-hard alloy base material. For the purpose of comparison, an object that was 8 mm in diameter and 2 mm thick made just from sintered diamond was heat-treated in aqua regia, resulting in a sintered object from which most of the metal Co binder phase had been removed. A core bit in the same shape was also produced. We ran uniaxial compressive strength tests (cutting 1.650 kg/cm2 andesite) on both bits. At a speed of 200 rpm with identical pressure applied to the bits, the bit using the sintered material of this invention could cut 20 m at a cutting speed of 10 cm per minute. Conversely, the bits using the comparison sintered material all broke during the initial cutting period.

4. Simple Description of Drawings

Figure 1 is an oblique view of a conventional diamond composite sintered object. 1 is the diamond sintered portion and 2 is the ultra-hard alloy base material. Figure 2 is a cross section of the sintered object of this invention. 1 and 2 are the same as in Figure 1. 1' is the area where most of the ferrous metal binder phase was removed from the diamond sintered material.

Representative and Patent Attorney: Tetsuji Jodai /official stamp/

Figure 1

Figure 2

Received from <713 934 6609> at 5/15/02 2:57:34 PM [Eastern Daylight Time]