



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
02.05.2007 Bulletin 2007/18

(51) Int Cl.:
B24B 53/14 (2006.01)

(21) Application number: **05770599.8**

(86) International application number:
PCT/JP2005/014858

(22) Date of filing: **05.08.2005**

(87) International publication number:
WO 2006/019062 (23.02.2006 Gazette 2006/08)

(84) Designated Contracting States:
DE

(30) Priority: **16.08.2004 JP 2004236416**

(71) Applicants:
• **Toyoda Van Moppes Ltd.**
Okaza-shi
Aichi 444-3594 (JP)
• **JTEKT Corporation**
Osaka-shi
Osaka 542-8502 (JP)

(72) Inventors:
• **IMAI, Tomoyasu,**
Toyoda Van Moppes Ltd.
Okazaki-shi, Aichi 444-3594 (JP)

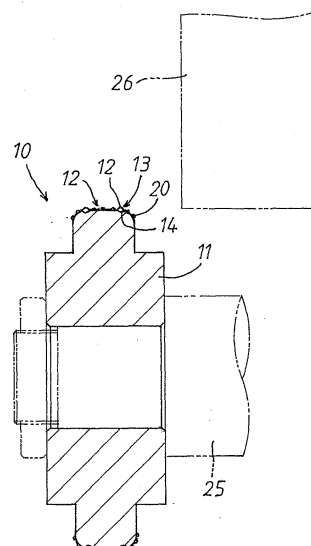
• **NOGIMORI, Toshihisa,**
Toyoda Van Moppes Ltd.
Okazaki-shi, Aichi 444-3594 (JP)
• **YANAGISAWA, Masashi,**
Toyoda Van Moppes Ltd.
Okazaki-shi, Aichi 444-3594 (JP)
• **HIRAIWA, Noboru,**
Toyoda Van Moppes Ltd.
Okazaki-shi, Aichi 444-3594 (JP)
• **SOMA, Shinji,**
c/o JTEKT Corporation
Chou-ku, Osaka-shi
Osaka 542-8502 (JP)

(74) Representative: **TBK-Patent**
Bavariaring 4-6
80336 München (DE)

(54) **ROTARY DIAMOND DRESSER**

(57) The present invention provides a rotary diamond dresser 10, with a V-groove 14 circumferentially formed around a heavily abraded high load part 13 of the circumference of a circular dressing body 11. A plurality of octahedral diamond grains 15 are sequentially set along the V-groove 14 of the circular dressing body such that the oriented crystal surfaces (1,1,1) of each diamond grain 15 are bonded to the respective surfaces of the V-groove 14. A plurality of small-sized diamond grains 20, other than the octahedral diamond grains, are secured to the surface of the circumference of the dressing body, other than the high load part. The oriented crystal surfaces (1,1,0) of the octahedral diamond grains and the small-sized diamond grains are formed to make respective contact surfaces 19 and 21 that contact and dress a grinding wheel. Thus, the present invention provides a rotary diamond dresser, which is easily produced, has excellent abrasion resistance, and is low-priced.

FIG. 1



Description

TECHNOLOGICAL FIELD:

[0001] The present invention relates to rotary diamond dressers for dressing grinding surfaces of grinding wheels.

BACKGROUND ART:

[0002] As shown in FIG. 2 of the Japanese Patent Laid-Open Publication No. S53-34193, when a traverse rotary diamond dresser 40 dresses the grinding surface of a grinding wheel 10 while moving along a template parallel to the generating line of the grinding wheel 10, both a junction point C between a straight part 41 and an arcuate part 42 of the dresser 40 and an area B around the junction point C are abraded, and thus the precision of the corrected shape of an arcuate part 13 of the grinding wheel 10 is reduced. As shown in FIG. 5 and FIG. 6 of the Japanese Patent Laid-Open Publication No. S53-34193, diamond grains 45 having octahedral grain shapes are set in an annular band part 44 of the dresser 40, which includes both the junction point C between the straight part 41 and the arcuate part 42 of the dresser 40 and the area around the junction point C, and has the center on a rotary axis 43, such that one crystal surface 46 of each diamond grain 45 is exposed outside parallel to the circumference of the dresser 40.

[0003] Further, in a diamond dresser disclosed in the Japanese Patent Publication No. 3450085, a plurality of V-grooves 211 are formed, as shown in FIG. 1 and FIG. 2 of the official gazette, on the front end of a metal shank 2 such that the surfaces of each of the V-grooves 211 are divergent from each other at an opening angle of about 110 degrees, which is equal to the angle defined between two oriented crystal surfaces (1,1,1) of an octahedral diamond grain 1. A plurality of octahedral diamond grains 1 are sequentially set in the V-grooves 211 such that the two oriented crystal surfaces (1,1,1) of each octahedral diamond grain 1 are soldered to the V-grooves 211 using solder made of an alloy of titanium (Ti), copper (Cu), silver (Ag), etc.

[0004] However, in the rotary diamond dresser disclosed in the Japanese Patent Laid-Open Publication No. S53-34193, each of the octahedral diamond grains is bonded to a female frame 50 at the oriented crystal surfaces (1,1,1) and is integrated with the female frame 50 by injecting molten nickel silver, added with fine powder, such as tungsten powder, between the female frame 50 and a core 51. Thus, the installation of octahedral diamond grains in the rotary diamond dresser requires excessive time and excessive labor. The oriented crystal surfaces (1,1,1) of the octahedral diamond grains are set in the inner surface of the female frame, so that the abrasion-resistant oriented crystal surfaces (1,1,1) of the octahedral diamond grains are not exposed outside the circumferential surface of the rotary diamond dresser. Fur-

ther, the oriented crystal surfaces (1,1,1) of the octahedral diamond grains are cleavage surfaces, so that the oriented crystal surfaces (1,1,0) or the oriented crystal surfaces (1,0,0) of the octahedral diamond grains are preferably exposed outside the circumferential surface of the rotary diamond dresser so as to take part in dressing work.

[0005] In the diamond dresser disclosed in the Japanese Patent Publication No. 3450085, the two oriented crystal surfaces (1,1,1) of the octahedral diamond grains 1 are seated in and soldered to the V-grooves 211 having an opening angle of about 110 degrees, and the oriented crystal surfaces (1,0,0) of the octahedral diamond grains 1 dress a grinding wheel. However, the diamond dresser in the Japanese Patent Publication No. 3450085, in which the diamond grains 1 are soldered to the front end of the shank 2, is not a rotary diamond dresser, and thus the number of the diamond grains 1 that take part in dressing work is reduced and thus the diamond grains are heavily abraded. Further, an error in the size of the front end of the diamond dresser may be generated, so that the diamond dresser may fail to dress the grinding surface of a grinding wheel to form a desired shape. Further, because the diamond dresser uses only expensive octahedral diamond grains, the diamond dresser increases the cost of dressing the grinding surface of a grinding wheel.

[0006] Further, a conventional conical-type diamond dresser, in which a plurality of octahedral diamond grains are set in the dresser such that the octahedral diamond grains protrude outwards from the middle part of the circumference of a circular double-sided truncated conical dressing body in a direction perpendicular to the rotary axis of the dressing body, has been proposed. In the conical-type diamond dresser, the plurality of octahedral diamond grains are sintered to the middle part of the circumference of the circular double-sided truncated conical dressing body such that portions of the octahedral diamond grains other than the outside vertices of the octahedral diamond grains, are set in sintered metal and two opposite surfaces of four oriented crystal surfaces (1,1,1) of each octahedral diamond grain, which form vertices on the oriented crystal surfaces (1,0,0), are oriented in the rotating direction of the dressing body. However, the sintered metal cannot strongly hold the octahedral diamond grains on the dressing body, and furthermore, increases the production cost of the dresser. Further, when the angle of the conical middle part of the circumference of the circular double-sided truncated conical diamond dresser is formed as an acute angle of less than about 70 degrees, defined between the two opposite surfaces of the four oriented crystal surfaces (1,1,1) of each octahedral diamond grain, the side surfaces of the octahedral diamond grains are exposed outside the sintered metal, and thus the octahedral diamond grains may be easily removed from the dressing body. Therefore, sintering cannot desirably secure the octahedral diamond grains to the dressing body.

[0007] The present invention has been made in view of the above problems, and it is an object of the present invention to provide a rotary diamond dresser, which is easily produced, has excellent abrasion resistance, and is low-priced.

DISCLOSURE OF THE INVENTION:

[0008] In order to accomplish the above objects, in one aspect, the present invention provides a rotary diamond dresser comprising a circular dressing body rotated around a rotary axis, with a plurality of diamond grains set into the circumference of the circular dressing body, thus dressing a grinding wheel, wherein a V-groove is formed along a high load part of the circular dressing body such that two surfaces of the V-groove are oriented in a rotating direction of the circular dressing body and are divergent from each other at an opening angle equal to an angle defined between two oriented crystal surfaces (1,1,1) that meet each other to form a ridge on a oriented crystal surface (1,1,0) of an octahedral diamond grain, the high load part being defined along the circumference of the circular dressing body and being heavily loaded during dressing, thus highly abrading the diamond grains; a plurality of octahedral diamond grains are set along the V-groove such that the two oriented crystal surfaces (1,1,1) of each of the octahedral diamond grains are bonded to the two respective surfaces of the V-groove using a bonding material, and the oriented crystal surface (1,1,0) of each of the octahedral diamond grains is formed as a contact surface that contacts and dresses the grinding wheel; a plurality of small-sized diamond grains other than the octahedral diamond grains are secured using the bonding material to a surface of the circumference of the circular dressing body other than the high load part; and each of the small-sized diamond grains is formed to make a contact surface that contacts and dresses the grinding wheel.

[0009] In the rotary diamond dresser, the plurality of octahedral diamond grains are set in the circular dressing body such that the two oriented crystal surfaces (1,1,1) of each octahedral diamond grain, which define a ridge on the oriented crystal surface (1,1,0), are bonded to the surfaces of the V-groove, which is formed along the high load part of the circular dressing body. Further, the plurality of small-sized diamond grains are secured to the surface of the circumference of the dressing body at portions other than the high load part. At the high load part of the circular dressing body, the octahedral diamond grains contact the grinding wheel at the oriented crystal surfaces (1,1,0), and dress the grinding wheel while relatively moving in the direction parallel to the ridge, which has high abrasion resistance. Thus, the present invention provides a rotary diamond dresser, which reduces the abrasion of diamond grains, dresses the grinding surface of the grinding wheel to form a desired shape with high precision, and is easily produced at a low cost.

[0010] In another aspect, the present invention pro-

vides a rotary diamond dresser comprising a circular dressing body rotated around a rotary axis, with a plurality of diamond grains set into the circumference of the circular dressing body, thus dressing a grinding wheel, wherein a V-groove is formed along a high load part of the circular dressing body such that two surfaces of the V-groove are oriented in a rotating direction of the circular dressing body or in a direction perpendicular to the rotating direction and contact two opposite surfaces of four oriented crystal surfaces (1,1,1) of an octahedral diamond grain, which form vertices on oriented crystal surfaces (1,0,0), the high load part being defined along the circumference of the circular dressing body and being heavily loaded during dressing, thus highly abrading the diamond grains; a plurality of octahedral diamond grains are set along the V-groove such that the two oriented crystal surfaces (1,1,1) of each of the octahedral diamond grains are bonded to the two respective surfaces of the V-groove using a bonding material, and the oriented crystal surface (1,0,0) of each of the octahedral diamond grains is formed as a contact surface that contacts and dresses the grinding wheel; a plurality of small-sized diamond grains other than the octahedral diamond grains are secured using the bonding material to a surface of the circumference of the circular dressing body other than the high load part; and each of the small-sized diamond grains is formed as a contact surface that contacts and dresses the grinding wheel.

[0011] In the rotary diamond dresser, the plurality of octahedral diamond grains are set to the circular dressing body such that two opposite surfaces of the four oriented crystal surfaces (1,1,1) of each octahedral diamond grain, which form vertices on the oriented crystal surfaces (1,0,0), are bonded to the two respective surfaces of the V-groove that is formed along the high load part of the circular dressing body in the rotating direction or in a direction perpendicular to the rotating direction. Further, the plurality of small-sized diamond grains are secured to the surface of the circumference of the circular dressing body at places other than the high load part. At the high load part of the circular dressing body, the octahedral diamond grains contact the grinding wheel with the oriented crystal surfaces (1,0,0), and dress the grinding wheel while moving in a direction having high abrasion resistance. Thus, the present invention provides a rotary diamond dresser, which reduces the abrasion of diamond grains, dresses the grinding surface of the grinding wheel to form a desired shape with high precision, and is easily produced at a low cost.

[0012] In the rotary diamond dresser, the V-groove may be continuously and circumferentially formed along the high load part, which is a junction part between a circumferential straight part and a side arcuate part of the circumference of the circular dressing body.

[0013] Thus, the V-groove, in which the two oriented crystal surfaces (1,1,1) of each of the plurality of octahedral diamond grains are secured using the bonding material, is circumferentially and continuously formed along

the high load part of the circular dressing body, so that the octahedral diamond grains can be easily set in the high load part with high precision such that the octahedral diamond grains can contact the grinding wheel and can move in a direction having high abrasion resistance. Thus, the present invention provides a rotary diamond dresser, which is easily produced at a low cost.

[0014] In a further aspect, the present invention provides a cup-type rotary diamond dresser comprising a circular truncated conical dressing body rotated around a rotary axis, with a plurality of diamond grains inclinedly protruding outwards from the circumference of a large-diameter part of the circular truncated conical dressing body at a predetermined inclination angle relative to the rotary axis of the dressing body, or a conical-type rotary diamond dresser comprising a circular double-sided truncated conical dressing body rotated around a rotary axis, with a plurality of diamond grains protruding outwards from a middle part of the circumference of the circular double-sided truncated conical dressing body in a direction perpendicular to the rotary axis of the dressing body, wherein a V-groove having two surfaces, which contact two opposite surfaces of four oriented crystal surfaces (1,1,1) of an octahedral diamond grain that form vertices on oriented crystal surfaces (1,0,0), is formed around the circumference of the large-diameter part of the circular truncated conical dressing body such that the center line of the V-groove is inclined outwards relative to the rotary axis of the dressing body, or is formed around the middle part of the circumference of the circular double-sided truncated conical dressing body such that the center line of the V-groove is perpendicular to the rotary axis of the dressing body, the two surfaces of the V-groove being oriented in a rotating direction of the dressing body or in a direction perpendicular to the rotating direction; a plurality of octahedral diamond grains are set along the V-groove such that the two oriented crystal surfaces (1,1,1) of each of the octahedral diamond grains are bonded to the two respective surfaces of the V-groove using a bonding material; an angle between the surfaces of each of the octahedral diamond grains, which protrude from the V-groove, is formed as an acute angle; and the oriented crystal surface (1,0,0) of each of the octahedral diamond grains is formed as a contact surface that contacts and dresses a grinding wheel.

[0015] In the rotary diamond dresser, the plurality of octahedral diamond grains are set in the dressing body such that two opposite surfaces of the four oriented crystal surfaces (1,1,1) that form the vertices on the oriented crystal surfaces (1,0,0) of each octahedral diamond grain are bonded using the bonding material to the two respective surfaces of the V-groove, which is formed around the circumference of the large-diameter part of the circular truncated conical dressing body or is formed around the middle part of the circumference of the circular double-sided truncated conical dressing body. Thus, the octahedral diamond grains are strongly secured to the dressing body. Particularly, when the angle between the

surfaces of each of the octahedral diamond grains is an acute angle, which is smaller than the angle of about 70 degrees defined between the two opposite surfaces of the four oriented crystal surfaces (1,1,1) of each octahedral diamond grain, it is possible to strongly secure the octahedral diamond grains to the dressing body. Thus, the present invention provides a cup-type or conical-type rotary diamond dresser, which reduces the abrasion of diamond grains, dresses the grinding surface of the grinding wheel to form a desired shape with high precision, and is easily produced at a low cost.

[0016] In still another aspect, the present invention provides a cup-type rotary diamond dresser comprising a circular truncated conical dressing body rotated around a rotary axis, with a plurality of diamond grains inclinedly protruding outwards from the circumference of a large-diameter part of the circular truncated conical dressing body at a predetermined inclination angle relative to the rotary axis of the dressing body, or a conical-type rotary diamond dresser comprising a circular double-sided truncated conical dressing body rotated around a rotary axis, with a plurality of diamond grains protruding outwards from a middle part of the circumference of the circular double-sided truncated conical dressing body in a direction perpendicular to the rotary axis of the dressing body, wherein a V-groove having two surfaces, which are divergent from each other at an opening angle equal to an angle defined between two oriented crystal surfaces (1,1,1) that meet each other to form a ridge on a oriented crystal surface (1,1,0) of an octahedral diamond grain, is formed around the circumference of the large-diameter part of the circular truncated conical dressing body such that a center line of the V-groove is inclined outwards relative to the rotary axis of the dressing body, or is formed around the middle part of the circumference of the circular double-sided truncated conical dressing body such that a center line of the V-groove is perpendicular to the rotary axis of the dressing body; a plurality of octahedral diamond grains are set along the V-groove such that the two oriented crystal surfaces (1,1,1) of each of the octahedral diamond grains are bonded to the two respective surfaces of the V-groove using a bonding material; an angle between the surfaces of each of the octahedral diamond grains, which protrude from the V-groove, is formed as an acute angle; and the oriented crystal surface (1,0,0) of each of the octahedral diamond grains is formed as a contact surface that contacts and dresses a grinding wheel.

[0017] In the rotary diamond dresser, the plurality of octahedral diamond grains are set in the dressing body such that the two oriented crystal surfaces (1,1,1) that meet each other to form a ridge on the oriented crystal surface (1,1,0) of each octahedral diamond grain are bonded, using the bonding material, to the two respective surfaces of the V-groove, which is formed around the circumference of the large-diameter part of the circular truncated conical dressing body or is formed around the middle part of the circumference of the circular double-

sided truncated conical dressing body. Thus, the octahedral diamond grains are strongly secured to the dressing body. Particularly, when the angle between the surfaces of each of the octahedral diamond grains is an acute angle, it is possible to strongly secure the octahedral diamond grains to the dressing body. Thus, the present invention provides a cup-type or conical-type rotary diamond dresser, which reduces the abrasion of diamond grains, dresses the grinding surface of a grinding wheel to form a desired shape with high precision, and is easily produced at a low cost.

[0018] In the rotary diamond dresser, the bonding material for bonding the octahedral diamond grains to the surface of the V-groove may be solder made of an alloy of metal selected from one Group among Group 4A including titanium (Ti), Group 5A including vanadium (V), and Group 6A including chromium (Cr) of the Periodic Table, and metal selected from Group 1B of the Periodic Table.

[0019] In the rotary diamond dresser, a titanium carbide layer is formed on each of the two oriented crystal surfaces (1,1,1) of the diamond grain. The titanium carbide layer is a half-metallic layer, and thus has excellent integration ability relative to metals included in the solder, so that the diamond grains can be securely fixed to the circular dressing body.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0020]

FIG. 1 is a cross sectional view of a rotary diamond dresser according to a first embodiment of the present invention;

FIG. 2 is an enlarged sectional view illustrating an important part of the rotary diamond dresser;

FIG. 3 is a perspective view of an octahedral diamond;

FIG. 4 is an enlarged cross sectional view of a circular dressing body of the rotary diamond dresser;

FIG. 5 is a view illustrating an octahedral diamond soldered to a V-groove of the circular dressing body;

FIG. 6 is a view illustrating a plurality of diamond grains having small particle sizes, soldered to the circular dressing body;

FIG. 7 is a view illustrating CBN abrasive grains soldered to the circular dressing body;

FIG. 8 is a view illustrating octahedral diamond grains set in the V-groove of the circular dressing body such that the ridges of the neighboring diamond grains come into close contact with each other;

FIG. 9 is a view illustrating two V-grooves, which are formed in the circular dressing body and hold a plurality of octahedral diamond grains therein;

FIG. 10 is an enlarged cross sectional view illustrating an important part of a rotary diamond dresser according to a second embodiment of the present invention;

FIG. 11 is an enlarged cross sectional view illustrating an important part of a cup-type rotary diamond dresser according to a third embodiment of the present invention;

FIG. 12 is a view illustrating the operation of the cup-type rotary diamond dresser, which dresses a grinding wheel;

FIG. 13 is an enlarged cross sectional view illustrating an important part of a conical-type rotary diamond dresser according to a fourth embodiment of the present invention; and

FIG. 14 is a view illustrating the operation of the conical-type rotary diamond dresser, which dresses a grinding wheel.

PREFERRED EMBODIMENTS TO PRACTICE THE INVENTION:

[0021] Hereinbelow, a rotary diamond dresser according to a first embodiment of the present invention will be described. As shown in FIG. 1 through FIG. 3, the rotary diamond dresser 10 comprises a circular dressing body 11, with a plurality of diamond grains set into the circumference of the circular dressing body 11. The circular dressing body 11, having a center hole, is fitted at the center hole thereof over a rotary shaft 25 of a dressing unit, which is installed on a grinding machine. Thus, the circular dressing body 11 is rotated along with the rotary shaft 25, thereby dressing the grinding surface of a grinding wheel 26.

[0022] A V-groove 14 is formed along a high load part 13 of the circular dressing body 11, which is defined along the circumference 12 of the circular dressing body 11 and is heavily loaded during dressing work, thus highly abrading the diamond grains. The angle between two surfaces of the V-groove 14 is set to an angle of about 110 degrees, which is equal to the angle defined between two oriented crystal surfaces (1,1,1) that meet each other to form a ridge on an oriented crystal surface (1,1,0) of an octahedral diamond grain 15. The high load part 13 is a junction part between a circumferential straight part 16 and a side arcuate part 17 of the circumference 12 of the circular dressing body 11. The V-groove 14 is continuously and circumferentially formed along the high load part 13 such that the two surfaces of the V-groove 14 are oriented in a rotating direction of the dressing body 11.

[0023] The plurality of octahedral diamond grains 15 are sequentially set along the circumference 12 of the circular dressing body 11 such that two oriented crystal surfaces (1,1,1) of each of the diamond grains 15, which meet each other and define a 110 degree angle therebetween, are bonded to the two respective surfaces of the V-groove 14 using a bonding material 18. The oriented crystal surface (1,1,0) of each of the octahedral diamond grains 15 is formed as a contact surface 19, which contacts a grinding wheel and moves toward the ridge having high abrasion resistance, and dresses the grinding surface of the grinding wheel. The bonding material

18 uses solder made of an alloy of metal selected from one Group among Group 4A including titanium (Ti), Group 5A including vanadium (V), and Group 6A including chromium (Cr) of the Periodic Table, and metal selected from Group 1B including copper (Cu) and silver (Ag) of the Periodic Table. In other words, the two oriented crystal surfaces (1,1,1) of each of the diamond grains 15, which meet each other and define a 110 degree angle between them, are soldered to the two respective surfaces of the V-groove 14. In the soldered area, a titanium carbide layer is formed on each of the two oriented crystal surfaces (1,1,1) of the diamond grain 15. The titanium carbide layer is a half-metallic layer, and thus has excellent integration ability relative to metals included in the solder, so that the diamond grains 15 can be securely fixed to the circular dressing body 11.

[0024] A plurality of diamond grains 20, having small particle sizes, other than the octahedral diamond grains 15, are secured using the bonding material 18 to the surface of the circumference 12 of the circular dressing body 11 other than the high load part 13. The circumferential surface of each of the small-sized diamond grains 20 is formed as a contact surface 21, which contacts a grinding wheel and dresses the grinding surface of the grinding wheel. The diamond grains 20, having small particle sizes, are securely soldered to the surface of the circumference 12 of the circular dressing body 11 other than the high load part 13, using a bonding material 18 that is a solder made of an alloy of metal selected from one Group among Group 4A including titanium (Ti), Group 5A including vanadium (V), and Group 6A including chromium (Cr) of the Periodic Table, and metal selected from Group 1B including copper (Cu) and silver (Ag) of the Periodic Table.

[0025] Hereinbelow, the method of producing the rotary diamond dresser 10 will be described. As shown in FIG. 4, a V-groove 14, which has two surfaces that meet each other at a 110 degree angle, is continuously and circumferentially formed along the high load part 13, which is the junction part between the circumferential straight part 16 and the side arcuate part 17 of the circumference 12 of the circular dressing body 11 (First Step). Thereafter, a viscous granular material 22 is prepared by mixing metal particles, whose metal is selected from one Group among Group 4A including titanium (Ti), Group 5A including vanadium (V), and Group 6A including chromium (Cr) of the Periodic Table, and metal particles, whose metal is selected from Group 1B including copper (Cu) and silver (Ag) of the Periodic Table, with an appropriate organic binder added to the metal particles. Metals laden in the viscous granular material 22 are baked to produce an alloy, and thus provide a solder to be used as the bonding material 18, as will be described later herein. The viscous granular material 22 is coated on the two surfaces of the V-groove 14 to a predetermined thickness using an appropriate device, such as a brush (Second Step). Thereafter, octahedral diamond grains 15, having sizes of 60~80 grains/cts, are sequen-

tially placed in the V-groove 14 at regular intervals of about 1.2 mm. The two oriented crystal surfaces (1,1,1) of each of the diamond grains 15, which meet each other to form a ridge on the oriented crystal surface (1,1,0), are seated on the two respective surfaces of the V-groove 14, with the viscous granular material 22 added to the junction of the contact surfaces (Third Step).

[0026] Thereafter, the circular dressing body 11, which has the diamond grains 15 seated in the V-groove 14 using the viscous granular material 22, is put in a kiln, and is baked at a calcination temperature of 840~940°C in an inert gas atmosphere, such as an argon gas atmosphere, or in a vacuum atmosphere. During the calcination, a metalized layer, such as a titanium carbide (TiC) layer, is formed between the titanium (Ti) and the two oriented crystal surfaces (1,1,1) of each of the diamond grains 15. The metalized layer is easily united with metals of Group 1B, including copper (Cu) and silver (Ag) of the Periodic Table. Further, due to the metalized layer, the diamond grains 15 and the solder have excellent wettability. Thus, as shown in FIG. 5, the two oriented crystal surfaces (1,1,1) of each of the diamond grains 15 are securely soldered to the two respective surfaces of the V-groove 14 of the circular dressing body 11, thus being fixed to the circumference 12 of the circular dressing body 11 (Fourth Step).

[0027] Thereafter, the viscous granular material 22 is coated on the surfaces of both the circumferential straight part 16 and the side arcuate part 17 of the circumference 12 of the circular dressing body 11, other than the high load part 13, to a predetermined thickness using an appropriate device, such as a brush (Fifth Step). A plurality of diamond grains 20 that have predetermined small particle sizes, for example, artificial diamond grains having sizes of #20 (average particle size 0.427mm), other than the octahedral diamond grains 15, are placed in the coated viscous granular material 22 with a predetermined concentration and a uniform distribution to form a single layer. Thus, the diamond grains 20, having the predetermined small particle sizes, are seated in the surfaces of both the circumferential straight part 16 and the side arcuate part 17 of the circumference 12 of the circular dressing body 11 other than the high load part 13 (Sixth Step). Thereafter, the circular dressing body 11, which has the diamond grains 20 having the predetermined small particle sizes and seated in the circumference 12 using the viscous granular material 22, is put in the kiln, and is baked in an inert gas atmosphere, such as an argon gas atmosphere, or in a vacuum atmosphere. Thus, as shown in FIG. 6, the diamond grains 20 are securely soldered to both the circumferential straight part 16 and the side arcuate part 17 of the circumference 12 of the circular dressing body 11 other than the high load part 13 (Seventh Step).

[0028] Thereafter, the viscous granular material 22 is coated again using a brush over the entire area of the circumference 12 of the circular dressing body 11 (Eighth Step), which has both the octahedral diamond grains 15

and the small-sized diamond grains 20. CBN abrasive grains (hexagonal boron nitride) 27 of #140/170 (average particle size 0.107mm) are distributed over the entire area of the circumference 12 (Ninth Step). The circular dressing body 11, which has the CBN abrasive grains 27 seated in the circumference 12 using the viscous granular material 22, is put in the kiln, and is baked in an inert gas atmosphere, such as an argon gas atmosphere, or in a vacuum atmosphere (Tenth Step, see FIG. 7). Thus, the oriented crystal surface (1,1,0) of each of the octahedral diamond grains 15, which have been soldered at the two oriented crystal surfaces (1,1,1) to the two respective surfaces of the V-groove 14, is formed as the contact surface 19, which contacts the grinding wheel and dresses the grinding surface of the grinding wheel. Further, the circumferential surface of each of the diamond grains 20, which have small particle sizes and are soldered to the surface of the circumference 12 of the circular dressing body 11 other than the high load part 13, is formed as the contact surface 21, which contacts the grinding wheel 26 and dresses the grinding surface of the grinding wheel 26 (Eleventh Step, see FIG. 2). The diamond grains 15 and 20 are secured to the circular dressing body 11 such that the contact surfaces 19 and 21 of the diamond grains 15 and 20 protrude from the surface of the circumference 12 by about 0.3 mm.

[0029] The rotary diamond dresser 10, which has been produced through the above-mentioned process, is fitted over the rotary shaft 25, which is installed in the dressing unit of a grinding machine parallel to the rotary axis of the grinding wheel 26. Thus, the rotary diamond dresser 10 can be rotated along with the rotary shaft 25 by a motor. During dressing work, the rotary diamond dresser 10 moves relative to the grinding wheel 26 according to the shape of the grinding surface of the grinding wheel 26. The grinding surface of the grinding wheel 26, which has, for example, a straight portion and rounded edges, is dressed by both the small-sized diamond grains 20, which are fixed to the circumferential straight part 16 and the side arcuate part 17 of the circular dressing body 11 of the rotary diamond dresser 10, and by the octahedral diamond grains 15 fixed to the high load part 13. When the rotary diamond dresser 10 traverses in the direction of the rotary axis of the grinding wheel 26, the high load part 13, which is at the junction of the circumferential straight part 16 and the side arcuate part 17, acts as a leading edge and dresses the straight part of the circumferential grinding surface of the grinding wheel 26. Thus, the high load part 13 is heavily loaded. However, in the operation of the rotary diamond dresser 10 of the present invention, the octahedral diamond grains 15, fixed to the high load part 13, contact the grinding wheel 26 with the oriented crystal surface (1,1,0), move relatively in the direction parallel to the ridge having high abrasion resistance, and dress the grinding surface of the grinding wheel 26. Thus, the rotary diamond dresser 10 is not partially abraded at the high load part 13, but dresses the grinding surface of the grinding wheel 26 to form a desired shape

with high precision.

[0030] In the first embodiment, octahedral diamond grains 15, having sizes of 60~80 grains per carat, are sequentially placed in the V-groove 14 at a regular pitch of about 1.2 mm such that the ridges of the neighboring diamond grains 15 come into close contact with each other. However, it should be understood that octahedral diamond grains, having sizes of 150~200 grains per carat, may be sequentially and closely placed in the V-groove 14 at a regular pitch of about 0.75 mm (see FIG. 8). Because the octahedral diamond grains 15 can be sequentially set in the V-groove 14 such that the ridges of the neighboring diamond grains 15 come into close contact with each other, as described above, the number of octahedral diamond grains 15 set in the V-groove 14 can be increased, and thus increase the abrasion resistance of the high load part 13. Although it is economically advantageous to place the expensive octahedral diamond grains 15 in the V-groove 14 at a greater pitch, the pitch of the octahedral diamond grains 15, which are placed in the V-groove 14, is preferably set to 0.5~10 mm to provide high abrasion resistance.

[0031] In the first embodiment, one V-groove 14 is formed on the high load part 13 of the rotary diamond dresser 10. However, a plurality of V-grooves, for example, two V-grooves 14, may be formed around the circular dressing body 11, as shown in FIG. 9. In the above case, a plurality of octahedral diamond grains 15 may be securely set in the two V-grooves 14 of the rotary diamond dresser 10 such that a phase difference is defined between the trains of diamond grains 15 set in the two grooves 14 along the circumference, and such that the summed lengths of the contact surfaces 19 of the diamond grains 15 in the generating line direction become almost equal to each other.

[0032] In the first embodiment, at the eighth through tenth steps, artificial diamond grains having sizes of #140/170 are distributed on and soldered to the entire area of the circumference 12 of the circular dressing body 11, which has both the octahedral diamond grains 15 and the small-sized diamond grains 20, so that the abrasion resistance of the solder surface can be increased. However, it should be understood that the eighth through tenth steps may be omitted from the process.

[0033] Further, in the first embodiment, the V-groove 14 is continuously formed around the circumference 12 of the rotary diamond dresser 10, and thus the machining process for forming the V-groove 14 can be easily executed. However, the V-groove 14 may be formed through indenting such that a plurality of V-grooves are intermittently formed along the high load part 13, which is present on the circumference 12 of the circular dressing body 11 and is highly loaded during dressing, thus heavily abrading the diamond grains.

[0034] Hereinbelow, the second embodiment of the present invention will be described. Unlike the first embodiment, in which two oriented crystal surfaces (1,1,1) of each of the octahedral diamond grains 15, which meet

each other to form a ridge on the oriented crystal surface (1,1,0), are soldered to the two respective surfaces of the V-groove 14, the second embodiment is characterized in that two opposite surfaces of four oriented crystal surfaces (1,1,1) of each octahedral diamond grain, which form vertices on oriented crystal surfaces (1,0,0), are secured to the two respective surfaces of a V-groove 24. The second embodiment is the same as the first embodiment in the other respects and in the process of manufacturing the diamond dresser. Therefore, in the drawings, the same elements as those in the first embodiment are denoted by the same reference numerals as those in the first embodiment, and a description thereof is omitted.

[0035] As shown in FIG. 10, the V-groove 24 is formed along the high load part 13, which is present on the circumference 12 of the circular dressing body 11 and is highly loaded during dressing, thus heavily abrading the diamond grains, such that the two surfaces of the V-groove 24 are oriented in the rotating direction of the dressing body 11. The angle between the two surfaces of the V-groove 24 is set to an angle of about 70 degrees, which is equal to the angle defined between the two opposite surfaces of the four oriented crystal surfaces (1,1,1) that form vertices on the oriented crystal surfaces (1,0,0) of each octahedral diamond grain 15. The high load part 13 is a junction part between a circumferential straight part 16 and a side arcuate part 17 of the circumference 12 of the circular dressing body 11. The V-groove 24 is continuously and circumferentially formed along the high load part 13. The plurality of octahedral diamond grains 15 are set along the circumference 12 of the circular dressing body 11 such that the two oppositely situated crystal surfaces (1,1,1) of each of the diamond grains 15, which define a 70 degree angle therebetween, are bonded to the two respective surfaces of the V-groove 24 using a bonding material 18. The oriented crystal surface (1,0,0) of each of the octahedral diamond grains 15 is formed as a contact surface 23, which contacts a grinding wheel 26 and dresses the grinding surface of the grinding wheel 26. Thus, each of the octahedral diamond grains 15 contacts the grinding wheel 26 with the oriented crystal surface (1,0,0), moves relatively in a direction that is perpendicular to the oriented crystal surface (1,0,0), and has high abrasion resistance. The octahedral diamond grains 15 in the above state dress the grinding surface of the grinding wheel 26, so that the rotary diamond dresser 10 is not partially abraded at the high load part 13, but dresses the grinding surface of the grinding wheel 26 to form a desired shape with high precision.

[0036] The third embodiment of the present invention will be described. Unlike the first and second embodiments, in which a plurality of octahedral diamond grains 15 are secured using a bonding material 18 to a V-groove 14 or 24 that is formed along the high load part 13 of the circumference 12 of a circular dressing body 11, and a plurality of diamond grains 20, having small particle sizes, other than the octahedral diamond grains 15, are secured

using the bonding material 18 to the surface of the circumference 12 of the circular dressing body 11 other than the high load part 13, the third embodiment provides a cup-type rotary diamond dresser, in which only a plurality of diamond grains are bonded using a bonding material to a V-groove that is formed around the circumference of a large-diameter part of a circular truncated conical dressing body. Hereinbelow, the difference between the third embodiment and the first and second embodiments will be described and, in the drawings, the same elements as those in the first and second embodiments are denoted by the same reference numerals as those in the first and second embodiments, and description thereof is omitted.

[0037] As shown in FIG. 11, in the cup-type rotary diamond dresser 34 of the third embodiment, the V-groove 33 is continuously formed around the circumference 32 of the large-diameter part 31 of the circular truncated conical dressing body 30, which is rotated around a rotary axis. The center line of the V-groove 33 is inclined outwards relative to the rotary axis of the dressing body 30. The angle between two surfaces of the V-groove 33 is set to an angle of about 70 degrees, which is equal to the angle defined between two opposite surfaces of the four oriented crystal surfaces (1,1,1) that form vertices on the oriented crystal surfaces (1,0,0) of each of the octahedral diamond grains 15. The plurality of octahedral diamond grains 15 are set along the V-groove 33 such that the two opposite oriented crystal surfaces (1,1,1) of each diamond grain 15, which define a 70 degree angle therebetween, are bonded to the two respective surfaces of the V-groove 33 using a bonding material 18. Thus, each of the diamond grains 15 inclinedly protrudes outwards from the circumference 32 of the large-diameter part 31 of the circular truncated conical dressing body 30 at a predetermined inclination angle relative to the rotary axis of the dressing body 30. The angle between the surfaces of each diamond grain 15, which protrudes from the V-groove 33, is an acute angle, and the oriented crystal surface (1,0,0) of the octahedral diamond grain 15 is formed as a contact surface, which contacts a grinding wheel 26 and dresses the grinding surface of the grinding wheel 26.

[0038] As shown in FIG. 12, the cup-type rotary diamond dresser 34 is fitted over a rotary shaft 35, which is installed on a dressing unit of a grinding machine at a predetermined inclination angle relative to the rotary axis of the grinding wheel 26. The dresser 34 is rotated along with the rotary shaft 35 by a motor. During dressing, the cup-type rotary diamond dresser 34 and the grinding wheel 26 are moved relative to each other according to the shape of the grinding surface of the grinding wheel 26. Thus, the oriented crystal surfaces (1,0,0) of the octahedral diamond grains 15, which inclinedly protrude outwards from the circumference 32 of the large-diameter part 31 of the circular truncated conical dressing body 30 at the predetermined inclination angle relative to the rotary axis of the dressing body 30, contact the grinding

wheel 26, and dress straight, for example, the side surface and the circumferential surface of the grinding wheel 26.

[0039] Hereinbelow, the fourth embodiment of the present invention will be described. Unlike the third embodiment, the fourth embodiment comprises a circular double-sided truncated conical dressing body. As shown in FIG. 13, in the conical-type rotary diamond dresser 44 of the fourth embodiment, a V-groove 43 is continuously formed around the middle part 42 of the circumference of the circular double-sided truncated conical dressing body 40, which is rotated around a rotary axis, such that the center line of the V-groove 43 is perpendicular to the rotary axis of the dressing body 40. The two surfaces of the V-groove 43 define an angle of about 70 degrees. A plurality of octahedral diamond grains 15 are set along the V-groove 43 such that two opposite oriented crystal surfaces (1,1,1) of each diamond grain 15, which define a 70 degree angle therebetween, are bonded to the two respective surfaces of the V-groove 43 using a bonding material 18. Thus, each of the diamond grains 15 protrudes outwards from the middle part 42 of the circumference of the circular double-sided truncated conical dressing body 40 in a direction perpendicular to the rotary axis of the dressing body 40. The angle between the surfaces of each diamond grain 15 protruding from the V-groove 43 is an acute angle, and the oriented crystal surface (1,0,0) of the octahedral diamond grain 15 is formed as a contact surface, which contacts a grinding wheel 26 and dresses the grinding surface of the grinding wheel 26.

[0040] As shown in FIG. 14, when the conical-type rotary diamond dresser 44 is used for dressing both side surfaces of a grinding wheel 26, the dresser 44 is located such that the rotary axis of the dressing body 40 is inclined relative to the rotary axis of the grinding wheel 26 and thus part of the circumference of the dressing body 40, which is near to the rotary axis of the grinding wheel 26 approaches the side surface of the grinding wheel 26. Meanwhile, when the conical-type rotary diamond dresser 44 is used for linearly dressing the circumference of the grinding wheel 26, the dresser 44 is located such that the rotary axis of the dressing body 40 is parallel to the rotary axis of the grinding wheel 26. The conical-type rotary diamond dresser 44 and the grinding wheel 26 move relative to each other according to the shape of the grinding surface of the grinding wheel 26. The oriented crystal surface (1,0,0) of each of the octahedral diamond grains 15 which perpendicularly protrudes outwards from the middle part 42 of the circumference of the circular double-sided truncated conical dressing body 40, contacts the grinding wheel 26 and dresses straight, for example, the opposite side surfaces and the circumference of the grinding wheel 26, thus forming a flat grinding surface.

[0041] Further, in the third and fourth embodiments, the two surfaces of the V-groove 33 or 43 define an angle of about 70 degrees therebetween. However, the angle

between two surfaces of the V-groove may be set to an angle of about 110 degrees, which is equal to the angle defined between two oriented crystal surfaces (1,1,1) that meet each other to form a ridge on an oriented crystal surface (1,1,0) of an octahedral diamond grain. In the above state, the plurality of octahedral diamond grains 15 are sequentially set along the circumference of the dressing body 30 or 40 such that two oriented crystal surfaces (1,1,1) of each diamond grain 15, which define a 110 degree angle therebetween, are bonded to the two respective surfaces of the V-groove 33 or 43 using a bonding material 18.

[0042] In the second through fourth embodiments, the V-groove 24, 33, or 43 is continuously formed around the circumference of the dressing body. However, a plurality of V-grooves 24 may be intermittently formed along the high load part 13, which is present on the circumference of the circular dressing body 11 and is highly loaded during dressing to heavily abrade the diamond grains, a plurality of V-grooves 33 may be intermittently formed around the circumference 32 of the large-diameter part of the circular truncated conical dressing body 30, and a plurality of V-grooves 43 may be intermittently formed around the middle part 42 of the circumference of the circular double-sided truncated conical dressing body 40, such that the two surfaces of each V-groove are oriented in a rotating direction of the dressing body 40 or in a direction perpendicular to the rotating direction of the dressing body.

[0043] In the above-mentioned embodiments, the octahedral diamond grains 15, the small-sized diamond grains 20 and the CBN abrasive grains 27 are soldered to the dressing body using solder as the bonding material 18. However, the octahedral diamond grains 15, the small-sized diamond grains 20 and the CBN abrasive grains 27 may be fixed to the dressing body through electro-plating or electroless plating.

INDUSTRIAL APPLICABILITY:

[0044] The rotary diamond dresser according to the present invention is preferably used as a rotary diamond dresser, which can dress the grinding surface of a grinding wheel installed in a grinding machine that grinds workpieces using the grinding wheel, so that the dresser can form a grinding surface having a desired shape with high precision.

Claims

1. A rotary diamond dresser comprising a circular dressing body rotated around a rotary axis, with a plurality of diamond grains set into a circumference of the circular dressing body, thus dressing a grinding wheel, wherein:

a V-groove is formed along a high load part of

the circular dressing body such that two surfaces of the V-groove are oriented in a rotating direction of the circular dressing body and are divergent from each other at an angle equal to an angle defined between two oriented crystal surfaces (1,1,1) that meet each other to form a ridge on an oriented crystal surface (1,1,0) of an octahedral diamond grain, the high load part being defined along the circumference of the circular dressing body and being heavily loaded during dressing, thus highly abrading the diamond grains;

a plurality of octahedral diamond grains are set along the V-groove such that the two oriented crystal surfaces (1,1,1) of each of the octahedral diamond grains are bonded to the two respective surfaces of the V-groove using a bonding material, and the oriented crystal surface (1,1,0) of each of the octahedral diamond grains is formed as a contact surface that contacts and dresses the grinding wheel;

a plurality of small-sized diamond grains other than the octahedral diamond grains are secured using the bonding material to a surface of the circumference of the circular dressing body other than the high load part; and

each of the small-sized diamond grains is formed to make a contact surface that contacts and dresses the grinding wheel.

2. A rotary diamond dresser comprising a circular dressing body rotated around a rotary axis, with a plurality of diamond grains set into a circumference of the circular dressing body, thus dressing a grinding wheel, wherein:

a V-groove is formed along a high load part of the circular dressing body such that two surfaces of the V-groove are oriented in a rotating direction of the circular dressing body, or in a direction perpendicular to the rotating direction, and contact two opposite surfaces of four oriented crystal surfaces (1,1,1) of an octahedral diamond grain, which form vertices on oriented crystal surfaces (1,0,0), the high load part being defined along the circumference of the circular dressing body and being heavily loaded during dressing, thus highly abrading the diamond grains;

a plurality of octahedral diamond grains are set along the V-groove such that the two oriented crystal surfaces (1,1,1) of each of the octahedral diamond grains are bonded to the two respective surfaces of the V-groove using a bonding material, and the oriented crystal surface (1,0,0) of each of the octahedral diamond grains is formed as a contact surface that contacts and dresses the grinding wheel;

a plurality of small-sized diamond grains other

than the octahedral diamond grains are secured using the bonding material to a surface of the circumference of the circular dressing body other than the high load part; and

each of the small-sized diamond grains is formed to make a contact surface that contacts and dresses the grinding wheel.

3. The rotary diamond dresser according to claim 1 or 2, wherein the V-groove is continuously and circumferentially formed along the high load part, which is a junction part between a circumferential straight part and a side arcuate part of the circumference of the circular dressing body.

4. A cup-type rotary diamond dresser comprising a circular truncated conical dressing body rotated around a rotary axis thereof, with a plurality of diamond grains inclinedly protruding outwards from a circumference of a large-diameter part of the circular truncated conical dressing body at a predetermined inclination angle relative to the rotary axis of the dressing body, or a conical-type rotary diamond dresser comprising a circular double-sided truncated conical dressing body rotated around a rotary axis thereof, with a plurality of diamond grains protruding outwards from a middle part of a circumference of the circular double-sided truncated conical dressing body in a direction perpendicular to the rotary axis of the dressing body, wherein:

a V-groove having two surfaces, which contact two opposite surfaces of four oriented crystal surfaces (1,1,1) of an octahedral diamond grain, which form vertices on oriented crystal surfaces (1,0,0), is formed around the circumference of the large-diameter part of the circular truncated conical dressing body such that a center line of the V-groove is inclined outwards relative to the rotary axis of the dressing body, or is formed around the middle part of the circumference of the circular double-sided truncated conical dressing body such that a center line of the V-groove is perpendicular to the rotary axis of the dressing body, the two surfaces of the V-groove being oriented in a rotating direction of the dressing body or in a direction perpendicular to the rotating direction;

a plurality of octahedral diamond grains are set along the V-groove such that the two oriented crystal surfaces (1,1,1) of each of the octahedral diamond grains are bonded to the two respective surfaces of the V-groove using a bonding material;

an angle between the surfaces of each of the octahedral diamond grains, which protrude from the V-groove, is formed as an acute angle; and the oriented crystal surface (1,0,0) of each of

the octahedral diamond grains is formed as a contact surface that contacts and dresses a grinding wheel.

of the Periodic Table.

5. A cup-type rotary diamond dresser comprising a circular truncated conical dressing body rotated around a rotary axis, with a plurality of diamond grains inclinedly protruding outwards from a circumference of a large-diameter part of the circular truncated conical dressing body at a predetermined inclination angle relative to the rotary axis of the dressing body, or a conical-type rotary diamond dresser comprising a circular double-sided truncated conical dressing body rotated around a rotary axis, with a plurality of diamond grains protruding outwards from a middle part of a circumference of the circular double-sided truncated conical dressing body in a direction perpendicular to the rotary axis of the dressing body, wherein:
 - a V-groove having two surfaces, which are divergent from each other at an angle equal to an angle defined between two oriented crystal surfaces (1,1,1) that meet each other to form a ridge on an oriented crystal surface (1,1,0) of an octahedral diamond grain, is formed around the circumference of the large-diameter part of the circular truncated conical dressing body such that a center line of the V-groove is inclined outwards relative to the rotary axis of the dressing body, or is formed around the middle part of the circumference of the circular double-sided truncated conical dressing body such that a center line of the V-groove is perpendicular to the rotary axis of the dressing body;
 - a plurality of octahedral diamond grains are set along the V-groove such that the two oriented crystal surfaces (1,1,1) of each of the octahedral diamond grains are bonded to the two respective surfaces of the V-groove using a bonding material;
 - an angle between the surfaces of each of the octahedral diamond grains, which protrude from the V-groove, is formed as the angle defined between two oriented crystal surfaces (1,1,1);
 - the oriented crystal surface (1,1,0) of each of the octahedral diamond grains is formed as a contact surface that contacts and dresses a grinding wheel.
6. The rotary diamond dresser according to any one of claims 1 through 5, wherein the bonding material for bonding the octahedral diamond grains to the surface of the V-groove is solder made of an alloy of metal selected from one Group among Group 4A including titanium (Ti), Group 5A including vanadium (V), and Group 6A including chromium (Cr) of the Periodic Table, and metal selected from Group 1B

FIG. 1

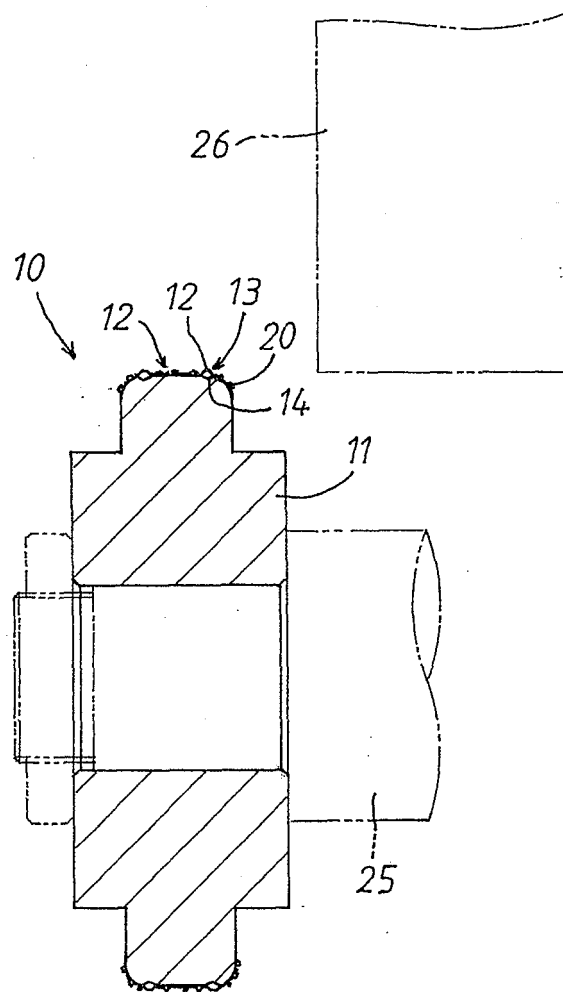


FIG. 2

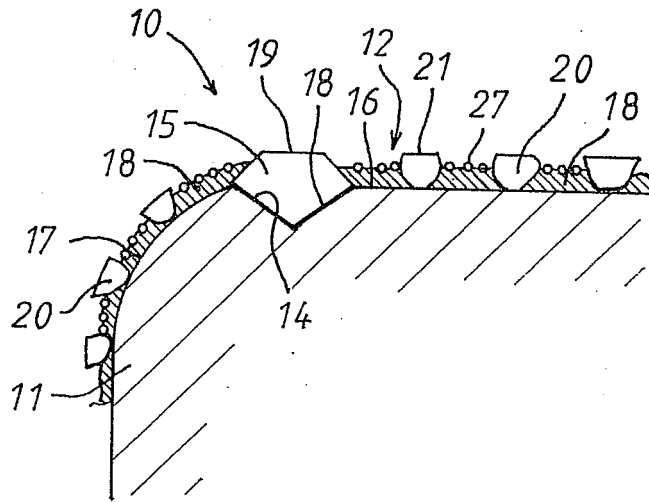


FIG. 3

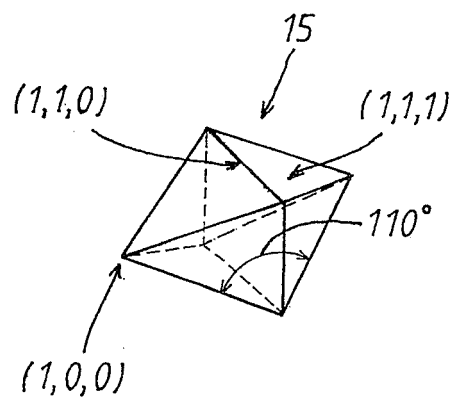


FIG. 4

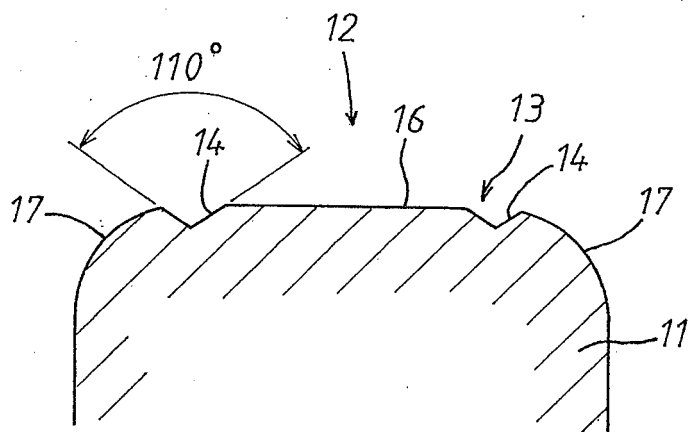


FIG. 5

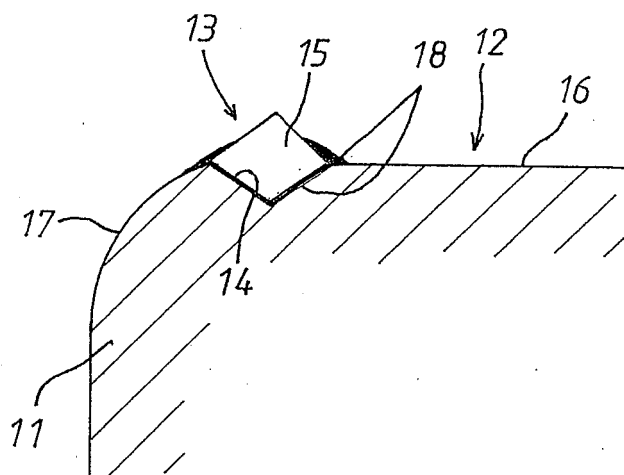


FIG. 6

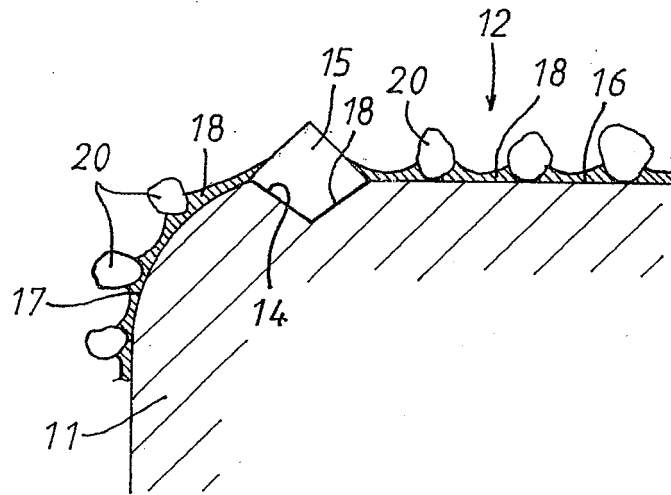


FIG. 7

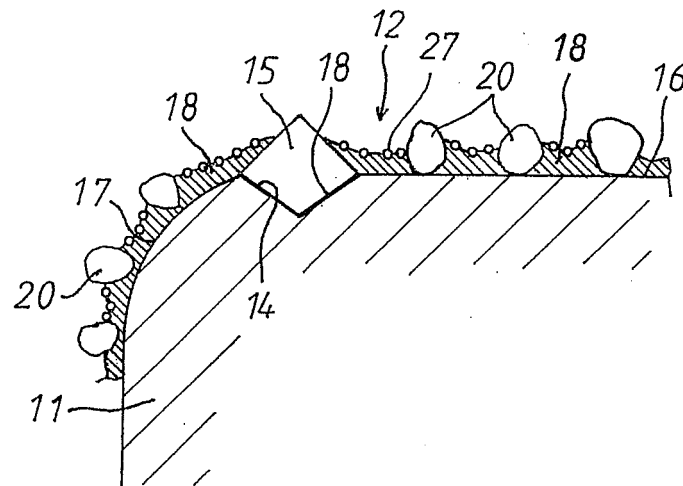


FIG. 8

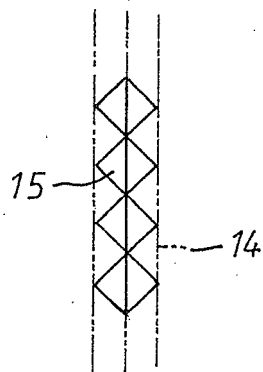


FIG. 9

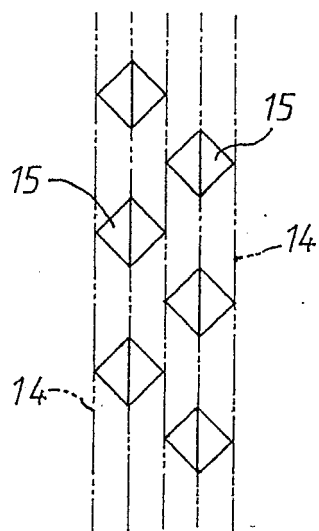


FIG. 10

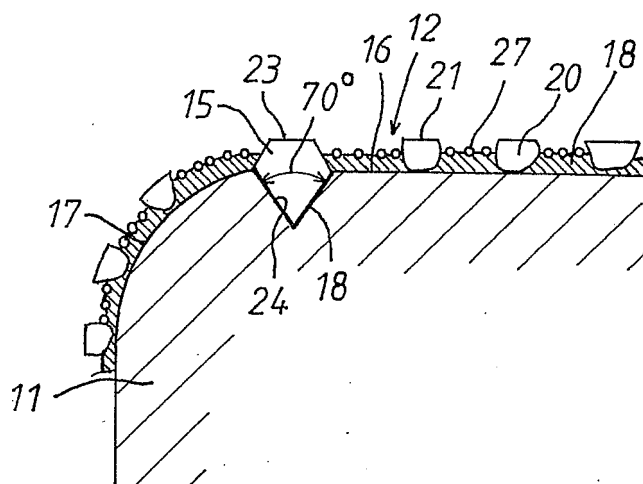


FIG. 11

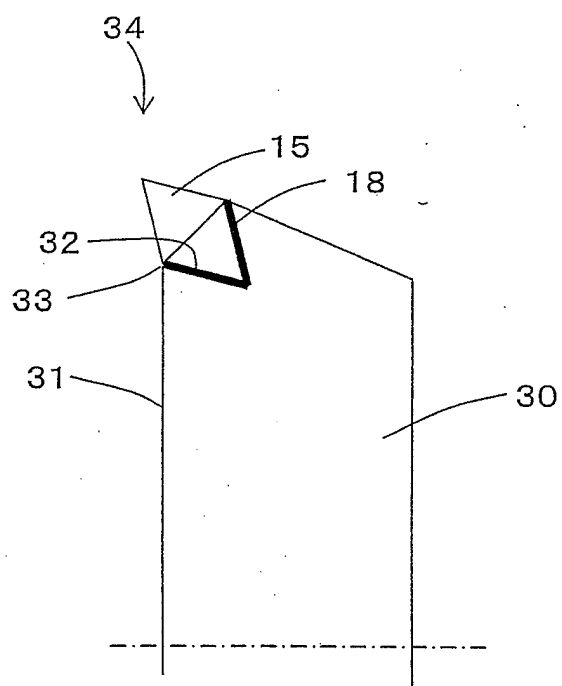


FIG. 12

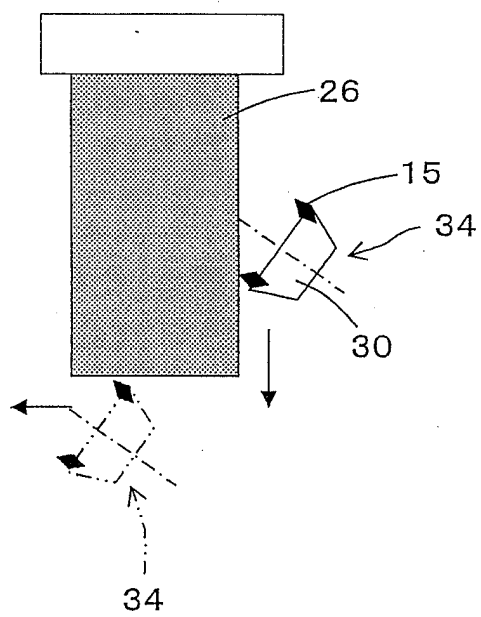


FIG. 13

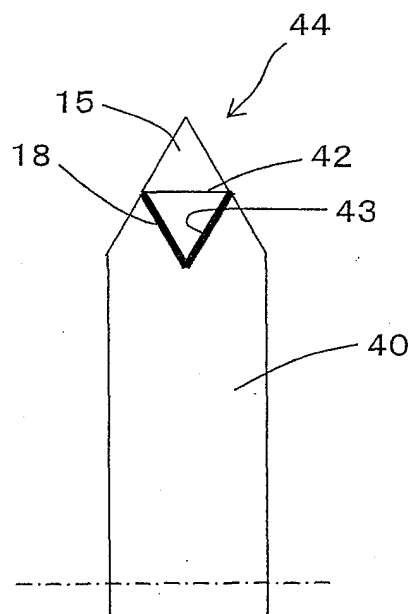
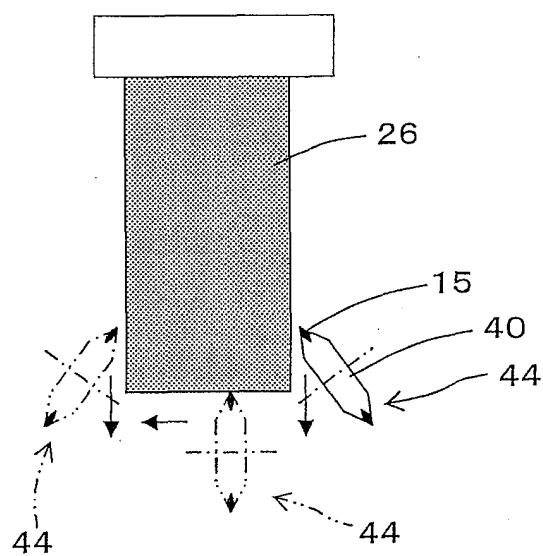


FIG. 14



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/014858

A. CLASSIFICATION OF SUBJECT MATTER

B24B53/14 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B24B53/14 (2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2005
Kokai Jitsuyo Shinan Koho	1971-2005	Toroku Jitsuyo Shinan Koho	1994-2005

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 54-86893 A (Toyota Banmmoppusu Kabushiki Kaisha), 10 July, 1979 (10.07.79), Full text; Figs. 2, 6 to 30 (Family: none)	1-6
Y	JP 3450085 B (Toyota Banmmoppusu Kabushiki Kaisha, Toyoda Machine Works, Ltd.), 22 September, 2003 (22.09.03), Full text; all drawings (Family: none)	1-6

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
07 November, 2005 (07.11.05)Date of mailing of the international search report
15 November, 2005 (15.11.05)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 53034193 A [0002] [0002] [0004]
- JP 3450085 B [0003] [0005] [0005]