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(54) **SAW BLADE AND METHOD FOR MULTIPLE SAWING OF RARE EARTH MAGNET**

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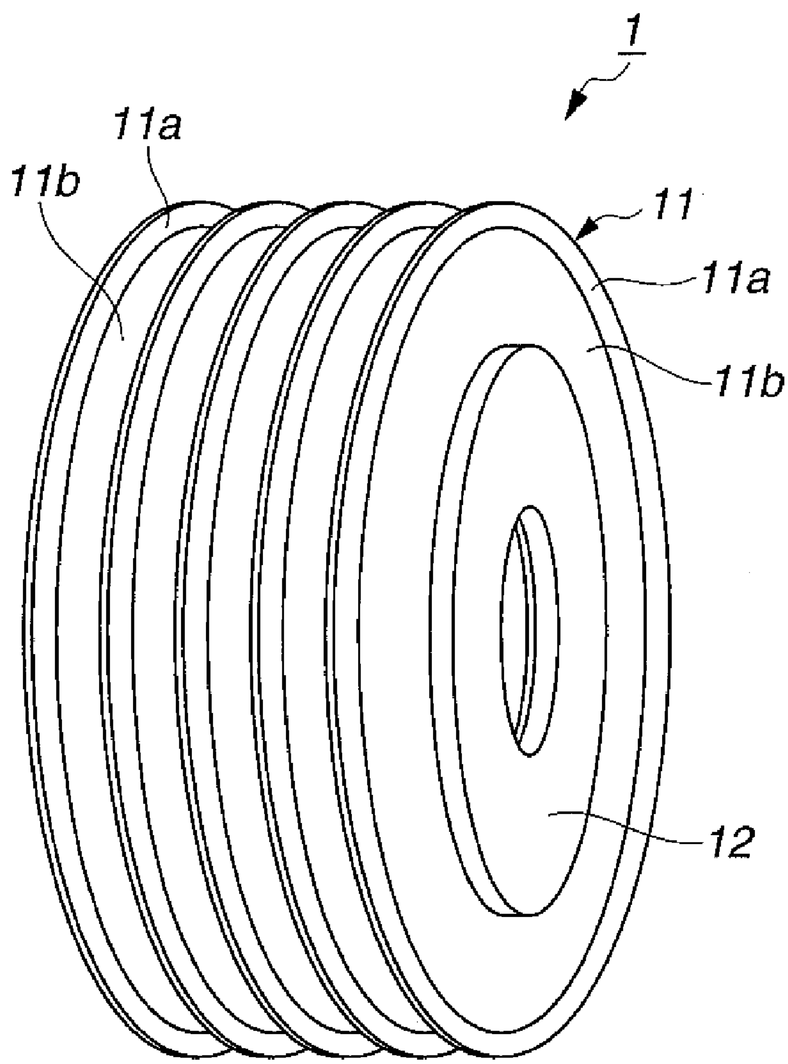
(57) **ABSTRACT**

A multiple blade assembly comprising a plurality of spaced apart saw blades mounted on a rotating shaft is used for sawing a rare earth magnet block into multiple pieces by rotating the plurality of saw blades. The saw blade comprises a core in the form of a thin doughnut disk and a peripheral cutting part on an outer peripheral rim of the core. The cutting part is made of a composition comprising an abrasive, a resin binder, and a lubricant.



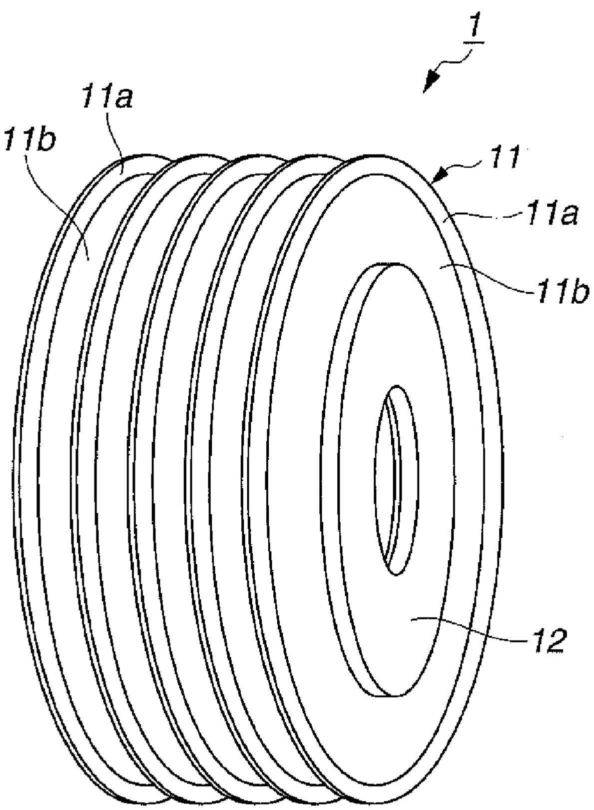


FIG.1A

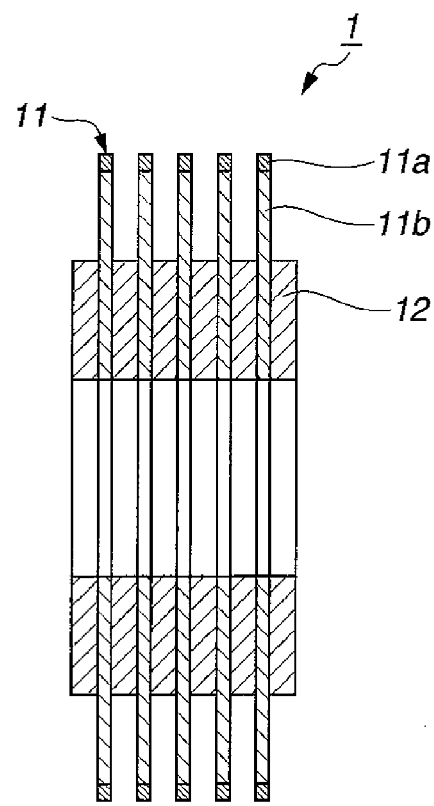
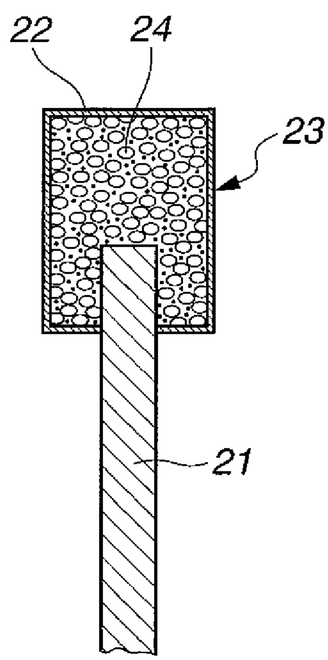


FIG.1B

FIG.2



SAW BLADE AND METHOD FOR MULTIPLE SAWING OF RARE EARTH MAGNET

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This non-provisional application claims priority under 35 U.S.C. §119(a) on Patent Application No. 2011-259157 filed in Japan on Nov. 28, 2011, the entire contents of which are hereby incorporated by reference.

TECHNICAL FIELD

[0002] This invention generally relates to a method for sawing a magnet block into multiple pieces. More particularly, it relates to a saw blade for use in sawing a rare earth magnet block into multiple pieces.

BACKGROUND ART

[0003] Systems for manufacturing commercial products of rare earth magnet include a single part system wherein a part of substantially the same shape as the product is produced at the stage of press molding, and a multiple part system wherein once a large block is molded, it is divided into a plurality of parts by machining. The single part system includes press molding, sintering or heat treating, and finishing steps. A molded part, a sintered or heat treated part, and a finished part (or product) are substantially identical in shape and size. Insofar as normal sintering is performed, a sintered part of near net shape is obtained, and the load of the finishing step is relatively low. However, when it is desired to manufacture parts of small size or parts having a reduced thickness in magnetization direction, the sequence of press molding and sintering is difficult to form sintered parts of normal shape, leading to a lowering of manufacturing yield, and at worst, such parts cannot be formed.

[0004] In contrast, the multiple part system eliminates the above-mentioned problems and allows press molding and sintering or heat treating steps to be performed with high productivity and versatility. It now becomes the mainstream of rare earth magnet manufacture. In the multiple part system, a molded block and a sintered or heat treated block are substantially identical in shape and size, but the subsequent finishing step requires cutting or sawing. It is the key for manufacture of finished parts how to saw the block in the most efficient and least wasteful manner.

[0005] Tools for cutting rare earth magnet blocks include two types, a diamond grinding wheel inner-diameter (ID) blade having diamond grits bonded to an inner periphery of a thin doughnut-shaped disk, and a diamond grinding wheel outer-diameter (OD) blade having diamond grits bonded to an outer periphery of a thin disk as a core. Nowadays the sawing technology using OD blades becomes the mainstream, especially from the aspect of productivity. The sawing technology using ID blades is low in productivity because of a single blade cutting mode. In the case of OD blade, multiple cutting is possible. FIG. **1** illustrates an exemplary multiple blade assembly **1** comprising a plurality of saw blades **11** coaxially mounted on a rotating shaft (not shown) alternately with spacers **12**, each blade **11** comprising a core **11***b* in the form of a thin doughnut disk and a cutting part or abrasive grain layer **11***a* on an outer peripheral rim of the core **11***b*. This multiple blade assembly **1** is capable of multiple sawing, that is, cutting a block into a multiplicity of parts at a time.

[0006] For the manufacture of OD abrasive blades, diamond grains are generally bonded by three typical binding systems including resin bonding with resin binders, metal bonding with metal binders, and electroplating. These abrasive blades are often used in sawing of rare earth magnet blocks.

[0007] When sawing abrasive blades are used to machine a rare earth magnet block of certain size into a multiplicity of parts, the relationship of the cutting part (axial) width of the saw blade is crucially correlated to the material yield of the workpiece (magnet block). It is important to maximize a material yield and productivity by using a cutting part with a minimal width, machining at a high accuracy to minimize a machining allowance and reduce chips, and increasing the number of parts available.

[0008] In order to form a cutting part with a minimal width (or thinner cutting part) from the standpoint of material yield, the abrasive wheel core must be thin. In the case of OD blade **11** shown in FIG. **1**, its core lib is usually made of steel materials from the standpoints of material cost and mechanical strength. Of these steel materials, alloy tool steels classified as SK, SKS, SKD, SKT, and SKH according to the JIS standards are often used in commercial practice. However, in an attempt to saw a hard material such as rare earth magnet by a thin OD blade, the prior art core of alloy tool steel is short in mechanical strength and becomes deformed or bowed during sawing operation, losing dimensional accuracy.

[0009] One solution to this problem is a cutoff wheel for use with rare earth magnet alloys comprising a core of cemented carbide to which high hardness abrasive grains such as diamond and CBN are bonded with a binding system such as resin bonding, metal bonding or electroplating, as described in JP-A H10-175172. Use of cemented carbide as the core material mitigates buckling deformation by stresses during machining, ensuring that rare earth magnet is sawed at a high accuracy. However, if a high frictional resistance is exerted between the cutting part and the magnet during sawing of the magnet, high accuracy machining is not expected. In particular, if substantial friction occurs between the side surface of the cutting part (not directly contributing to grinding operation) and the magnet, the grinding resistance is enhanced. Then, even if the cemented carbide core is used, chipping and/or bowing can occur, adversely affecting the machined state.

[0010] One solution to the above problem is to add a lubricant such as fatty acid to grinding fluid or coolant. However, since the space between the saw blade and the workpiece or rare earth magnet is extremely narrow, it is difficult to effectively supply the coolant between the saw blade and the magnet.

CITATION LIST

[0011] Patent Document 1: JP-A H10-175172

DISCLOSURE OF INVENTION

[0012] An object of the invention is to provide a saw blade in the form of a resinoid wheel, which is used in multiple sawing of a rare earth magnet block into multiple pieces, which reduces the sawing resistance between the saw blade and the magnet block, and which ensures sawing at a high accuracy and high speed even if the saw blade is thinner than the conventional blades. Another object is to provide a method for sawing a rare earth magnet block into multiple pieces.

[0013] The invention pertains to a multiple blade assembly comprising a plurality of saw blades coaxially mounted on a rotating shaft at axially spaced apart positions. The multiple blade assembly is used for sawing a rare earth magnet block into multiple pieces by rotating the plurality of saw blades. The saw blade has a core in the form of a thin disk or thin doughnut disk and a peripheral cutting part on an outer peripheral rim of the core. The inventors have developed a saw blade in the form of a resinoid wheel having a cutting part made of a composition comprising a component or lubricant for reducing the friction between the cutting part and the magnet block during the sawing operation. When the magnet block is sawed by the saw blades, the sawing operation experiences a reduced cutting resistance, and achieves an equivalent yield and accuracy compared with the prior art even if thinner saw blades are used.

[0014] The invention generally pertains to a multiple blade assembly comprising a plurality of saw blades coaxially mounted on a rotating shaft at axially spaced apart positions, which is used for sawing a rare earth magnet block into multiple pieces by rotating the plurality of saw blades. In one aspect, the invention provides the saw blade comprising a core in the form of a thin disk or thin doughnut disk and a peripheral cutting part on an outer peripheral rim of the core, the cutting part being made of a composition comprising an abrasive, a resin binder, and a lubricant for reducing the friction between the cutting part and the magnet block during the sawing operation.

[0015] In a preferred embodiment, the lubricant is selected from the group consisting of boron nitride, carbon, molybdenum disulfide, tungsten disulfide, graphite fluoride, and polytetrafluoroethylene, and mixtures thereof. Also preferably, the lubricant is in particulate form having a particle size in the range of 1 to 200 μm.

[0016] Typically, the cutting part is made of a composition comprising 10 to 40% by weight of diamond and/or CBN as the abrasive; 20 to 60% by weight of a matrix selected from the group consisting of SiC having a particle size of 1 to 100 μm, SiO_2 having a particle size of 1 to 100 μm, Al_2O_3 having a particle size of 1 to 100 μm, WC having a particle size of 0.1 to 50 μm, Fe, Ni and Cu having a particle size of 1 to 200 μm, and mixtures thereof; 10 to 50% by weight of a thermosetting resin as the binder; and 1 to 50% by weight of the lubricant.

[0017] In another aspect, the invention provides a method for sawing a rare earth magnet block into multiple pieces, comprising the steps of providing a multiple blade assembly comprising a plurality of the above-defined saw blades coaxially mounted on a rotating shaft at axially spaced apart positions, and rotating the plurality of saw blades.

ADVANTAGEOUS EFFECTS OF INVENTION

[0018] The saw blades in the form of a resinoid wheel are used in multiple sawing of a rare earth magnet block into multiple pieces. As compared with the prior art, the saw blade reduces the cutting resistance, improves the sawing accuracy, and ensures sawing at a high accuracy and high speed even if the saw blade is thinner than the conventional blades. The blade is of great worth in the industry.

BRIEF DESCRIPTION OF DRAWINGS

[0019] FIG. **1** illustrates a multiple blade assembly in one embodiment of the invention, FIG. **1***a* being a perspective view and FIG. **1***b* being a cross-sectional view.

[0020] FIG. **2** is an enlarged cross-sectional view of a peripheral portion of the saw blade.

DESCRIPTION OF EMBODIMENTS

[0021] The term "axial" refers to the axis of a rotating shaft and "radial" refers to a circular blade in an assembly. The width of the cutting part corresponds to an axial size in this sense.

[0022] A multiple blade assembly is constructed by coaxially mounting a plurality of saw blades on a rotating shaft at axially spaced apart positions (as shown in FIG. **1**). The multiple blade assembly is operated by rotating the plurality of saw blades for thereby sawing a rare earth magnet block into a multiplicity of pieces at the same time. The saw blade **23** in the form of a resinoid wheel according to the invention is shown in FIG. **2** as comprising a core **21** in the form of a thin disk or thin doughnut disk and a peripheral cutting part **22** on an outer peripheral rim of the core **21**. The cutting part **22** is made of a composition comprising an abrasive **24**, a resin binder, and a lubricant for reducing the friction between the cutting part and the workpiece (or magnet block) during the sawing operation.

[0023] Examples of the lubricant used herein include boron nitride, carbon (including graphite and amorphous carbon), molybdenum disulfide, tungsten disulfide, graphite fluoride, and polytetrafluoroethylene (PTFE), which may be used alone or in admixture of two or more. Although the conventional sawing operation is difficult to reduce the friction between the cutting part side surface and the workpiece by providing a coolant supply for lubrication, the inclusion of the lubricant within the cutting part is effective for reducing the friction between the cutting part side surface and the workpiece, thereby preventing the cutting edge from axial runout during the sawing operation. This allows the cutting part to transmit its grinding force only in a radial direction and ensures high-accuracy sawing operation even with the saw blade using a thin core with a low deflective strength.

[0024] If a smaller amount of the lubricant is used, the effect of reducing friction on the side surface is reduced. A larger amount of the lubricant used has the problem that since the lubricant lacks the strength of a structural matrix, not only the strength of the cutting part of the blade is reduced, but also the frictional force of the grinding surface is reduced, resulting in a degraded grinding rate. The lubricant should preferably be used in an amount of 1 to 50% by weight of the composition of which the cutting part is made. As to the preferred amount of each species (% by weight based on the composition), boron nitride is 1 to 40% by weight, carbon (including graphite and amorphous carbon) is 1 to 40% by weight, molybdenum disulfide is 1 to 40% by weight, tungsten disulfide is 5 to 50% by weight, graphite fluoride is 5 to 40% by weight, and PTFE is 5 to 40% by weight. More preferably, boron nitride is 5 to 30% by weight, carbon (including graphite and amorphous carbon) is 5 to 30% by weight, molybdenum disulfide is 5 to 30% by weight, tungsten disulfide is 10 to 40% by weight, graphite fluoride is 10 to 30% by weight, and PTFE is 10 to 30% by weight. When a mixture of two or more lubricants is used, the total amount should preferably be in the range of 1 to 50% by weight, more preferably 5 to 40% by weight.

[0025] The lubricant is typically available in particulate form. Since the cutting part has a width of 0.2 to 2 mm, a particle size in excess of 0.2 mm (200 μm) is inadequate. Too fine particles have an increased volume, detracting from the strength of the cutting part. The lubricant preferably has a particle size of 1 to 200 μm, more preferably 10 to 150 μm.

[0026] In addition to the lubricant, the composition of which the cutting part is made contains abrasive grains, a resin binder, and a structural matrix. Preferred examples of the matrix include SiC having a particle size of 1 to 100 μm, SiO_2 having a particle size of 1 to 100 μm, Al_2O_3 having a particle size of 1 to 100 μm, WC having a particle size of 0.1 to 50 μm, Fe, Ni and Cu having a particle size of 1 to 200 μm, which may be used alone or in admixture of two or more. The role of the matrix is to increase the strength of the cutting part, prevent the cutting part from deforming in a direction perpendicular to the feed direction of the saw blade during the sawing operation, prevent the cutting edge from axial runout during the sawing operation, allows the saw blade to transmit its grinding force only in a radial direction, and ensures high-accuracy sawing operation even with the saw blade using a thin core with a low deflective strength. The matrix is available in particulate form. Too fine particles have an increased volume, failing to provide the cutting part with strength. If the particle size is large, only one particle is present per width of the cutting part, also leading to a reduced strength. Thus the matrix preferably has a particle size in the above range. More preferably, the particle size of SiC is 2 to 50 μm, SiO_2 is 2 to 50 μm, Al_2O_3 is 2 to 50 μm, WC is 1 to 30 μm, and Fe, Ni and Cu is 10 to 150 μm.

[0027] The matrix should preferably be used in an amount of 20 to 60% by weight, more preferably 25 to 50% by weight of the composition. Outside the range, a smaller amount of the matrix may be less effective whereas a larger amount may detract from the strength of the cutting part.

[0028] The abrasive grains may be any well-known abrasives, preferably diamond and CBN. The abrasive grains preferably have a particle size of 10 to 200 μm, more preferably 50 to 200 μm. A particle size in excess of 200 μm may exceed the width of the cutting part whereas a smaller particle size may interfere with grinding efficiency, sawing speed, and productivity. The abrasive should preferably be used in an amount of 20 to 60% by weight, more preferably 20 to 40% by weight of the composition. Outside the range, a smaller amount of the abrasive may lead to a lower grinding rate whereas a larger amount may detract from the strength of the cutting part.

[0029] The binder has a function of binding diamond or CBN, the lubricant and the matrix together to high strength so that a cutting part having a high stiffness despite thinness may be formed. Thermosetting resins are preferred as the binder. Inter alia, phenolic resins, formaldehyde resins and urea resins are more preferred. Phenol formaldehyde resins obtained by condensation of phenol and formaldehyde are most preferred since they have excellent heat resistance and water resistance and can tightly bind the abrasive and matrix. Melamine resins prepared from melamine and formaldehyde are also favorable. The binder should preferably be used in an amount of 10 to 50% by weight of the composition. Outside the range, a smaller amount of the binder may be weak in binding the other components whereas a larger amount of the binder indicates smaller amounts of the other components, leading to shortage of strength, grinding rate and lubrication.

[0030] The core supporting the cutting part is preferably made of cemented carbide. Any of the cemented carbides described in Patent Document 1 may be used.

[0031] The workpiece which is intended herein to saw is a rare earth magnet block. The rare earth magnet as the workpiece is not particularly limited. Suitable rare earth magnets include sintered rare earth magnets of R—Fe—B systems wherein R is at least one rare earth element inclusive of yttrium.

[0032] Suitable sintered rare earth magnets of R—Fe—B systems are those magnets containing, in weight percent, 5 to 40% of R, 50 to 90% of Fe, and 0.2 to 8% of B, and optionally one or more additive elements selected from C, Al, Si, Ti, V, Cr, Mn, Co, Ni, Cu, Zn, Ga, Zr, Nb, Mo, Ag, Sn, Hf, Ta, and W, for the purpose of improving magnetic properties and corrosion resistance. The amounts of additive elements added are conventional, for example, up to 30 wt % of Co, and up to 8 wt % of the other elements. The additive elements, if added in extra amounts, rather adversely affect magnetic properties.

[0033] Suitable sintered rare earth magnets of R—Fe—B systems may be prepared, for example, by weighing source metal materials, melting, casting into an alloy ingot, finely dividing the alloy into particles with an average particle size of 1 to 20 μm, sintered R—Fe—B magnet powder, compacting the powder in a magnetic field, sintering the compact at 1,000 to 1,200° C. for 0.5 to 5 hours, and heat treating at 400 to 1,000° C.

[0034] When the rare earth magnet block is sawed into a multiplicity of pieces by the multiple blade assembly of saw blades, any well-known procedures may be employed.

EXAMPLE

[0035] Examples and Comparative Examples are given below for further illustrating the invention although the invention is not limited thereto.

Example 1

[0036] OD blades were fabricated by providing a doughnut-shaped disk core of cemented carbide (consisting of WC 90 wt %/Co 10 wt %) having an outer diameter 120 mm, inner diameter 40 mm, and thickness 0.3 mm, and heat pressing a composition to an outer peripheral rim of the core to form a resinoid grinding wheel section or cutting part. The composition contained 10 wt % of graphite having a particle size of 5 to 30 μm as the lubricant, 40 wt % of #800 SiC (GC powder) as the matrix, 25 wt % of a phenol formaldehyde resin as the binder, and 25 wt % of synthetic diamond grains having an average particle size of 150 μm. Subsequent finish work completed OD blades (or sawing abrasive blades). The axial extension of the cutting part from the core was 0.05 mm on each side, that is, the cutting part had a width of 0.4 mm (in the thickness direction of the core). The radial extension or length of the cutting part is 2.5 mm, that is, the blade had an outer diameter of 125 mm.

[0037] Using the OD blades, a sawing test was carried out on a workpiece which was a sintered Nd—Fe—B magnet block. A multiple blade assembly was constructed as shown in FIG. **1** by coaxially mounting 41 OD blades on a shaft at an axial spacing of 2.1 mm, with spacers interposed therebetween. The spacers each had an outer diameter 85 mm, inner diameter 40 mm, and thickness 2.1 mm. The multiple blade assembly was designed so that the magnet block was cut into magnet strips having a thickness of 2.0 mm.

[0038] Using the multiple blade assembly consisting of 41 OD blades and 40 spacers alternately mounted on the shaft, the sintered Nd—Fe—B magnet block was sawed. The sintered Nd—Fe—B magnet block had a length 101 mm, width 30 mm and height 17 mm and had been polished on all six surfaces at an accuracy of ±0.05 mm by a vertical double-disk polishing tool. By the multiple blade assembly, the magnet block was longitudinally divided into a multiplicity of magnet strips of 2.0 mm thick. Specifically, one magnet block was cut into 40 magnet strips.

[0039] The sawing operation was carried out while supplying 30 L/min of a grinding fluid or coolant from the feed nozzle, rotating the OD blades at 7,000 rpm (circumferential speed of 46 m/sec), and feeding the multiple blade assembly at a speed of 20 mm/min.

[0040] After magnet strips were cut using the OD blades constructed as above, they were measured for thickness between the machined surfaces at the center by a micrometer. The strips were rated "passed" if the measured thickness was within a cut size tolerance of 2.0±0.05 mm. If the measured thickness was outside the tolerance, the multiple blade assembly was tailored by adjusting the thickness of spacers, so that the measured thickness might fall within the tolerance. If the spacer adjustment was repeated more than two times for the same OD blades, these OD blades were judged as having lost stability and replaced by new OD blades. Under these conditions, 1000 magnet blocks were sawed. The evaluation results of the sawed state are shown in Table 1.

Comparative Example 1

[0041] A sintered rare earth magnet block was sawed by the same procedure as in Example 1 except that the cutting part composition was changed. In this way, 1000 magnet blocks were sawed, and the sawed state was evaluated. The evaluation results are also shown in Table 1.

[0042] The composition of the cutting part in Comparative Example 1 contained 45 wt % of #800 SiC (GC powder) as the matrix, 30 wt % of the phenol formaldehyde resin as the binder, and 25 wt % of synthetic diamond grains having an average particle size of 150 μm.

[0043] As seen from Table 1, the multiple sawing method of the invention maintains consistent dimensional accuracy for products over a long term despite the reduced blade thickness and is successful in reducing the number of spacer adjustments and the number of OD blade replacements. Then an increase in productivity is attained.

Examples 2 to 10 and Comparative Example 2

[0044] OD blades were fabricated by providing a doughnut-shaped disk core of cemented carbide (consisting of WC 90 wt %/Co 10 wt %) having an outer diameter 95 mm, inner diameter 40 mm, and thickness 0.3 mm, and heat pressing a composition shown in Table 2 to an outer peripheral rim of the core to form a cutting part. The axial extension of the cutting part from the core was 0.025 mm on each side, that is, the cutting part had a width of 0.35 mm (in the thickness direction of the core). The radial extension or length of the cutting part is 2.5 mm, that is, the blade had an outer diameter of 100 mm.

[0045] Using the OD blades, a sawing test was carried out on a workpiece which was a sintered Nd—Fe—B magnet block. A multiple blade assembly was constructed as shown in FIG. **1** by coaxially mounting 38 OD blades on a shaft at an axial spacing of 1.05 mm, with spacers interposed therebetween. The spacers each had an outer diameter 70 mm, inner diameter 40 mm, and thickness 1.05 mm. The multiple blade assembly was designed so that the magnet block was cut into magnet strips having a thickness of 1.0 mm.

[0046] The multiple blade assembly consisting of 38 OD blades and 37 spacers alternately mounted on the shaft was set relative to the sintered Nd—Fe—B magnet block such that the lowermost end of the blades was 2 mm below the bottom surface of the magnet block. The sintered Nd—Fe—B magnet block had a length 50 mm, width 30 mm and height 12 mm and had been polished on all six surfaces at an accuracy of ±0.05 mm by a vertical double-disk polishing tool. By the multiple blade assembly, the magnet block was longitudinally divided into a multiplicity of magnet strips of 1.0 mm thick. Specifically, one magnet block was cut into 37 magnet strips.

[0047] The sawing operation was carried out while supplying 30 L/min of a grinding fluid or coolant from the feed nozzle, rotating the OD blades at 7,000 rpm (circumferential speed of 37 m/sec), and feeding the multiple blade assembly at a speed of 20 mm/min.

[0048] Using each of the OD blades of Examples 2 to 10 and Comparative Example 2, 1000 magnet blocks were sawed. The magnet strips were measured for thickness between the machined surfaces at the center by a micrometer. Provided that the cut size tolerance was 1.0±0.075 mm, a process capability index (Cpk) of measured thickness was computed. The results are shown in Table 2.

TABLE 1

	Number of	After sawing of 200 blocks		After sawing of 400 blocks		After sawing of 600 blocks		After sawing of 800 blocks		After sawing of 1000 blocks	
	strips	A	B	A	B	A	B	A	B	A	B
Example 1	40	0	0	0	0	0	0	0	0	0	0
Comparative Example 1	40	10	0	16	2	25	7	39	18	69	27

A: number of spacer adjustments

B: number of OD blade replacements

TABLE 2

	Composition (wt %)	Example 2	3	4	5	6	7	8	9	10	Comparative Example 2
Lubricant	BN, 10 μm	5								5	
	Graphite, 10 μm		3				7				
	Graphite, 100 μm		3						3		
	Amorphous carbon, 30 μm			3							
	Molybdenum disulfide, 50 μm	5			5			10			
	Molybdenum disulfide, 150 μm			7							
	Tungsten disulfide, 5 μm				10						
	Graphite fluoride, 50 μm					3					
	PTFE, 100 μm					2					
Matrix	GC powder, 10 μm		30				40		25	37	
	SiO2, 90 μm	40		5							10
	Al2O3, 80 μm		10	5							
	WC, 1 μm			5		10		35	15		
	Fe, 15 μm			10							
	Ni, 10 μm			10							
	Cu, 10 μm				30	30					30
Abrasive	Synthetic diamond, 80 μm	15	10			30	23	24		23	
	Synthetic diamond, 150 μm		20		25				22		25
	CBN, 100 μm			25							
Binder	Phenolic resin	35	24		30	25	30		35	35	
	Melamine resin			30				31			35
Cpk		0.67	0.89	0.91	0.71	0.65	0.95	0.93	0.87	0.91	0.52

[0049] As seen from Table 2, the saw blades comprising the lubricant ensures high-accuracy sawing operation even when they are as thin as 0.35 mm. The number of cut strips is increased.

[0050] Japanese Patent Application No. 2011-259157 is incorporated herein by reference.

[0051] Although some preferred embodiments have been described, many modifications and variations may be made thereto in light of the above teachings. It is therefore to be understood that the invention may be practiced otherwise than as specifically described without departing from the scope of the appended claims.

1. In connection with a multiple blade assembly comprising a plurality of saw blades coaxially mounted on a rotating shaft at axially spaced apart positions, which is used for sawing a rare earth magnet block into multiple pieces by rotating the plurality of saw blades,

the saw blade comprising a core in the form of a thin disk or thin doughnut disk and a peripheral cutting part on an outer peripheral rim of the core, the cutting part being made of a composition comprising an abrasive, a resin binder, and a lubricant for reducing the friction between the cutting part and the magnet block during the sawing operation.

2. The saw blade of claim **1** wherein the lubricant is selected from the group consisting of boron nitride, carbon, molybdenum disulfide, tungsten disulfide, graphite fluoride, and polytetrafluoroethylene, and mixtures thereof.

3. The saw blade of claim **1** wherein the lubricant is in particulate form having a particle size in the range of 1 to 200 μm.

4. The saw blade of claim **1** wherein the cutting part is made of a composition comprising

10 to 40% by weight of diamond and/or CBN as the abrasive,

20 to 60% by weight of a matrix selected from the group consisting of SiC having a particle size of 1 to 100 SiO_2 having a particle size of 1 to 100 μm, Al_2O_3 having a particle size of 1 to 100 μm, WC having a particle size of 0.1 to 50 μm, Fe, Ni and Cu having a particle size of 1 to 200 μm, and mixtures thereof,

10 to 50% by weight of a thermosetting resin as the binder, and

1 to 50% by weight of the lubricant.

5. A method for sawing a rare earth magnet block into multiple pieces, comprising the steps of providing a multiple blade assembly comprising a plurality of saw blades coaxially mounted on a rotating shaft at axially spaced apart positions, each saw blade being as set forth in claim **1**, and rotating the plurality of saw blades.

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