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(54) **Grinding wheel**

(57) A grinding wheel 10 comprises a disk core 11 and a grinding stone 20 surrounding the core 11. The grinding stone 20 includes a first abrasive portion 30 and a second abrasive portion 40. The first abrasive portion forms a circumferential surface of the grinding stone 20 and has small grains. The second abrasive portion 40 forms at least one lateral surface of the grinding stone 20 and has larger grains than the first abrasive portion 30.

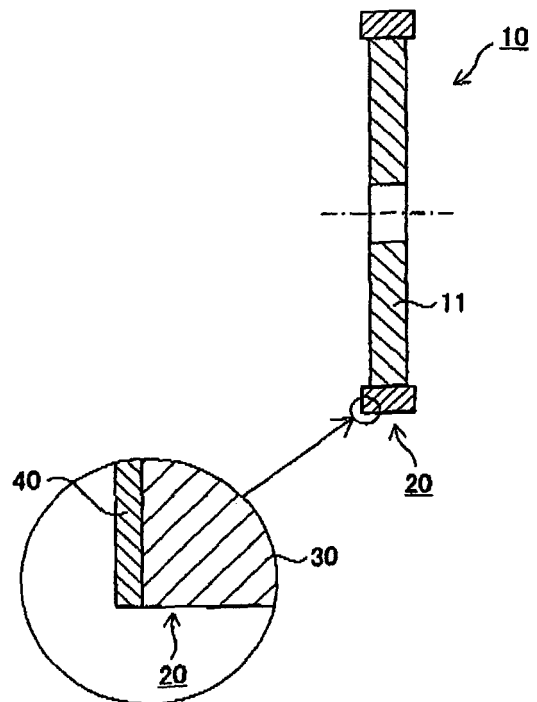


FIG. 1

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Description

INCORPORATION BY REFERENCE

[0001] The present application claims priority under 35 U.S.C. §119 to Japanese Patent Application No. 2004-271163, filed on September 17, 2004. The contents of that application are incorporated herein by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] This invention relates to a grinding wheel.

2. Discussion of the background

[0003] A conventional cylindrical grinding machine has a grinding wheel. In general, the grinding wheel is disk-like and has a grinding stone surrounding itself. The grinding wheel is attached to a wheel spindle of a wheel head of the grinding machine and is rotationally driven by an electric motor connected to the wheel spindle. The rotational grinding wheel grinds a workpiece with its circumferential surface of the grinding stone. As shown in Fig. 4, the grinding wheel 10 may grind not only a cylindrical surface Wa of the workpiece W but also a face Wb of the workpiece W. Especially, where the workpiece W is a crankshaft of which cylindrical surfaces Wa of crank journals and crank pins would be ground, the grinding wheel may grind faces Wb of crank webs therebetween with the lateral surfaces of the grinding stone 20. During grinding the face Wb with the lateral side of the abrasive portion 20, because the lateral surface 20 widely contacts with the face Wb radially, coolant hardly penetrates into the contact area between the workpiece W and the grinding stone 20 (the contact area will be explained as "grinding area") and the chip is hardly discharged from the grinding area. Thus, grinding burn may occur to the workpiece W so that it is hard to improve grinding efficiency.

SUMMARY OF THE INVENTION

[0004] In view of the foregoing, it is an object of the present invention to provide a grinding wheel which hardly causes a workpiece burn and is able to improve grinding efficiency even in the case of face grinding. In order to achieve the above and other objects, an aspect of the present invention provides a grinding wheel comprising a first abrasive portion forming a circumferential surface and a second abrasive portion forming a lateral surface whose grain size is larger than the first abrasive portion.

[0005] The second abrasive portion may unite the first abrasive portion with an adhesive. Or, the grains forming the second abrasive portion may be implanted in the lateral side of the first abrasive portion. Additionally, the second abrasive portion may form a single layer or a

multiple layers. Further, the external radius of the second abrasive portion may be as large as the external radius of the first abrasive portion. Or, the external radius of the second abrasive portion may be smaller than the external radius of the first abrasive portion. The external corner of the second abrasive portion may form a chamfer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Various other objects, features and many of the attendant advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description of the preferred embodiments when considered in connection with the accompanying drawings, in which:

Fig. 1 is a section view of an embodiment of a grinding wheel and its partial section view related to the invention;

Fig. 2 is partial section views of first and second examples of the embodiment related to the invention; Fig. 3 is partial section views of third and fourth examples of the embodiment related to the invention; Fig. 4 is a schematic sketch of a grinding process of a face of a rotational workpiece.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0007] An embodiment of the present invention will be described with reference to figures. As shown in Fig. 1, a grinding wheel 10 comprises a disk core 11 and a grinding stone 20 surrounding the circumference of the core 11. The grinding wheel 10 is used for a grinding machine, for example a cylindrical grinding machine which grinds a workpiece with the grinding wheel 10 attached to a spindle of a wheel head of the grinding machine, similar to the conventional related art shown in Fig. 4. The workpiece W has a cylindrical surface Wa and a face Wb to be ground by the grinding wheel 10. One example of the workpiece W is a crank shaft whose crank journal has a cylindrical surface Wa adjacent to a crank web of a face Wb. The grinding stone 20 surrounding the core 11 includes a first abrasive portion 30 forming a circumferential surface and a second abrasive portion 40 forming at least one lateral surface. Each lateral surface is able to form the second abrasive portion 40.

[0008] The first abrasive portion 30 is made from small CBN (Cubic Boron Nitride) grains whose size is between #80 and #120, a bond (vitrified bond etc.), a filling whose material is weaker than the grains to adjust the grain distance, and pores. Thus, the first abrasive portion 30 is able to grind the cylindrical surface Wa of the workpiece W as precisely as required surface roughness. On the other hand, the second abrasive portion 40 is made from CBN grains whose size is between #20 and #60 that is larger than the first abrasive portion 30, thereby the second abrasive portion 40 is appropriately able to grind the face Wb of the workpiece W not to be required as pre-

cisely as the cylindrical surface Wa.

[0009] In the above grinding wheel, the lateral surface (s) of the grinding stone is/are formed by the second abrasive portion 40 whose grain size is larger than the first abrasive portion 30. Because of the large grains, during the face grinding, coolant is easily supplied into the grinding area and chip is discharged better. Therefore, even in the case of the face grinding, the above grinding wheel 10 hardly causes workpiece burn so that grinding efficiency improves.

[0010] In general face grinding, grinding allowance is approximately set 0.2 millimeters, so that the face Wb is able to be ground well and rapidly with the second abrasive portion 40 whose grain size is larger than the grinding allowance. For example, the grain size of #60 is 0.25 millimeters in average that is larger than the general grinding allowance of 0.2 millimeters. Additionally, the second abrasive portion 40 provides higher wear resistance and reduces its own wear.

[0011] Where the workpiece W is a crank shaft or the like, more precise surface roughness is generally required for the cylindrical surface Wa than the face Wb. Because the circumferential surface of the grinding wheel 10 forms the first abrasive portion 30 made from the smaller grains than the second abrasive portion 40, the cylindrical surface Wa of the workpiece W such as a crank journal is able to be ground precisely with the first abrasive portion 30. On the other hand, although the face grinding is not required as precisely as the cylindrical surface grinding, the precise perpendicular to the cylindrical surface Wa is required for the face grinding to grind a crank web Wb. In the case that the coolant does not penetrate well into the grinding area or the chip is not discharged well from the grinding area, the workpiece W is overheated and is deformed, thereby the perpendicular may not be obtained between the face Wb and the cylindrical surface Wa. Using the grinding wheel 10 with the large grains on its lateral surface(s), however, the coolant is easily able to penetrate into the grinding area so that the workpiece W is cooled down well. And the chip is discharged from the grinding area well so that the workpiece W is not overheated. Therefore, the workpiece W is hardly deformed and the perpendicular is obtained between the face Wb and the cylindrical surface Wa.

[0012] Fig. 2(a) shows a first example of the second abrasive portion 40 according to the embodiment. In the first example, the second abrasive portion 40 is made by the large grains 41 adhering on the lateral side of the first abrasive portion 30 with vitrified bond or the like 42. Although the surface of the second abrasive portion 40 is filled with the grains 41 in Fig. 2(a), the grains 41 may be loosely mounted with appropriate distance between of themselves. In this case, the grains 41 may be mixed with filling more brittle than the grains 41.

[0013] The second abrasive portion 40 is flatly studded with single layer of the large grains 41 that are not piled but stud the surface of the second abrasive portion 40. As shown in Fig. 2(a), there form appropriate gaps be-

tween each tip of the grains 41 where cutting edges appear, so that the coolant is easily able to penetrate into the grinding area and the chip is discharged better due to the gaps.

[0014] Although the second abrasive portion 40 is flatly studded with single layer of the large grains 41 in Fig. 2(a), a pile of layers (a multiple layers) of the grains 41 is also available.

[0015] Fig. 2(b) shows a second example of the second abrasive portion 40 according to the embodiment. Manufacturing method of the second example includes following steps of; mixing bond and the small grains for the first abrasive portion 30; mounting the large grains 41 on the lateral surface(s) of a molding flask; putting the mixture of the bond and the small grains into the molding flask; and sintering them. Thus, the second abrasive portion 40 is adhered on the lateral surface(s) of the first abrasive portion 30 of the grinding wheel 10. Although the second abrasive portion 40 is flatly studded with single layer of the large grains 41 in Fig. 2(a), a multiple layers of the grains 41 is also available. And although the surface of the second abrasive portion 40 is filled with the grains 41 in Fig. 2(b), each of the grains 41 may be loosely mounted with appropriate distance between of themselves. In this case, the grains 41 may be mixed with filling more brittle than the grains 41.

[0016] There may form some appropriate shapes at the external corner of the grinding stone 20. Fig. 3(a) shows a third example of the embodiment related to the shape at the external corner of the grinding stone 20. The external corner forms an R-chamfer that extends from the lateral surface of the second abrasive portion 40 to the circumferential surface of the first abrasive portion 30. So the external radius of the second abrasive portion 40 is smaller than the first abrasive portion 30 (see dimension "A" in Fig. 3(a)). Further, the R-chamfer forms a part of a circle in its section view and the width of the second abrasive portion 40 is smaller than the radius of the R-chamfer. Therefore, during plunge cutting, the large grains of the second abrasive portion 40 do not grind but the small grains of the first abrasive portion 30 grind the cylindrical surface Wa of the workpiece W, so that the cylindrical surface Wa of the workpiece W is precisely ground.

[0017] Although the chamfer forms an R-shape in its section view, it may form a C-shape or taper-shape. Instead of the chamfer, for the dimension of the external radius of the second abrasive portion 40 being smaller than the first abrasive portion 30, there may form the radius of the whole circumferential surface of the second abrasive portion 40 than the first abrasive portion 30. In this case, there forms a step between the first and second abrasive portions 30, 40.

[0018] In the third example, because the external radius of the second abrasive portion 40 with large grains is smaller than the first abrasive portion 30 with small grains, the cylindrical surface Wa of the workpiece W is precisely ground during the plunge cutting. Where the

chamfer forms R-shape, there may form a recess or R-shape between the cylindrical surface Wa and the face Wb of the workpiece W.

[0019] Fig. 3(b) shows a forth example of the embodiment. In the forth example, the whole external radius of the second abrasive portion 40 is set as large as the first abrasive portion 30, thereby the second abrasive portion 40 forms the same circumferential surface of the first abrasive portion 30 and forms a right angle at the corner. Where such grinding wheel 10 is used for traverse cutting, the second abrasive portion 40 with the large grains precedes the first abrasive portion 30 with the small grains. Therefore, the cylindrical surface Wa of the workpiece W is efficiently ground because it is roughly ground by the first abrasive portion 40, and then precisely ground by the first abrasive portion 30. In the forth example, because the external radius of the second abrasive portion 40 having the large grains is as large as the first abrasive portion 30 having the small grains, the traverse cutting performs rough grinding and finish grinding continuously and effectively. Although the forth example shows the right-angled corner of the second abrasive portion 40, the corner may form appropriate chamfer (R, C or tapered) or the like that does not reach the first abrasive portion 30.

[0020] As described above, according to the embodiment of the invention, where the face Wb of the workpiece W is ground, there is produced the grinding wheel 10 that the grinding burn hardly occurs and the grinding efficiency easily improves.

[0021] Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is thereby to be understood that within the scope of the appended claims, the present invention may be practiced otherwise than as specifically described herein.

[0022] For example, the second abrasive portion 40 may be made in advance and then be adhered on the lateral side of the first abrasive portion 30. Or, the second abrasive portion 40 may form the shape of backed taper that becomes thinner in direction of inward of the grinding wheel 10, so that the coolant easily penetrates into the grinding area and the chip is easily discharged.

[0023] A grinding wheel 10 comprises a disk core 11 and a grinding stone 20 surrounding the core 11. The grinding stone 20 includes a first abrasive portion 30 and a second abrasive portion 40. The first abrasive portion forms a circumferential surface of the grinding stone 20 and has small grains. The second abrasive portion 40 forms at least one lateral surface of the grinding stone 20 and has larger grains than the first abrasive portion 30.

a grinding stone surrounding the core;
a first abrasive portion forming a circumferential surface of the grinding stone;
a second abrasive portion forming at least one lateral surface of the grinding stone; and

wherein the second abrasive portion has larger grains than the first abrasive portion.

2. A grinding wheel according to claim 1, wherein:

the second abrasive portion is studded with single layer of the grains.

3. A grinding wheel according to claim 1, wherein:

the second abrasive portion is studded with a multiple layers of the grains.

4. A grinding wheel according to claim 1, wherein:

the external radius of the second abrasive portion is smaller than the first abrasive portion.

5. A grinding wheel according to claim 1, wherein:

the external radius of the second abrasive portion is as large as the first abrasive portion.

6. A grinding wheel according to claim 1, wherein:

the corner of the second abrasive portion forms a chamfer.

7. A grinding wheel according to claim 6, wherein:

the chamfer is R-chamfer and its radius is larger than the width of the second abrasive portion.

8. A grinding wheel according to claim 1, wherein:

the corner of the second abrasive portion is right-angled.

Claims

1. A grinding wheel comprising:

a disk core;

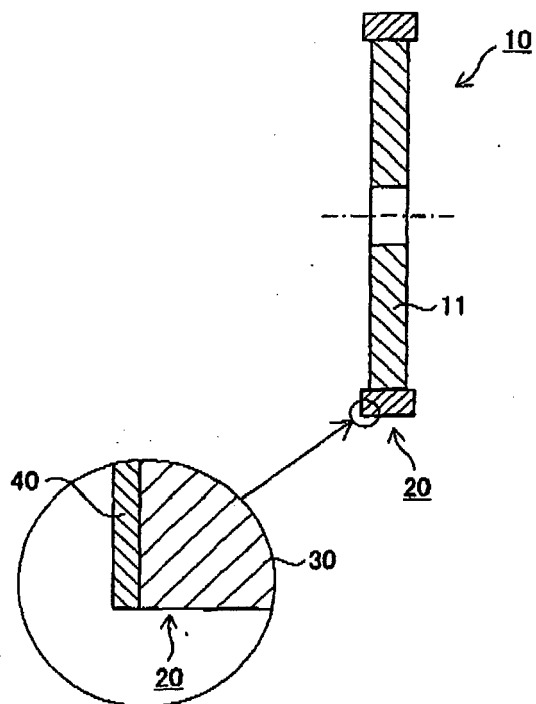


FIG. 1

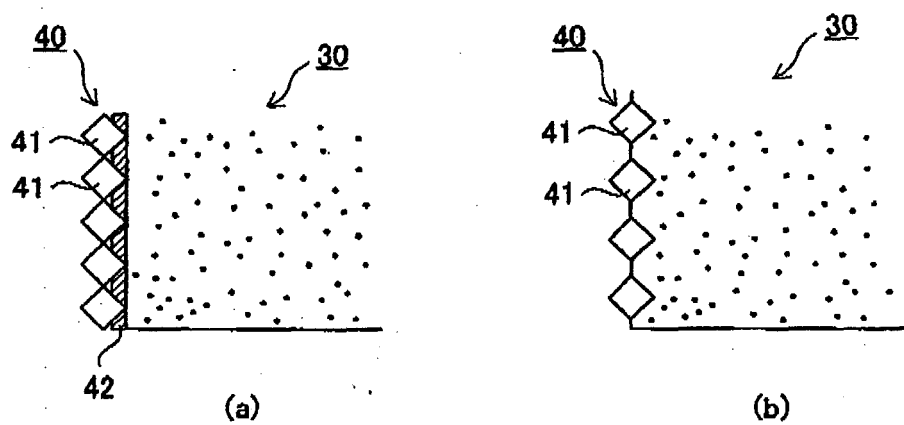


FIG. 2

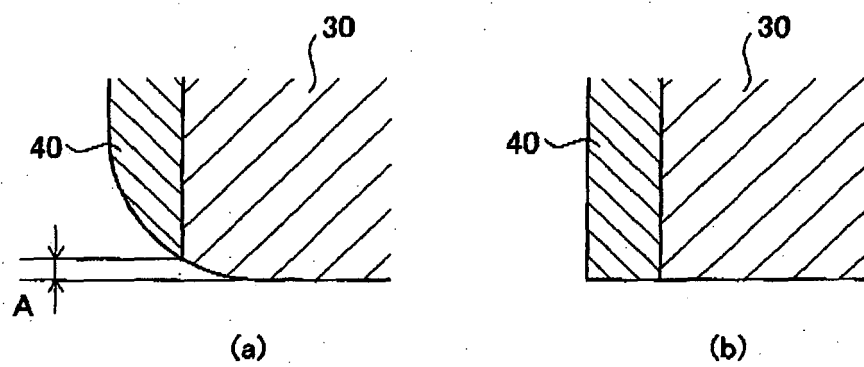


FIG. 3

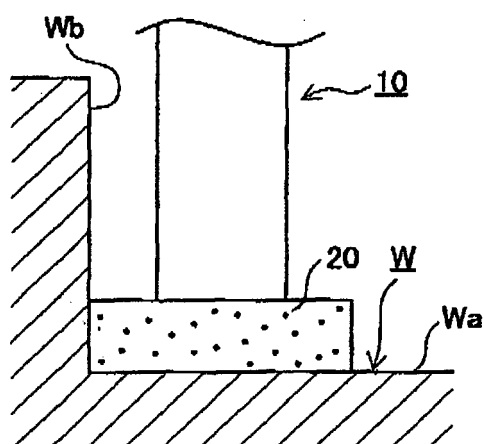


FIG. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 05 02 0230

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 12 December 2005	Examiner Vaglienti, G
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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