(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 120 195 A1

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

(43) Date of publication:
01.08.2001 Bulletin 2001/31

(21) Application number: **98938580.2**

(22) Date of filing: **10.08.1998**

(51) Int Cl.[7]: **B24C 1/00**

(86) International application number:
PCT/CN98/00156

(87) International publication number:
WO 00/09292 (24.02.2000 Gazette 2000/08)

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IT LI NL PT SE

(71) Applicant: **Tseng, Shao-Chien**
Yang-Mei, Taoyuan 326, Taiwan (CN)

(72) Inventor: **Tseng, Shao-Chien**
Yang-Mei, Taoyuan 326, Taiwan (CN)

(74) Representative: **Want, Clifford James**
Langner Parry
52-54 High Holborn
London WC1V 6RR (GB)

(54) **POWERFUL ABRASIVE MEDIUM**

(57) A high performance grinding medium formed by engaging two half housings to each other, each half housing being made with a plurality of raised circular blades, to form a single medium structure. In use, materials suitable for collision grinding can be selected for the blades according to material hardness and contour of the workpiece to be ground. The medium structure can be made into spherical or other smoothly curved shapes formed by assembling two halves. Suitable numbers of raised and smooth circular blades are selected to perform three-dimensional vibrational grinding operation on workpiece surfaces, so as to further improve grinding efficiency and quality.

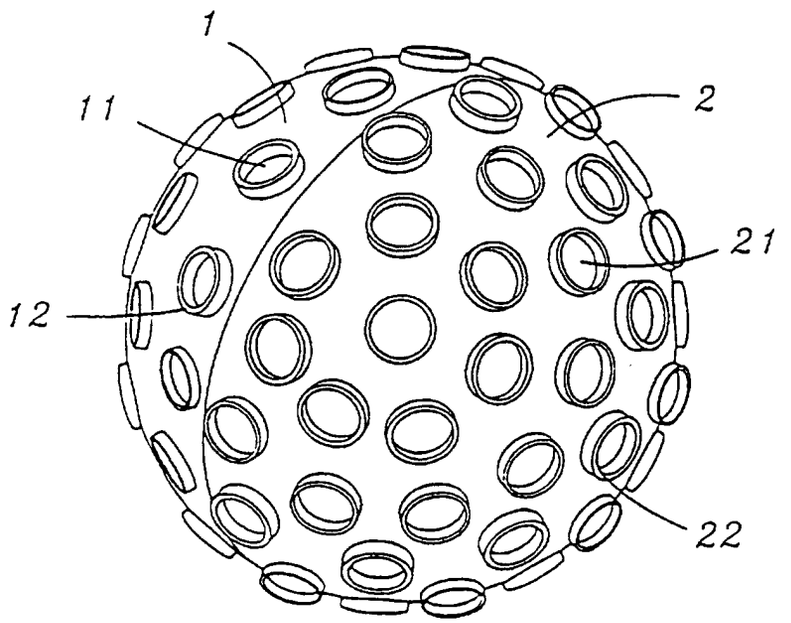

FIG. 1

EP 1 120 195 A1

Description

Technical Field

[0001] The present invention relates to a grinding medium for metal grinding and polishing, and more particularly, to a high performance grinding medium for three-dimensional grinding of relatively hard workpieces.

Technical Background

[0002] The technique of three-dimensional vibrational grinding for polishing workpieces has been widely used by people in this technical field. Generally speaking, this is a technique in which grinding granulae of respective sizes, hardness and shapes are chosen according to the material of a workpiece to be ground and its contour and shape to be ground and polished; and a grinding liquid is formulated to have the workpiece ground by vibration in the vibration trough of a vibrational grinder.

[0003] It has been known that for mixing in a grinding liquid together with workpieces, the grinding granulae, referred to as grinding medium in this invention, are usually made of plastics, stone or ceramic material of various hardness, mass and shapes. Wherein the selection of the hardness of a grinding medium is significantly correlated with the hardness of a workpiece to be ground in three-dimensional collision grinding by high frequency vibration, so that the surfaces of a workpiece casting can be well polished by the grinding medium to produce required smoothness. Furthermore, the volume per unit and quantity of a grinding medium before grinding must be balanced proportionally with the workpiece to be ground, so that the efficiency of three-dimensional turbulent collision between the grinding medium and the workpiece can be accurately controlled. In addition, the size and contour shape of the grinding medium must be properly chosen in accordance with the shapes of the minimum grooves, ribs or holes on the workpiece to be ground in order to facilitate turning and collision of the medium inside the grooves, ribs or holes and to achieve intended effects by vibrational grinding. Elements such as vibrating angle, vibrating frequency and orientation generated in a vibrational grinding trough, as well as the vibrational quality of a grinding liquid etc. are important factors in deciding efficiency and quality of vibrational grinding.

[0004] Existing vibrational grinding techniques in this field can achieve reasonably good grinding results on workpieces of relatively soft alloy. However, when working on workpieces made by precision casting of relatively hard alloys, such as stainless steel, titanium alloy, chromium and molybdenum alloy etc., there are apparent problems of low grinding accuracy and efficiency. The reason for the problems is that when grinding by the conventional techniques, only plastics, stones or ceramic materials etc. are used as grinding media and such media have very limited variation in hardness, toughness and shapes. They cannot achieve reasonable grinding and polishing results on relatively hard workpieces, which are difficult to grind, therefore it is difficult to further improve grinding quality and efficiency.

[0005] Furthermore, the shapes of conventional grinding media are less efficient in grinding and cutting. Namely, its capacity in increasing surface distribution of smoothly formed grinding and cutting points is very limited, therefore any improvement to the collision grinding efficiency would be restricted by the limited number of cutting points formed by a unit of medium on the surfaces of a workpiece during three-dimensional vibrating collision.

Summary of Invention

[0006] In view of the above-described background, it is clear that the conventional techniques can hardly grind workpieces of relatively hard alloys. Such a problem is exactly the one to be solved by the high performance grinding medium of the present invention.

[0007] The primary object of the present invention is to select a suitable grinding and cutting material according to the material quality and hardness of a workpiece to be ground, and to make a grinding medium which can be assembled by engagement and can change its assembly contour, for use on workpieces to be ground, of different shapes and hardness.

[0008] Aiming at the object, a technical solution employed by the present invention includes: a high performance grinding medium formulated in a grinding liquid within a vibrational grinding environment for using in three-dimensional grinding on workpiece surfaces, wherein each medium structure is formed by a pair of half-housings, characterised in that the half-housings have smooth curvature and are engaged as two equal halves to form an assembled medium structure, and both of the half-housings have a plurality of circular cutting blades formed in a raised formation projecting from inside towards outside in radial direction, so as to facilitate flexible and smooth three-dimensional vibrational grinding and polishing performed on the workpiece surfaces. The two half-housings engage to form a medium structure of spherical, ellipsoidal, conical or any other shapes suitable for three-dimensional rotational grinding. The engagement between the two half-housings is achieved by equal numbers of engaging ribs and grooves formed along their formation edges for engaging into a medium structure. Through holes can be formed inside each circular cutting blades, making it in communication with the interior of the half-housings. Further, according to the density of the workpiece, a counterweight can be placed inside the half-housings to increase the collision grinding momentum of the medium structure, thereby to further improve grinding efficiency.

[0009] The high performance grinding medium provided by the present invention employs a plurality of

raised and circular cutting blades formed on every individual medium structure to ensure highly dense and smooth grinding processing areas during three-dimensional vibrational grinding, so as to improve grinding efficiency when the medium structure collides with the workpiece. Also, due to the fact that the medium structure can be easily made by selecting stainless steel sheets or spring steel sheets, which can get required hardness and toughness by heat treated after punch into form, or they can be formed by sintering in a powder metallurgy process to reach the required hardness and toughness, thereby to enable them to work on workpieces which are hard and difficult to grind.

[0010] In summary, the present invention has the following features:

1. The grinding medium structure has raised cutting blades integrally formed in circular shape to facilitate curved, smooth and flexible grinding on the surfaces of a workpiece during three-dimensional vibrational and rotational collision grinding.

2. All the circular cutting blades are integrally formed with the housing of the medium structure and are very thin (about 0.3 to 0.5 mm). They have excellent toughness, so that when they collide with the surface of a workpiece, they can achieve highly delicate and high quality grinding results.

3. Distribution of the circular cutting blades integrally formed with the housing can be made to have a certain density according to the requirement of matching the curvature of the housing with the surface shape of the workpiece to be ground.

4. The way of using two half-housings to form an assembled medium structure can facilitate forming a medium structure of a spherical or any other smooth shape suitable to three-dimensional rotational grinding.

5. A counterweight can be placed inside the medium structure in accordance with the density of the workpiece to be ground. This can increase grinding and cutting efficiency, and collision momentum between the medium structure and the workpiece during three-dimensional turbulent collision grinding.

Brief Description of Drawings

[0011] For further understanding of the present invention, preferred embodiments are described in detail with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view the structure of a high performance grinding medium according to the present invention;
FIG. 2 is an exploded perspective view of the high performance grinding medium structure of the present invention;
FIG. 3 is a sectional view of the high performance grinding medium structure of the present invention;
FIG. 4 is a localized illustration showing a plurality of high performance grinding medium structures of the present invention in grinding and cutting operation against a workpiece in a vibrational grinding liquid;
FIG. 5 is a perspective view of another preferred embodiment of high performance grinding medium structure of the present invention;
FIG. 6 is a perspective view of a further preferred embodiment of high performance grinding medium structure of the present invention; and
FIG. 7 is a sectional view showing that a counterweight is placed in a preferred embodiment of high performance grinding medium structure of the present invention.

Reference numbers of parts
Housing 1, 2, 51, 52, 61, 62
Spherical medium 10
Cutting edge 12,22
Workpiece 3
Grinding liquid 4
Conical medium 6
Through hole 11
Engaging mortises 13, engaging tenons 23
Wall surface 31
Ellipsoidal medium 5
Counterweight 7

Detailed Description of Preferred Embodiment

[0012] Refer to FIG. 1, the structure of a high performance grinding medium of the present invention is formed by two half-housings 1 and 2 which are engaged with each other. These two half-housings 1 and 2 have integrally formed thereon a plurality of circle shaped blades 12 and 22, the centers of which form a plurality of through holes 11 and 21 (as shown in FIG. 2) in communication with the interior of the half-housings 1 and 2. The half-housings 1 and 2 have an equal number of engaging mortises 13 and engaging tenons 23 formed along their respective connecting edges opposite to each other, so that the two half-housings 1 and 2 can be press assembled easily to form a single medium structure (as shown in FIG. 3).

[0013] When in use (as shown in FIG. 4), suitable grinding material can be chosen according to the hardness and the contour of the wall surface 31 of a workpiece 3 to be ground. The medium structure can be formed by two half-housings connected with each other to form a spherical shape (as shown in FIG. 1 to 3), an ellipsoidal shape (as is shown in FIG. 5) or a truncated cone (as shown in FIG. 6) etc., to facilitate three dimensional vibrational grinding for forming a smooth contour

on the workpiece. The spherical medium structure 10 as shown in FIG. 4, the elliptical medium structure 5 as shown in FIG. 5 or the truncated cone shaped medium structure 6 as shown in FIG. 6 all have a non-acute-angled smooth curvature which can prevent the curved surface 31 of the workpiece 3 from being damaged during the three-dimensional turbulent collision and rotation. This only allows the parts of the raised circular cutting blades 12, 22 to have flexible grinding and cutting on the wall surface 31 of the workpiece 3.

[0014] In practice, one needs to select suitable quantity and volume of medium structures (as shown in FIG. 4) to formulate a grinding liquid 4 in a three-dimensional vibrational grinding trough, wherein, each spherical medium structure 10 (or of other types of curved smooth shape) is provided thereon with a plurality of smooth and raised circular blades 12, 22 which can flexibly grind and cut the wall surface 31 of the workpiece 3 in three-dimensional vibrational grinding and polishing, so as to improve grinding efficiency and quality.

[0015] One more embodiment is shown in FIG. 5, it is an ellipsoidal medium structure, again formed by two half-housings 51 and 52 engaging each other. FIG. 6 shows a truncated conical medium structure formed by two half-housings 61 and 62 engaging each other. By using two equal half housings engaging each other, the medium structures are formed to have smooth contours for facilitating three-dimensional vibration, rotation and collision, and for facilitating grinding of smoothly curved workpieces.

[0016] Further, by designing the medium structure of two equal half housings engaging each other, it is beneficial in processing each of the half-housings 1, 2 (as shown in FIG. 2) to form integrally the plurality of smooth circular blades 12, 22 during production thereof. All the circular blades 12, 22 are respectively integrally formed on the half-housings 1, 2, and they are very thin (about 0.3 to 0.5 mm), therefore the blades 12 and 22 have excellent flexible cutting capability, and their strength does not become weaker by such thickness. This is because the half-housings 1, 2 are both curved and strengthened by the circular blades 12, 22 and the through holes 11 and 21, therefore, ensured their excellent strength.

[0017] Distribution of the circular blades 12, 22 can be made to have a certain density according to the requirements of matching the curvature of the half-housings 1 and 2 with the shapes of the surface 31 of the workpiece 3 to be ground, so as to facilitate three-dimensional vibrational and rotational grinding.

[0018] When in practical grinding operation, a counterweight 7 can be placed in the two half-housings 1, 2 (as shown in FIG. 7) during assembling of the medium structure in accordance with the density of the workpiece 3 to be ground. The counterweight 7 has a certain mass, so it can increase grinding and cutting momentum when the medium structure collides with the workpiece 3 during grinding and cutting. Of course, the unit mass and the quantity of the counterweight 7 to be loaded must match the actual density of the workpiece 3 and the three-dimensional vibration environment, so that the grinding and cutting efficiency can be effectively improved.

[0019] In conclusion, the medium structure of the present invention is made by selecting material according to the hardness and material of a workpiece to be ground, and the technology for controlling the thickness of the cutting blades to the order of 0.3 to 0.5 mm can be achieved by other known techniques, which are not included in the scope of the present invention. The substantive feature of the present invention is that any medium structure for grinding and cutting shall be formed by engagement of two half-housings which each is provided with a plurality of raised circular blades arranged in radial direction. Thereby, workpieces of relatively complicated contours and different materials and hardness can be ground to overcome problems in existing techniques.

Claims

1. A high performance grinding medium, formulated in a grinding liquid (4) within a vibrational grinding environment for using in three-dimensional grinding on workpiece (3) surfaces (31), wherein each medium structure is formed by two half-housings (1 and 2); characterised in that said two half-housings (1 and 2) have smooth curvature and are engaged as two halves to form an assembled medium structure, and both said two half-housings (1 and 2) have a plurality of circular cutting blades formed in a raised formation projecting from inside towards outside in radial direction, so as to facilitate flexible and smooth three-dimensional vibrational grinding and polishing performed on the workpiece (3) surfaces (31).

2. The high performance grinding medium as in claim 1, characterised in that said two half-housings (1 and 2) are engaged with each other to form a spherical, ellipsoidal, truncated conical or any other structure shapes suitable for three-dimensional vibrational rotational grinding.

3. The high performance grinding medium as in claim 1, characterised in that the engagement of said two half-housings is achieved by equal number of mortises (13) and tenons (23) formed along their respective connecting edges of said two half-housings, so as to form said medium structure by engagement.

4. The high performance grinding medium as in claim 1, characterised in that each of said circular blades (12 and 22) has a through hole (11 and 21) formed

in its centre in communication with the interior of said two half-housings (1 and 2).

5. The high performance grinding medium as in claim 1, characterised in that a counterweight (7) is placed in said two half-housings (1 and 2) according to the density of said workpiece to be ground to increase the structure's collision momentum so as to improve grinding efficiency.

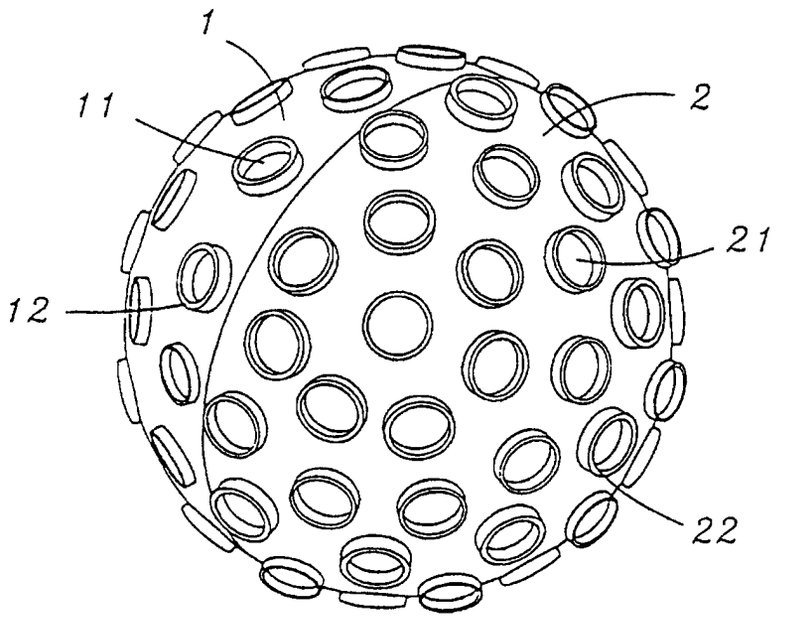

FIG. 1

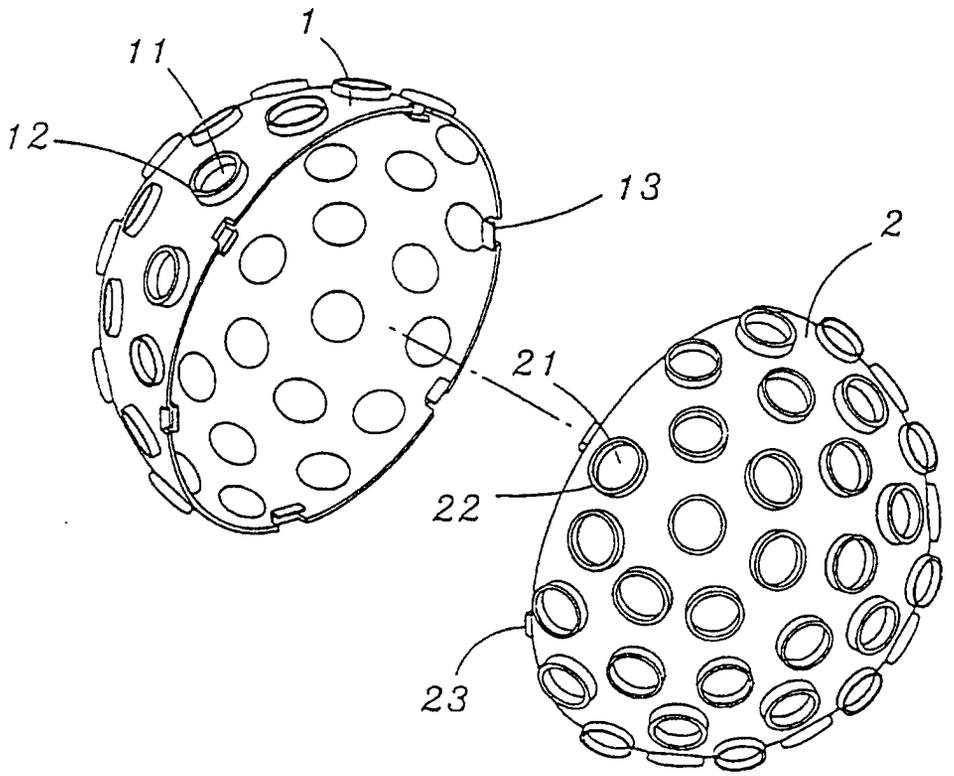

FIG. 2

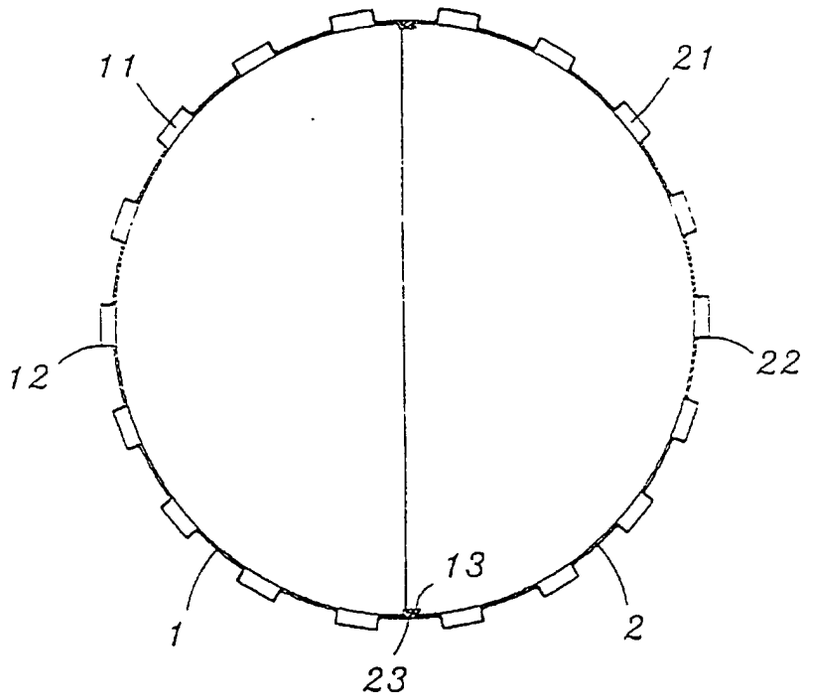

FIG. 3

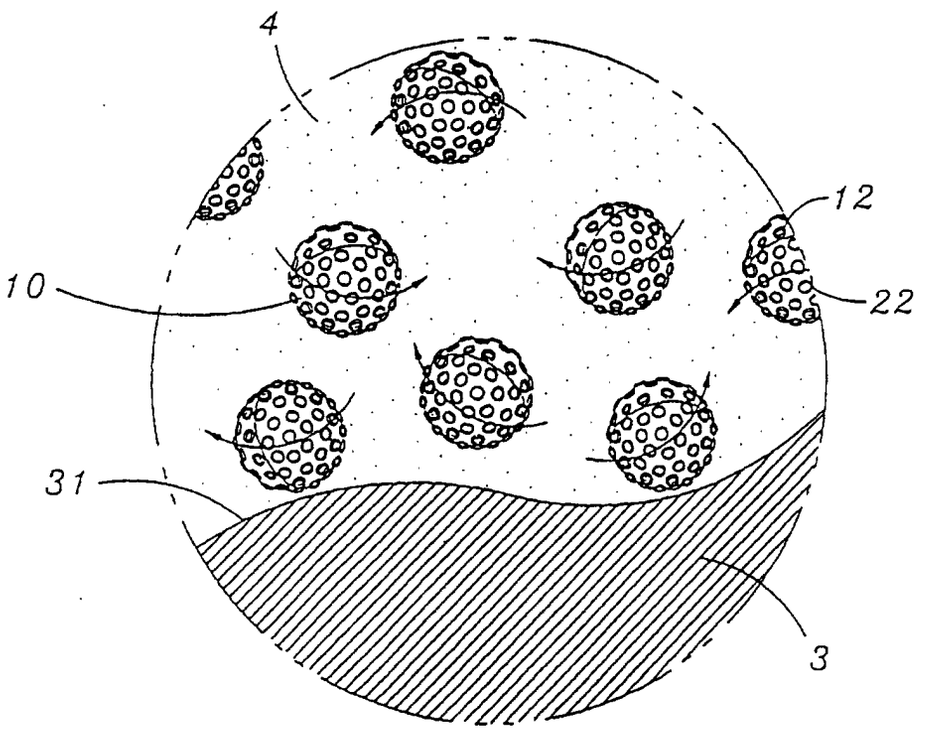

FIG. 4

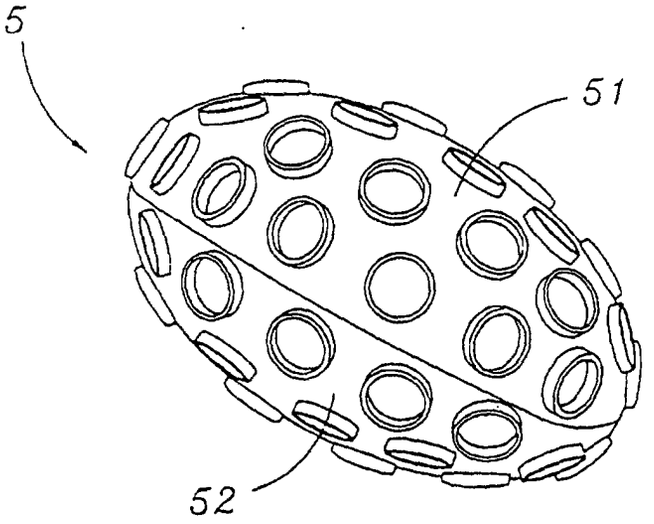

FIG. 5

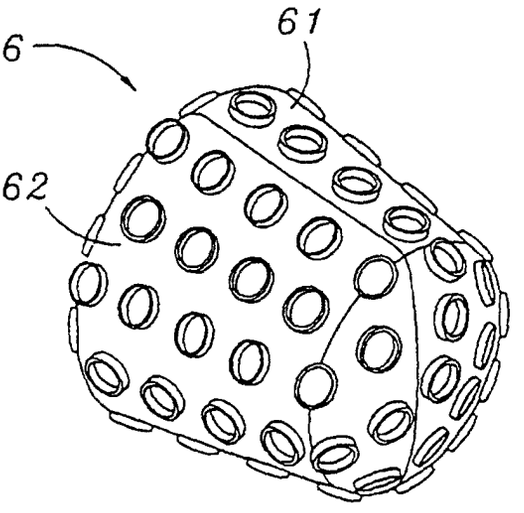

FIG. 6

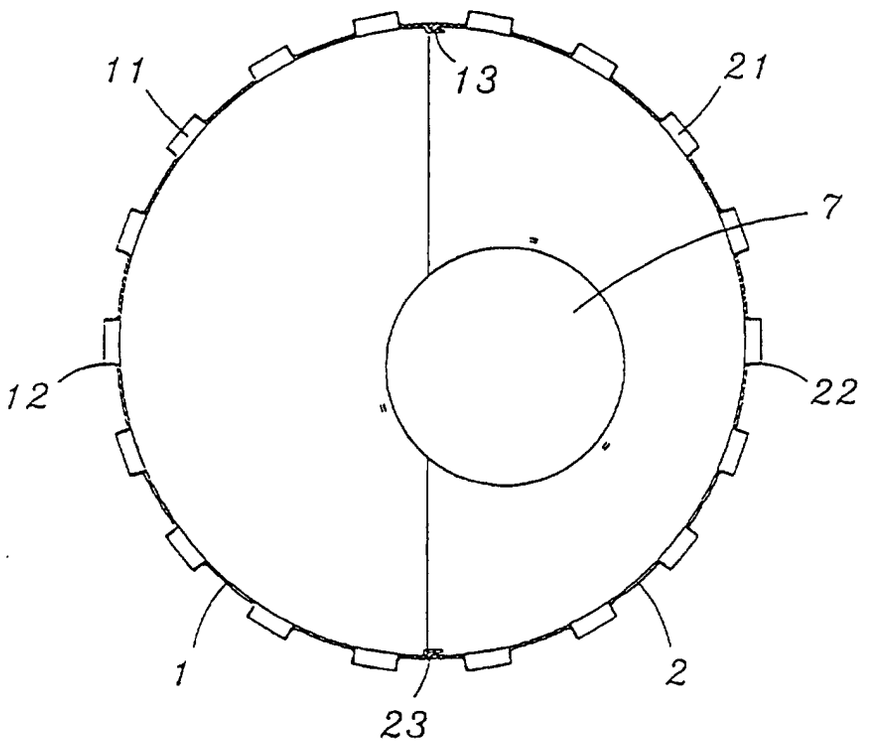

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN 98/00156

A. CLASSIFICATION OF SUBJECT MATTER

IPC[6] B24C 31/14

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

B. FIELDS SEARCH

Minimum documentation searched (classification system followed by classification symbols)

IPC[6] B24C 31/14, 31/12, 31/00

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

CHINESE INVENTION 1985-1998, CHINESE UTILITY MODELS 1985-1998

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

WPI, CPRS, CNPAT:

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,E	CN2295563Y (TSENG,SHAOCHIEN) 28 OCTOBER 1998 (28.10.98) ENTIRETY	1-5
A	US,A,4712333 (HUGH. P. LOFTON) 15 DECEMBER 1987 (15.12.87) ENTIRETY	
A	US,A,4652469(ROLF HILLER,KIPPENHEIM et al)24 MARCH 1987 (24.03.87) ENTIRETY	
A	US,A,3808747 (WILLIAM L. KENAGY) 7 MAY 1974 (07.05.74) ENTIRETY	

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"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 application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention can not be considered novel or can not be considered to involve an inventive step when the document is take alone

"Y" document of particular relevance; the claimed invention can not be considered to involve an invention step when document is combined with one or more other such document, 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	Date of mailing of the international search report
10 May,1999	20 MAY 1999 (20.05.99)

Name and mailing address of the ISA/CN	Authorized officer
Chinese Patent Office No. 6 Xitucheng Road, Jimen Bridge, Haidian District 100088 BEIJING, P.R of CHINA Facsimile No. 86-10-62019451	WANG Kai Telephone No. 86-10-62093725

Form PCT / ISA 210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family member

International application No.
PCT/CN 98/00156

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 2295563Y	28 Oct. 1998	NONE	
US-A-4712333	15 Dec. 1987	NONE	
US-A-4652469	24 Mar. 1987	NONE	
US-A-3808747	07 May 1974	NONE	

Form PCT / ISA 210 (patent family annex) (July 1992)