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

(11) EP 1 252 975 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
30.10.2002 Bulletin 2002/44

(51) Int Cl.[7]: **B24D 18/00**

(21) Application number: **02252980.4**

(22) Date of filing: **26.04.2002**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **26.04.2001 JP 2001129313**

(71) Applicant: **Tsune Seiki Co., Ltd.**
Nei-gun, Toyama (JP)

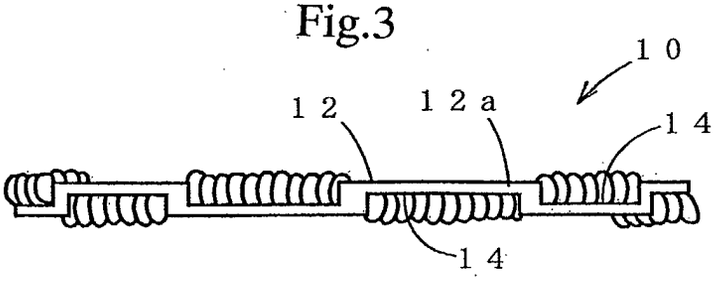
(72) Inventor: **Okina, Tomoji**
Toyama-shi, Toyama (JP)

(74) Representative: **Greenwood, John David et al**
Graham Watt & Co.
St. Botolph's House
7-9 St. Botolph's Road
Sevenoaks Kent TN13 3AJ (GB)

(54) Electro-deposited thin-blade grindstone

(57) To provide an electro-deposited thin-blade grindstone containing a plate-shaped base metal (12), depressed portions (14) that are open from near the edge portion (12a) of the base metal to the edge portion (12a) and are formed alternately on both side surfaces of the base metal, and a number of abrasive grains (16) fixedly deposited on the depressed portions (14) and protruded from the side surfaces and end portion of the base metal (12). The depressed portion (14) is formed in a depth of 1/2 or more of the thickness of the base metal (12). The abrasive grain is a hard abrasive grain (16) made of diamond, CBN or the like. The diameter of the abrasive grain (16) is nearly equal to the thickness of the base metal (12).

Fig.3



EP 1 252 975 A2

Description

[0001] The present invention relates to an electro-deposited thin-blade grindstone used for grinding, cutting and grooving a metallic material, a nonmetallic material and the like.

[0002] Conventionally, in order to cut a difficult-to- machine material such as ceramics, FRP or the like, as disclosed in JP-A-2000-210872 or as shown in Fig. 1, a thin-blade grindstone 6 on which super-abrasive grains 2 made of diamond, CBN or the like are electro-deposited by plating method has been used. This thin-blade grindstone 6 is made, for example, by dispersing the super-abrasive grains 2 in a nickel- plating tank and by electrodepositing the super-abrasive grains 2 near the edge portion of a disc-shaped base metal 4 by a nonelectrolytic plating method and an electrolytic plating method. In the thin-blade grindstone 6, the super-abrasive grains 2 are electro-deposited in a single layer on the surface of the outer peripheral edge portion of the base metal 4.

[0003] However, in the thin-blade grindstone 6 in the related art, as shown in Fig. 1, letting the thickness of the base metal 4 be t and the diameter of the super-abrasive grain 2 be d, a grinding width w in cutting or grooving is expressed as W = t + 2d. Accordingly, in order to reduce the cutting width w, the thickness of the base metal 4 needs to be thinned. However, the thickness t of the base metal 4 can not be thinned too much because of the strength of the base metal 4. Therefore, there is presented a problem that because the cutting width w of a material 8 to be ground becomes large, a grinding force becomes large and a yield decreases in the cutting of a precious material.

[0004] Further, the actual machining portion of the grinding and grooving grindstone of this type in which the super-abrasive grains 2 are electro-deposited on the peripheral edge portion of the disc-shaped base metal 4 is only the outermost peripheral end face of the edge portion and the abrasive grains electro-deposited on both side surfaces do not have a cutting action. Therefore, when the abrasive grains on the outermost peripheral end surface wear out or drop, the outer peripheral end surface of the base metal 4 is exposed to lose the cutting action.

[0005] Still further, because the super-abrasive grains 2 are electro-deposited in a single layer on the outermost peripheral end surface of the edge portion of the base metal 4, when the super-abrasive grains 2 on the base metal 4 wear out or drop, the outer peripheral end face, with no super-abrasive grains 2, of the base metal 4 is exposed. As a result, even if the base metal 4 has no problem, the thin-blade grindstone 6 can not be used. Therefore, this wastes the precious base metal 4, increases the frequency of replacement of the grindstone in a cutting work, and thus reduces work efficiency.

[0006] The invention has been made in view of the above-mentioned problem in the related art. It is the object of the invention to provide an electro-deposited thin-blade grindstone capable of reducing a cutting width, increasing a tool life, reducing the frequency of replacement, and improving efficiency in the cutting and grinding work.

[0007] The invention relates to an electro-deposited thin-blade grindstone, characterized by including a plate-shaped base metal, depressed portions that are open from near the edge portion of the base metal to edge portion and are formed alternately on both side surfaces of the base metal, and a number of abrasive grains deposited on the depressed portions and protruded from the side surfaces and, optionally, from end portion of the base metal. The above-mentioned abrasive grain may be a super-abrasive grain made of diamond, CBN or the like. The depressed portion may be formed in a depth of 1/2 or more of the thickness of the base metal. It is preferable that the abrasive grain has a grain size nearly equal to the thickness of the base metal.

[0008] Between the respective depressed portions adjacent to each other along the edge portion of the base metal may be formed a cutout in which the edge portion of the disc-shaped base metal is cut away by a predetermined amount in the radial direction of the disc, and the edge portions of the abrasive grains on the depressed portions are exposed by the cutout.

[0009] The abrasive grains may be electro-deposited on the depressed portions formed on both the side surfaces of the base metal overlap each other on an outer peripheral envelope and the outer periphery of the base metal is actually positioned completely inside the envelope of the abrasive grains. Even if the abrasive grains on the outermost periphery wear out or drop, the edge portion of the base metal is brought into contact with a material to be ground or chips, thereby being worn out, whereby the abrasive grains are exposed one after another in the radial direction or the like of the disc-shaped base metal. This action is similar to the wearing mechanism of a metal-bonded diamond grindstone.

[0010] Further, an electro-deposited thin-blade grindstone in accordance with the invention may have the depressed portions that are open from near the edge portion of the disc-shaped base metal to the edge portion and are formed alternately on both the side surfaces of the base metal are formed by a chemical treatment such as an electrolytic machining, an etching, or the like, and a number of abrasive grains protruded from the side surfaces and edge portion of the base metal are fixedly electro-deposited on the depressed portions by a nonelectrolytic plating, an electrolytic plating, or the like.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, of which:

Fig. 1 is an enlarged cross-sectional view to show the state of use of an electro-deposited thin-blade grindstone in the related art.

Fig. 2 is a plan view of the electro-deposited thin-

blade grindstone in accordance with the first embodiment of the invention.

Fig. 3 is a front view of the electro-deposited thin-blade grindstone in accordance with the first embodiment of the invention.

Fig. 4 is an enlarged cross-sectional view to show the state of use of the electro-deposited thin-blade grindstone in accordance with the first embodiment of the invention.

Fig. 5 is a plan view of an electro-deposited thin-blade grindstone in accordance with the second embodiment of the invention.

Fig. 6 is a front view of the electro-deposited thin-blade grindstone in accordance with the second embodiment of the invention.

Fig. 7 is an enlarged cross-sectional view taken on a line A-A in Fig. 5.

[0011] Modes for carrying out the invention will be hereinafter described with reference to the drawings. Fig. 2 to Fig. 4 show an electro-deposited thin-blade grindstone 10 in accordance with the first embodiment of the invention. The electro-deposited thin-blade grindstone 10 in accordance with the present embodiment is made of a base metal 12 made of a disc-shaped metallic plate having a thickness of from about 0.05 mm to 0.5 mm, for example, 0.2 mm. The base metal 12 has depressed portions 14 which are formed at predetermined pitches in the vicinity of its edge portion and are open to its edge portion 12a of the base metal 12 and are formed in a concentric manner alternately on both side surfaces of the base metal 12. The depressed portions 14 are formed in a depth of 1/2 or more of the thickness of the base metal 12. A shaft hole 18 for clamping is concentrically formed at the center of the base metal 12. The base metal 12 is made of a tough and hard metal and thus can be reduced in thickness. Further, the peripheral portions of the depressed portions 14 of the base metal 12 may be made of a comparatively soft material or a brittle material as compared with a material to be ground so that they are easy to wear out.

[0012] A number of abrasive grains 16 that protrude by a predetermined amount from the side surfaces and edge portion 12a of the base metal 12 are fixedly electro-deposited on the depressed portions 14. The abrasive grains 16 are hard super-abrasive grains made of diamond, CBN or the like. The abrasive grain size is preferably, for example, from about 50 μm to 300 μm, and more preferably, nearly equal to the thickness of the base metal 12, depending on the thickness of the base metal 12. It is recommended that the amount of protrusion of the abrasive grains 16 from the both side surfaces of the base metal 12 be, for example, about from 5 % to 20 % of the grain size of the abrasive grain 16. It is recommended that the amount of protrusion of the abrasive grains 16 from the edge portion 12a of the base metal 12 be appropriately set, for example, at a value ranging from about 0 %, ie no protrusion initially, to 50 % of the grain size of the abrasive grain 16. Here, the amount of protrusion of the abrasive grains 16 from the edge portion 12a is autonomously formed during cutting, that is, the metal portion of the base metal 12 is worn out more quickly to protrude the abrasive grains 16 from about 5% to 20 % of the grain size.

[0013] In a method for manufacturing an electro-deposited thin-blade grindstone 10 in accordance with the present embodiment, depressed portions 14 that are open from near the edge portion of a disc-shaped base to the edge portion and are formed in a concentric manner alternately on both side surfaces of the base metal 12 are formed by an electrolytic grinding. The depressed portions 14 are formed by facing electrodes each corresponding to the shape of the depressed portion 14 to the both side surfaces near the edge portion of the base metal 12. First, the electrodes that are formed in the circumferential direction of the base metal 12 in the same shape as the depressed portion 14 and are symmetric to each other are faced to the edge portion of the base metal 12. Then, the opposed electrodes are turned by a half pitch of the depressed portion 14, thereby being arranged in a staggered manner to form the depressed portions at the same time on both the sides of the base metal 12. Here, the depressed portions 14 may be formed by a chemical treatment such as an etching or the like.

[0014] Next, a number of abrasive grains 16 are fixedly electro-deposited on the depressed portions such that they are protruded by a small amount from the side surfaces and edge portion 12a of the base metal 12. The abrasive grains 16 are electro-deposited by giving a usual chemical plating and then by giving an electrolytic plating thereon. A heat treatment after the electrodeposition leads to the distortion of the base metal 12 and hence it is preferable to avoid the heat treatment.

[0015] After the electrodeposition, the abrasive grains 16 are dressed up to make the grain size even with each other. The dressing of the abrasive grains 16 is to remove portions protruding 30 % or more than a desired value from the surface of the base metal 12. A method for dressing the abrasive grains 16 is to polish the abrasive grains 16 protruding from the depressed portions 14 by means of a diamond grindstone.

[0016] In the electro-deposited thin-blade grindstone 10 in accordance with the present embodiment, as shown in Fig. 4, letting the thickness of the base metal 12 be t, the diameter of the super abrasive grain 2 or the thickness of a plated layer be d, the depth of the depressed portion 14 be a, the grinding width w of cutting or grooving is expressed as $W = t + 2(d-a)$. Therefore, the cutting width w can be reduced by 2 times the depth of the depressed portion 14 as compared with the conventional technology. Further, in the electro-deposited thin-blade grindstone 10 in accordance with the present embodiment, even if the abrasive grains 16 wear out and drop as the grinding proceeds, the edge portion 12a of the base metal 12 wears out in the radial direction of

the base metal 12 and hence the abrasive grains 16 inside in the radial direction of the base metal 12 are exposed and can grind a material 8 to be ground until the width in the radial direction of the base metal 12 in the depressed portion 14 becomes zero. This makes it possible to extremely elongate the tool life of the electro-deposited thin-blade grindstone 10 and thus to continuously cut the material 8 for a long time without replacing the tool of the electro-deposited thin-blade grindstone 10 even if the material 8 is hard to cut. Further, since the edge portion 12a of the base metal 12 is worn out by the material 8 to be ground as the grinding proceeds, it does not affect a cutting or grinding work. Still further, by making the base metal 12 around the depressed portions 14 of a material softer or more brittle than the material 8 to be ground, the reproducing of the abrasive grains 16 can be speeded up.

[0017] As an example of this electro-deposited thin-blade grindstone 10 was formed a grindstone of the type in which the diameter of a base metal 12 was 80 mm, the diameter of a shaft hole 18 was 20 mm, the thickness of the base metal 12 was 0.3 mm, the depth of the depression was 0.24 mm, the grain size of a diamond abrasive grain was 0.3 mm, the number of divisions on both sides of the base metal 12 (the number of depressed portions 14) was 36, and the width in the radial direction of the depressed portion 14 was 3 mm. Thereby, the cutting width w was made 0.42 mm and the cutting tool life of the grindstone 16 was made 100 times or more as compared with the conventional thin-blade grindstone.

[0018] Next, an electro-deposited thin-blade grindstone 20 in accordance with the second embodiment of the invention will be described with reference to Fig. 5 to Fig. 7. Here, the same members as in the above-mentioned embodiment will be denoted by the same reference characters and the description thereof will be omitted. The electro-deposited thin-blade grindstone 20 in accordance with the second embodiment has cutouts 22 where the edge portion 12a is cut away in the radial direction between the neighboring depressed portions 14 along the edge portion 12a of the base metal 12. The cutouts 22 may be cut away to an appropriate depth, and they can be cut away, at the maximum depth, to the width of the depressed portion 14 in the radial direction of the base metal 12, and may be cut to such an extent that part of the abrasive grains 16 are exposed from the depressed portions 14.

[0019] By these cutouts 22 are exposed the end portions in the grinding direction of the abrasive grains 16 on the depressed portions 14, whereby the cutting or grinding can be more effectively performed.

[0020] Incidentally, the electro-deposited thin-blade grindstone in accordance with the invention is not limited to the embodiments described above, but may be formed in such a manner that the same depressed portions as described above are formed along the blade-forming edge portion of a band saw made by forming a slim rectangular steel plate in the shape of a loop and that abrasive grains are electro-deposited on the depressed portions. Also by this electro-deposited thin-blade grindstone, it is possible to produce the same effect as described above and to cut a larger material. Further, the material and size of the abrasive grain can be appropriately selected.

[0021] Still further, the abrasive grains may be deposited on the depressed portions even in only a single layer of a single abrasive grain, or it is recommended that abrasive grains made of sintered bodies of polycrystals or the other grinding particles be formed in a desired diameter and be deposited on the depressed portions. Still further, the material of the abrasive grain may be formed even of a hard metal and can be appropriately selected in accordance with the material to be ground.

[0022] The electro-deposited thin-blade grindstone in accordance with the invention can reduce the grinding allowance of the material to be ground and greatly expand a tool life and improve a work efficiency, and further, is easily manufactured and can be machined with accuracy.

Claims

1. An electro-deposited thin-blade grindstone, **characterized by** including:

   a plate-shaped base metal (12);
   depressed portions (14) that are open from near the edge portion of the base metal (12) to edge portion and are formed alternately on both side surfaces of the base metal (12); and
   a number of abrasive grains (16) deposited on the depressed portions(14) which protrude from the side surfaces of the base metal (12).

2. An electro-deposited thin-blade grindstone according to claim 1, wherein the depressed portion (14) is formed in a depth of 1/2 or more of the thickness of the base metal (12).

3. An electro-deposited thin-blade grindstone according to claim 1 or 2, wherein the abrasive grain (16) has a grain size nearly equal to the thickness of the base metal (12).

4. An electro-deposited thin-blade grindstone according to any preceding claim, wherein a cutout (22) in which the edge portion (12a) of the disc-shaped base metal (12) is cut away by a predetermined amount in its radial direction is formed between the respective depressed portions (14) adjacent to each other along the edge portion (12a) of the base metal (12) and wherein the edge portions (12a) of the abrasive grains on the depressed portion (14) are exposed to the cutout (22).

5. An electro-deposited thin-blade grindstone as claimed in any preceding claim, in which a number of the abrasive grains (16) deposited on the depressed portions (14) protrude from the edge portion of the base metal (16).

6. An electro-deposited thin-blade grindstone according to any preceding claim, wherein the depressed portions (14) that are open from near the edge portion (12a) of the disc-shaped base metal (12) to the edge portion (12a) and are formed alternately on both the side surfaces of the base metal (12) are formed by a chemical treatment and wherein a number of abrasive grains (16) protruded from the side surfaces or edge portion (12a) of the base metal (12) are fixedly electro-deposited on the depressed portions (14).

7. A method of making a grindstone as claimed in any one of claims 1 to 5, in which the depressed portions (14) that are open from near the edge portion (12a) of the disc-shaped base metal (12) to the edge portion (12a) and are formed alternately on both the side surfaces of the base metal (12) are formed by a chemical treatment and wherein a number of abrasive grains (16) protruded from the side surfaces and edge portion (12a) of the base metal (12) are fixedly electro-deposited on the depressed portions (14).

Fig.1

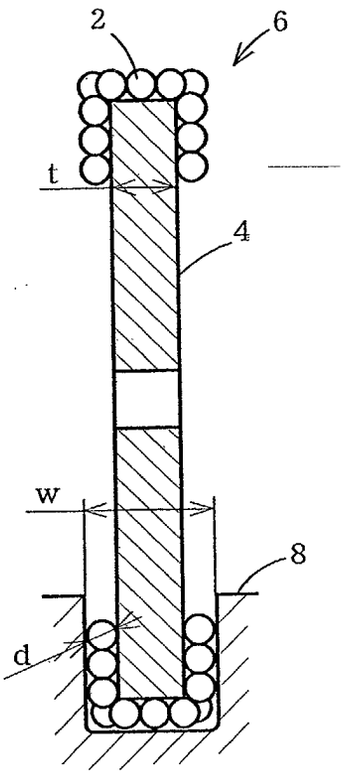


Fig.2

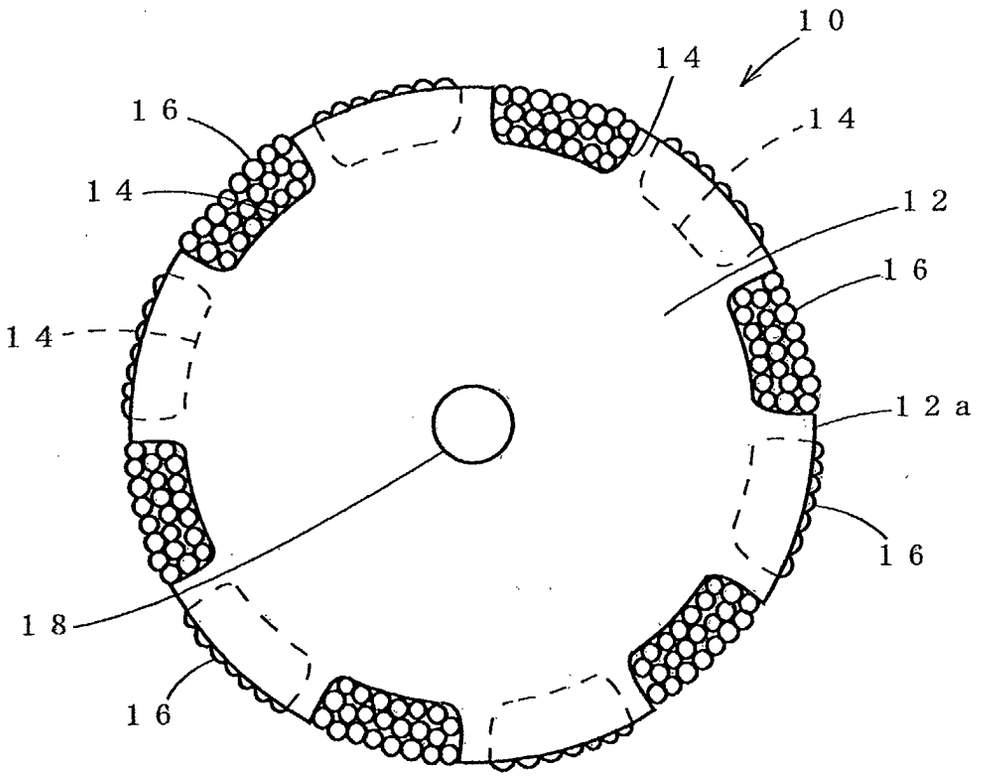


Fig.3

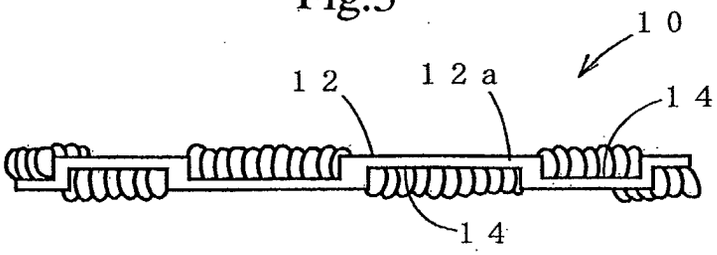


Fig.4

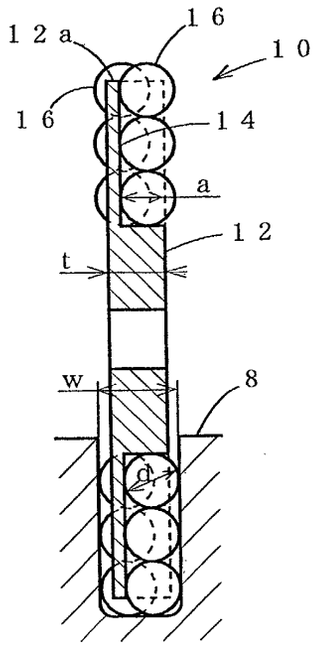

12a
16
10
16
14
a
12
t
w
8
d

Fig.5

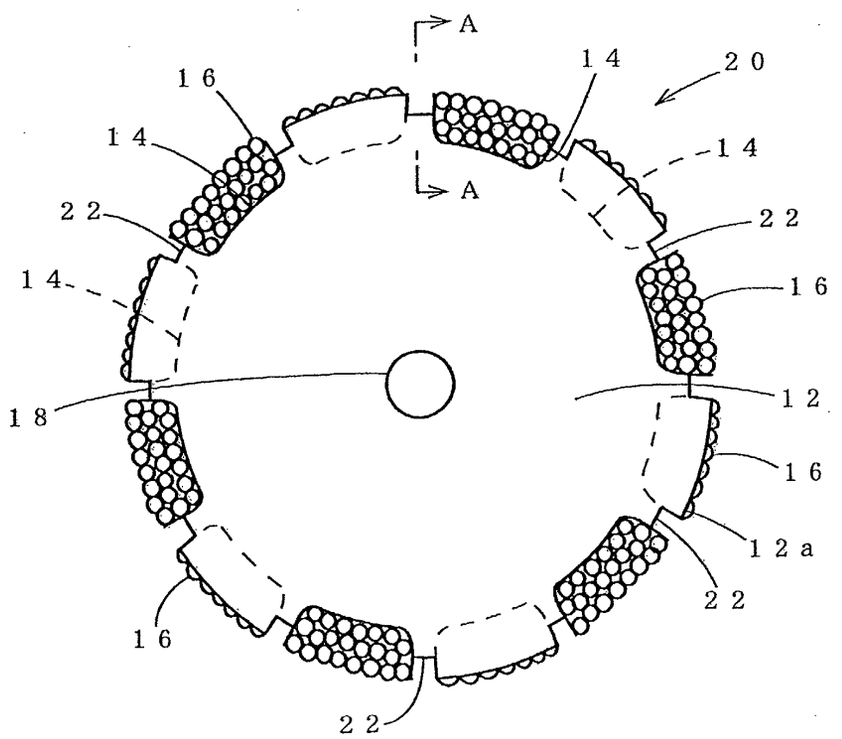

A
16
14
20
14
14
A
22
22
14
16
18
12
16
12a
22
16
22

Fig.6

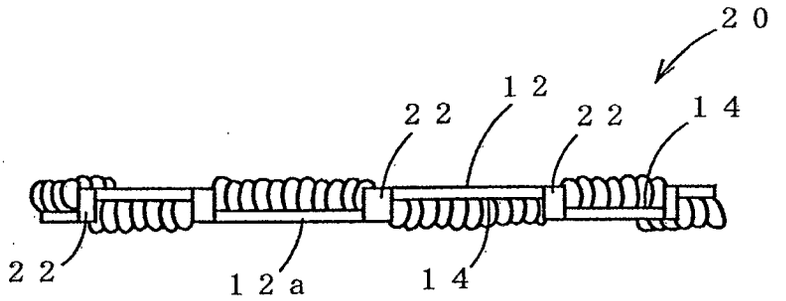


Fig.7