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(54) REED FOR HIGH SPEED LOOM

WEBBLATT FÜR HOCHGESCHWINDIGKEITSWEBMASCHINEN

PEIGNE POUR METIER RAPIDE

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- **PATENT ABSTRACTS OF JAPAN vol. 010, no. 269 (C-372)12 September 1986 & JP-A-61 091 354 (KUWABARA TETSUO) 9 May 1986**
- **DATABASE WPI Week 9021, Derwent Publications Ltd., London, GB; AN 90-159738 & JP-A-2 100 969 (IDEMITSU PETROCHEM) 12 April 1990**
- **PATENT ABSTRACTS OF JAPAN vol. 013, no. 384 (C-629)24 September 1989 & JP-A-01 132 779 (SUGIMURA HIROYUKI) 25 May 1989**

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Description

[Technical Field]

The present invention relates to a reed for a high-speed loom and, more particularly, to a reed for a high-speed loom which has reed blades coated with a hard film in order to increase the wear resistance of the reed blades constituting the reed.

[Background Art]

A reed as a component of a loom is used to align and press the warps and wefts, respectively, of the loom, thereby straightening the weave pattern. The reed is constituted by arranging a large number of reed blades comprising thin metal plates parallel to each other at small gaps, and fixing the reed blades by a frame comprising right and left side master blades and upper and lower metal side portions. In a high-speed loom, reed blades made of a stainless steel are generally used. However, due to an increase in operating speed of the loom and introduction of new material fibers, wear of the reed blades is severe, and the wear resistance of the reed blades -poses an important problem.

More specifically, wear of the reed blades causes raising of the woven fabric and end breakage. Since exchange of the reed requires a large amount of labor and cost, the durability of the reed blades is the most significant factor that determines the operating efficiency and cost of the loom. In a woven fabric, since the width of the woven fabric becomes smaller than the total width of the arranged warps to cause a phenomenon called "crimp", an especially large frictional force acts on the reed blades arranged in the vicinities of the two sides of the reed. Hence, the durability of these portions determines the service life of the entire reed.

Therefore, in order to improve the durability of the reed, it is proposed to coat the surfaces of the reed blades especially in the vicinities of the two sides of the reed with a hard film which has an excellent wear resistance, e.g., a hard chrome plating film, a ceramic film (Japanese Patent Laid-Open No. 60-52658) made of tungsten carbide, titanium carbide, titanium nitride or the like, and a chrome oxide film (Japanese Patent Laid-Open No. 61-245346, and U.S.P. No. 4,822,662).

A hard chrome plating film is formed by electroplating. However, the hard chrome plating film has poor wear resistance as well as poor adhesive properties and corrosion resistance. A ceramic film is formed in accordance with PVD (Physical Vapor Deposition), CVD (Chemical Vapor Deposition), flame spraying, or the like. However, the ceramic film has poor adhesive properties and it causes softening of the base material upon a high temperature treatment. A chrome oxide film is formed thermochemically and has an effect when it is formed on reed blades and applied to a polyester fibre. However, the chrome oxide film does not povide a sufficient effect when it is formed on the reed blades and applied to a natural or new material fiber.

Wear of the reed blades is a phenomenon in which the types of fibers, frictional force, vibration characteristics of the reed, and the like are closely related to each other in a complex manner. It is known that a hard film having a high surface hardness does not always provide a good effect. Accordingly, although a hard film matched with the types of fibers, the operating speed of the loom, and other conditions is employed, it provides an improvement in durability of only about 2 to 5 times that of a stainless steel base material not coated with a hard film.

JP-U-61-59688 teaches the coating of reed blades with a wear resistant material and JP-A-2100969 teaches diamond-like carbon (DLC) film as a wear resistant coating for elements exposed to friction from running yarns.

It is, therefore, an object of the present invention to provide a reed blade suitable to many types of fibers, ranging from a natural fiber to a synthetic and new material fibers, and having a remarkably improved durability at a relatively low cost.

In order to achieve the above object, according to the present invention, a diamond-like carbon film (to be referred to as a DLC film hereinafter) is formed on a portion ofa reed blade requiring a highest wear resistance. When a stainless steel is used as the base material of the reed blade, an intermediate layer comprising e.g. a titanium carbide layer is interposed between the base material and the DLC film to improve the adhesive properties. Furthermore, reed blades each coated with a DLC film are arranged in the vicinities of the two sides of the reed where wear progresses most quickly, and reed blades each coated with a hard film requiring a relatively low cost, or non-coated reed blades are arranged in the central portion of the reed, thereby uniforming the wear amount of the reed blades throughout the entire reed. As a result, an improvement in total durability is realized at a relatively low cost.

The DLC film employed in the present invention is a hydrogen-coupled amorphous carbon film and is introduced in, e.g., L. P. Anderson, A Review of Recent Work On Hard i-C Films, Thin solid Films, 86 (1981), pp. 193 - 200.

An example of a method of forming a DLC film is plasma CVD in a hydrocarbon gas atmosphere. A DLC film exhibits a large hardness next to diamond, a large thermal conductivity of about 5 times that of copper, and a very small coefficient of friction. These characteristics are utilized in the slidable surfaces of mechanical components and the like. Since the large tensile strength and small internal friction of the DLC film realize vibration characteristics suitable to acoustic

appliances, a DLC film is also formed on a diaphragm of a loudspeaker and the like. Not much is known regarding the behavior of the DLC film in the wear mechanism of a reed blade driven at a high speed. However, not only the large surface hardness and small coefficient of friction but also the thermal conductivity and vibration characteristics are assumed to contribute to improvement in durability of the reed blade.

The invention is claimed in Claim 1, with other features in Claims 2-6.

[Brief Description of Drawings]

Fig. 1 is a front view of a reed as the target of the present invention and the prior art, Fig. 2 is a plan view of a flat reed blade as the target of the present invention and the prior art, Fig. 3 is a plan view of a modified reed blade as the target of the present invention and the prior art, Fig. 4 is a sectional view of the main part of a reed blade according to an embodiment of the present invention, Fig. 5 is a partially cutaway front view of a reed according to another embodiment of the present invention, and Fig. 6 is a graph showing the relationship between the position and wear amount of the reed blades in the present invention and the prior art.

[Best Mode of Carrying Out the Invention]

The preferred embodiments of the present invention will be described with reference to the accompanying drawings.

Fig. 6 is a graph schematically showing the relationship between the position and wear amount of the reed blades under average operating conditions of a high-speed loom for three types of reed blades. The axis of abscissa represents the position of a reed blade by way of the number of reed blades counted from a side portion of the reed. A curve ADHM indicates the wear amount of reed blade made of a non-coated stainless steel base material, a curve BEFKN indicates the wear amount of reed blades coated with hard chrome plating films, and a curve CGL indicates the wear amount of reed blades coated with DLC films according to the present invention.

The service life of the reed is determined by the wear of the outermost (1st) reed blades which are worn most, as described above. However, when the hard chrome plating films are formed on the reed blades made of the stainless steel base material, the wear amount of the outermost reed blades is decreased to half from A to B. Since this wear amount B corresponds to a wear amount D of the non-coated 30th reed blades, the wear amount of the entire reed can be decreased to a level of B or less by coating the 1st to 30th reed blades with hard chrome plating films. However, even if plating films are formed on the internal reed blades following the 30th reed blades, the service life of the entire reed is not prolonged.

In contrast to this, when DLC films are formed on the reed blades according to the present invention, the wear amount of the outermost reed blades is greatly decreased from A to C. This wear amount C corresponds to a wear amount H of the non-coated 110th reed blades. Therefore, in order to obtain a sufficiently high effect by forming DLC films, the reed blades must be coated at least up to the 110th ones with the DLC films.

To form a DLC film requires a relatively high cost. However, since the DLC film improves the durability of the reed remarkably, it has a sufficiently high practicality depending on the weaving conditions. To combine a DLC film with other hard films is also a very effective means. In the case shown in Fig. 6, the wear amount C of the outermost reed blades coated with the DLC films corresponds to a wear amount F of the 45th reed blades coated with hard chrome plating films. Therefore, when DLC films are formed on the 1st to 45th reed blades and hard chrome plating films are formed on the 46th to 110th reed blades, the same practical effect as that obtained when LCD films are formed on all the reed blades can be obtained. In this manner, when a plurality of hard films having different coating costs and wear resistances are combined to uniform wear of the reed blades throughout the entire reed, the durability of the reed can be remarkably improved at a relatively low cost.

Fig. 1 is a front view of a reed as the target of the present invention and the prior art.

A reed 10 holds a large number of reed blades 20 at predetermined gaps with a frame 16 constituted by upper and lower metal side portions 12 and right and left side master blades 14. The reed blades 20 comprise thin metal plates and have a shape as shown in Fig. 2 or 3.

A reed blade 20A shown in Fig. 2 is a simple belt-shaped one called a flat reed blade.

A reed blade 20B shown in Fig. 3 is called a profiled reed blade and used in a water jet loom or air jet loom. In either reed blade, a hatched portion 22A or 22B shown in Fig. 2 or 3, i.e., the central portion of the reed blade is the maximum wear portion which is worn most. In the reed blade of the present invention, part of the reed blade at least including this portion is coated with a DLC film.

A stainless steel is generally used as the base material of the reed blade. However, when a DLC film is directly formed on the surface of the stainless steel, sufficiently high adhesive properties cannot be obtained, and the object of the present invention cannot be attained.

Therefore, according to the present invention, an intermediate film is interposed between the stainless steel base material and the DLC film to improve the adhesive properties. As the intermediate layer, a two-layered film having a

chromium (Cr) or titanium (Ti) lower layer exhibiting good adhesive properties with the stainless steel, and a silicon (Si) upper layer exhibiting good adhesive properties with the DLC film, and a carbide film of, e.g., titanium (Ti), zirconium (Zr), and hafnium (Hf) are effective. Especially, a titanium carbide film (Japanese Patent Laid-Open No. 64-79372) containing an excessive amount of carbon is most effective.

Fig. 4 is a sectional view of the main part of the maximum wear portion 22B of the reed blade 20B shown in Fig. 3.

A titanium carbide film is formed as an intermediate layer 26 on the surface of a base material 24 made of a stainless steel, and a DLC film 28 is formed on the surface of the intermediate layer 26. The titanium carbide film can be formed in accordance with plasma CVD in a vacuum chamber in which a hydrocarbon gas is introduced.

Fig. 5 is a front view of a reed showing the arranged state of reed blades according to another embodiment of the present invention.

Reed blades 20 are divided into first, second, and third groups 201, 202, and 203 sequentially from the groups close to master blades 14 on two sides toward the center. Each first group 201 is a group of reed blades each obtained by forming a DLC film on the surface of a stainless steel base material through an intermediate layer, each second group 202 is a group of reed blades each obtained by forming a hard film different from the DLC film on the surface of a stainless steel base material, and each third group 203 is a group of reed blades each made of a non-coated stainless steel base material.

Various types of fibers were woven into fabrics by using a reed according to the present invention having a plurality of reed blade groups in this manner, a reed according to the present invention in which DLC films were formed on all the reed blades, a reed of the prior art in which hard films different from the DLC films were formed on the reed blades, and a general reed in which the reed blades are made only of a stainless steel base material. The durabilities of the reeds were studied. Tables 1 and 2 show the obtained results.

[Table 1] Fiber: Cotton Yarn

	Side ---------- Central Portion	Operating Time	Ratio of Durability	Cost
Comparative Example 1	Stainless steel (SS) base material 100%	12 hr	1.0	1.0
Comparative Example 2	Chrome plating 10% | SS base material 90%	26 hr	2.2	1.1
Comparative Example 3	Cr_2O_3 20% | SS base material 80%	36 hr	3.0	1.8
Example 1	DLC film 40% | SS base material 60%	80 hr	6.7	4.7
Example 2	DLC film 10% | Cr_2O_3 10% | Chrome 20% | SS base material 60%	80	6.7	2.5

Table 1 shows the result of a durability test wherein standard weaving was performed by a high-speed loom by using a cotton yarn which is the most general as the fiber. As shown in Comparative Example 1, when weaving was executed under predetermined conditions by using a conventional reed made of only the stainless steel base material,

defects such as end breakage and raising of the woven fabric occurred after an operation of about 12 hours. The ratio of durability was calculated from the operating time until a defect occurred by using the result of this reed as a reference value of 1.0 for the durability.

As shown in Comparative Example 2, in the conventional reed in which hard chrome plating films are formed on the reed blades on the two sides of the reed that correspond to 10% of all the reed blades, the durability is increased to twice or more. As shown in Comparative Example 3, in a conventional reed in which chrome oxide (Cr_2O_3) films are formed on the reed blades on the two sides of the reed that correspond to 20% of all the reed blades, the durability is increased to about three times or more.

In contrast to this, as shown in Example 1, in the reed of the present invention in which DLC films are formed on the reed blades corresponding to 40% of all the reed blades from the side portions, the durability is increased to about seven times.

In this case, although the cost of the reed itself is increased to about five times, when the quality of the woven fabric and the operating efficiency of the loom are considered, the cost performance of the reed is high enough. In Example 2, three groups of reed blades made of a stainless steel are arranged in a reed. In each first group, DLC films are formed on the reed blades of the side portions of the reed which correspond to 10% of all the reed blades and on which the largest frictional force acts. In each second group next to the first group, reed blades coated with chrome oxide films and reed blades coated with hard chrome plating films are arranged. In each third group corresponding to 60% of the central portion of the reed, reed blades made of a stainless steel base material are arranged. In this reed, a durability similar to that obtained in the Example 1 can be obtained, and the cost can be decreased to half. In this manner, to uniform the wear amount throughout the whole reed by adopting a plurality of types of hard films is a means effective in decreasing the cost.

[Table 2]

Fiber: Modified Polyester						
	Side Portion ---------- Central Portion			Operating Time	Ratio of Durability	Cost
Comparative Example 4	Stainless Steel (SS) 100%			4	1.0	1.0
Comparative Example 5	Chrome plating 30%	SS base material 70%		22	5.5	1.3
Example 3	DLC film 70%		SS base material 30%	42	10.5	7.3
Example 4	DLC film 40%	Chrome plating 30%	SS base material 30%	40	10.0	4.9

It is known that when modified polyester fibers having complex sectional shapes are to be woven into a fabric, wear of the reed blades made of a stainless base material is severe, and the operating efficiency of the loom is considerably low. Table 2 shows Examples wherein the reed of the present invention is applied to weaving of modified polyester fibers together with Comparative Examples. As shown in Comparative Example 4, wear of the reed blades made of a stainless steel base material is severe, and the durability is decreased to about 30% that obtained when weaving is performed using a cotton yarn. Hence, as shown in Comparative Example 5, a reed in which hard chrome plating films are formed on the reed blades in the vicinities of the side portions of the reed is used.

In contrast to this, as shown in Example 3, in the reed of the present invention in which DLC films are formed on the reed blades corresponding to 70% of all the reed blades from the side portions of the reed, the durability is remarkably improved. Furthermore, as shown in Example 4, when both DLC films and hard chrome plating films are used, the cost can be decreased.

[Table 3]

Fiber: Cotton Yarn Sized With Special Fabric Size				
	Side Portion ---------- Central Portion	Operating Time	Ratio of Durability	Cost
Comparative Example 6	Stainless steel (SS) 100%	0.33	1.0	1.0

Continuation of the Table on the next page

[Table 3] (continued)

Fiber: Cotton Yarn Sized With Special Fabric Size					
	Side Portion ---------- Central Portion		Operating Time	Ratio of Durability	Cost
Comparative Example 7	Titanium nitride (TiN) film 100%		2.5	7.6	5.0
Example 5	DLC film 100%		8.0	24.0	10.0
Example 6	DLC film 30%	Titanium nitride film 70%	8.0	24.0	6.5

A fiber on which a fine ceramic powder having a special function is applied together with a fabric size is attracting attention as a functional new material fabric. As shown in Comparative Example 6, when such a new material fabric is woven into a fabric by using conventional stainless steel reed blades, a defect occurs within a very short period of time, and thus a practical operation using this fiber is impossible. Hence, as shown in Comparative Example 7, a reed in which titanium nitride (TiN) films known as ultra-hard films are formed on all the reed blades is used. In this case, however, the wear amount of the reed blades is large to cause a defect within 2 to 3- hours. Therefore, the operability is poor, and the operating efficiency of the loom is very low.

In contrast to this, as shown in Example 5, when the reed of the present invention in which DLC films are formed on all the reed blades is used, a continuous operation of 8 hours is possible, and no problem occurs in the weaving operability. In addition, when reed blades coated with DLC films are arranged in the vicinities of the two side portions of the reed and reed blades coated with titanium nitride films are arranged at the central portion of the reed, a similar effect can be obtained while decreasing the cost.

As has been described above, according to the present invention, the specific effects as follows can be obtained.

(1) The reed of the present invention is suitable to various types of fibers, ranging from a natural fiber to synthetic and new material fibers, and exhibits an excellent durability.

(2) Since a sufficient effect can be obtained with a DLC film having a thickness of 2 to 3 microns including the intermediate layer, the DLC film can be applied to a reed having a small blade pitch.

(3) When the quality of the fabric and the operating efficiency of the loom are considered, a decrease in total cost is enabled.

Claims

1. A reed (10) for a high-speed loom, in which a large number of reed blades (20) each comprising a thin metal plate made of a stainless steel as a base metal are arranged parallel to one another at predetermined gaps and are fixed and held with a frame (16) comprising right and left side master blades (14) and upper and lower side metal portions (12), characterised in that: assuming that a plurality of reed blades adjacent to said master blades form a pair of first groups (201) of outside reed blades; and that a plurality of reed blades adjacent to said first groups of outside reed blades form a pair of second groups (202) of inside reed blades, each blade of each of said first groups of outside reed blades is coated with a DLC film in at least a portion including a maximum wear portion thereof, so that a wear amount of an outermost reed blade of each of said first groups of outside reed blades substantially corresponds to a wear amount of an outermost reed blade of each of said second groups of inside reed blades.

2. A reed for a high-speed loom according to claim 1, characterised in that said DLC film is carried by an intermediate layer.

3. A reed for high-speed loom according to claim 2, characterised in that said intermediate layer comprises a titanium carbide layer.

4. A reed for a high-speed loom according to claim 1 characterised in that said reed blades of said second group are further divided into a plurality of groups, and reed blades of the divided groups are coated with different types of hard films, respectively.

5. A reed for a high-speed loom according to claim 1, characterised in that reed blades of a third group (203) which are made of only a stainless steel are arranged adjacent to said reed blades of said second group.

6. A reed for a high speed loom according to claim 1 or 3, characterised in that said different types of hard films are selected from the group consisting of hard compound films of an oxide, a carbide, or a nitride, and hard chrome plating films.

Patentansprüche

1. Webblatt (10) für eine Hochgeschwindigkeits-Webmaschine, bei welcher eine große Anzahl von Webblattmessern (20), die jeweils eine dünne Metallplatte aus rostfreiem Stahl als Grundmetall aufweisen, parallel zueinander mit vorbestimmten Spalten angeordnet und durch einen Rahmen (16) fixiert und gehalten sind, welcher rechts- und linksseitige Hauptmesser (14) und obere und untere Seitenmetallbereiche (12) aufweist, dadurch gekennzeichnet, daß unter der Annahme, daß mehrere Webblattmesser angrenzend an die Hauptmesser ein Paar von ersten Gruppen (201) von äußeren Webblattmessern bilden und daß mehrere Webblattmesser angrenzend an die ersten Gruppen von äußeren Webblattmessern ein Paar von zweiten Gruppen (202) von inneren Webblattmessern bilden, ist jedes Messer in jeder der ersten Gruppen von äußeren Webblattmessern mit einem DLC-Film in zumindest einem Bereich enthaltend einen Bereich maximaler Abnutzung hiervon beschichtet, so daß eine Abnutzungsmenge eines äußersten Webblattmessers jeder der ersten Gruppen von äußeren Webblattmessern im wesentlichen einer Abnutzungsmenge eines äußeren Webblattmessers jeder der zweiten Gruppen von inneren Webblattmessern entspricht.

2. Webblatt für eine Hochgeschwindigkeits-Webmaschine nach Anspruch 1, dadurch gekennzeichnet, daß der DLC (diamantartiger Kohlenstoff)-Film von einer Zwischenschicht getragen ist.

3. Webblatt für eine Hochgeschwindigkeits-Webmaschine nach Anspruch 2, dadurch gekennzeichnet, daß die Zwischenschicht eine Titankarbid-Schicht aufweist.

4. Webblatt für eine Hochgeschwindigkeits-Webmaschine nach Anspruch 1, dadurch gekennzeichnet, daß die Webblattmesser der zweiten Gruppe weiterhin in mehrere Gruppen unterteilt sind und Webblattmesser der unterteilten Gruppen jeweils mit unterschiedlichen Typen von harten Filmen beschichtet sind.

5. Webblatt für eine Hochgeschwindigkeits-Webmaschine nach Anspruch 1, dadurch gekennzeichnet, daß Webblattmesser einer dritten Gruppe (203), die nur aus rostfreiem Stahl hergestellt sind, angrenzend an die Webblattmesser der zweiten Gruppe angeordnet sind.

6. Webblatt für eine Hochgeschwindigkeits-Webmaschine nach Anspruch 1 oder 3, dadurch gekennzeichnet, daß die unterschiedlichen Typen von harten Filmen aus der Gruppe bestehend aus harten Verbundfilmen eines Oxids, eines Karbids oder eines Nitrids und harten galvanischen Chromfilmen ausgewählt sind.

Revendications

1. Peigne (10) pour métier à grande vitesse, dans lequel un grand nombre de lames de peigne (20) ayant chacune une mince plaque métallique formée d'acier inoxydable comme métal de base, sont placées parallèlement les unes aux autres avec des espaces prédéterminés et sont fixées et maintenues dans un cadre (16) comprenant des lames principales droite et gauche (14) et des parties métalliques supérieure et inférieure (12), caractérisé en ce que, dans l'hypothèse où plusieurs lames de peigne adjacentes aux lames principales forment une paire de premiers groupes (201) de lames externes de peigne, et où plusieurs lames de peigne adjacentes aux premiers groupes de lames externes de peigne forment une paire de seconds groupes (202) de lames internes de peigne, chaque lame de chacun des premiers groupes de lames externes de peigne est revêtue d'un film DLC dans une partie au moins comprenant une partie d'usure maximale, si bien que l'amplitude d'usure d'une lame la plus externe de peigne de chacun des premiers groupes de lames externes de peigne correspond pratiquement à l'amplitude d'usure d'une lame la plus externe de peigne de chacun des seconds groupes de lames internes de peigne.

2. Peigne pour métier à grande vitesse selon la revendication 1, caractérisé en ce que le film DLC est supporté par une couche intermédiaire.

3. Peigne pour métier à grande vitesse selon la revendication 2, caractérisé en ce que la couche intermédiaire est une couche de carbure de titane.

4. Peigne pour métier à grande vitesse selon la revendication 1, caractérisé en ce que les lames de peigne du second groupe sont en outre divisées en plusieurs groupes, et les lames de peigne des groupes divisés sont revêtues de films durs de types différents.

5. Peigne pour métier à grande vitesse selon la revendication 1, caractérisé en ce que les lames de peigne d'un troisième groupe (203) qui sont formées uniquement d'acier inoxydable sont disposées afin qu'elles soient adjacentes aux lames de peigne du second groupe.

6. Peigne pour métier à grande vitesse selon la revendication 1 ou 3, caractérisé en ce que des types différents de films durs sont sélectionnés dans le groupe comprenant des films de composés durs d'oxyde, de carbure ou de nitrure et des films ayant un dépôt de chrome dur.

FIG. 1

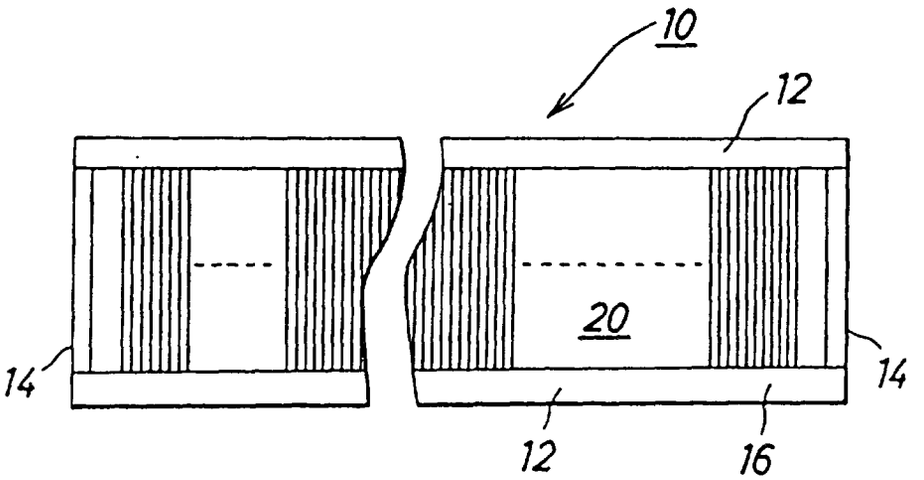


FIG. 2



FIG. 3

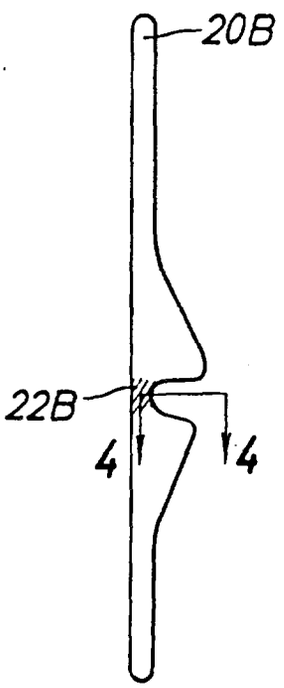


FIG. 4

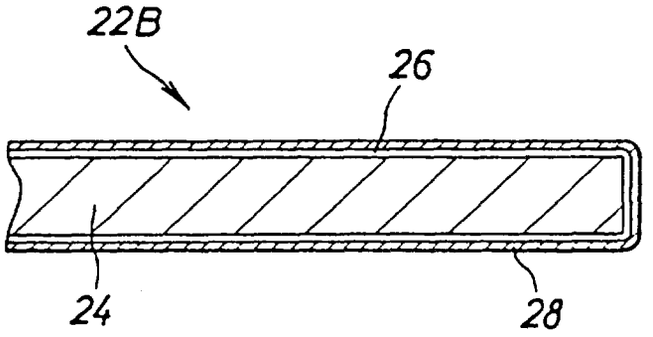


FIG. 5

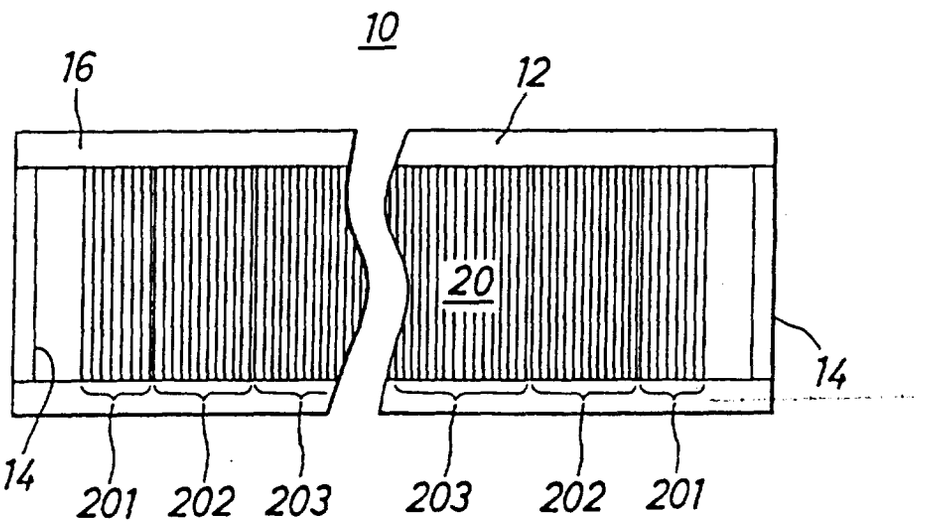


FIG. 6

