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(54) Title: COMPOSITE DISC BRAKE BACKING PLATE

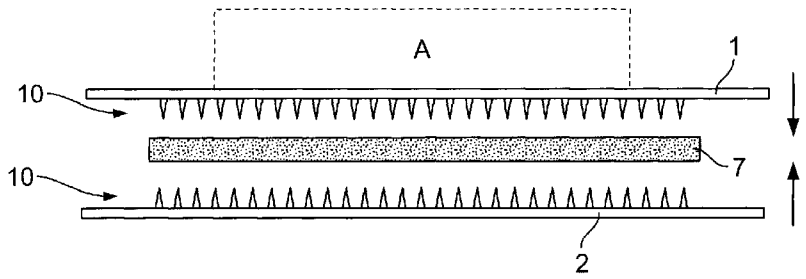

FIG. 2

(57) Abstract: A brake backing plate is provided in which a non-compressible core material (7) is sandwiched between two sheet metal stampings to make a lightweight, composite brake backing plate. Each of the stampings has a textured face with a plurality of integrally formed piercing members (5). By rolling or pressing, the piercing members of the textured faces are fully embedded in the core material (7), and thus lock the stampings and the core material together.

COMPOSITE DISC BRAKE BACKING PLATE

FIELD OF THE INVENTION

The invention relates to backing plates for disc brake pads.

BACKGROUND OF THE INVENTION

Modern vehicle brake systems allow for slowing or stopping movement of the vehicle in a controlled manner. A typical automobile or light truck brake system includes a disc brake assembly for each of the front wheels and either a drum brake assembly or a disc brake assembly for each of the rear wheels. The brake assemblies are simultaneously actuated by hydraulic or pneumatic pressure generated when an operator of the vehicle depresses a brake pedal. The structures of these drum brake assemblies and disc brake assemblies, and their actuators, are well known in the art.

A typical disc brake assembly includes a rotor which is secured to the wheel of the vehicle for rotation therewith. The rotor has a pair of opposed friction faces which are selectively engaged by portions of a caliper assembly. The caliper assembly is slidably supported by pins secured to an anchor plate. This anchor plate is in turn secured to a non-rotatable component of the vehicle, such as the suspended wheel hub. A pair of brake pads (or shoes) are disposed in the caliper assembly on opposite sides of the rotor. These brake pads are operatively connected to one or more hydraulically actuated pistons for movement between a non-braking position, wherein they are spaced apart from the opposed friction plates of the rotor; and a braking position, wherein they are moved into frictional engagement with the opposed friction plates of the rotor. Depressing the brake pedal causes the piston to urge the brake pads from the non-

braking position to the braking position, frictionally engaging the friction faces to the rotor and thereby slowing or stopping the rotation of the associated wheel of the vehicle.

Each brake pad is made up of a relatively thick, substantially planar metallic body (the backing plate) to which is attached a cake of friction material (typically a molded composite material) in various ways (including adhesive, rivets, and integral molding into holes or raised features in/on the backing plate).

Backing plates for brake pads are typically made of a single piece of solid steel. The backing plate distributes the force of the caliper piston across the brake pad, and thus it has been believed that a single piece solid backing plate is necessary to provide sufficient strength and rigidity. However, such pieces are very heavy, particularly in large truck applications. This has been a recognized problem in the art. Weight on the sprung or suspended components of a vehicle degrades ride quality and handling, as well as leading to increased fuel consumption and waste of valuable material. There have been attempts to address the weight issue by making a slightly thinner backing plate that is "thickened" in local areas (typically edge perimeter) by embossing. However, the resulting plates are still quite heavy.

It would be desirable to provide a lighter weight alternative, taking advantage of other materials' beneficial properties, while maintaining strength and rigidity.

SUMMARY OF THE INVENTION

According to a first aspect of the invention, a brake backing plate is provided. To make up the plate, a non-compressible core material is sandwiched between a first sheet metal stamping and a second sheet metal stamping. The first sheet metal stamping and the second sheet metal stamping each have a textured face with a plurality of integrally formed piercing members.

By rolling or pressing, the textured faces of each of the stampings engage the core material and their piercing members are fully embedded in the core material. Thus, the piercing members act to lock together the first sheet metal stamping, the second sheet metal stamping and the core material.

Preferably, at least one of the first sheet metal stamping and the second sheet metal stamping is steel.

Preferably, the core material is a lightweight composite material. In one embodiment, the core material is a friction material.

In certain embodiments, the core material may be a curable material, in which case, the first sheet metal stamping and the second sheet metal stamping can be assembled together while the core material is in an uncured or partially cured state, before allowing the core material to cure or finish curing.

The first sheet metal stamping may include a second textured face with a plurality of integrally formed piercing members for attaching to a friction material to form a brake friction pad.

The first sheet metal stamping may include at least one embossment (e.g. to increase the sheet metal stamping stiffness).

Various shapes of piercing members are possible. In one (presently preferred) embodiment, the piercing members have a hook shape.

At least some of the piercing members may extend through the core material to contact the opposing textured face. These piercing members may be clinched by contact with the opposite textured face. Further, the piercing members may be co-clinched with each other.

In one embodiment, the core material is a fibrous material and the piercing members engage with and catch on fibers of the fibrous material.

Preferably, the core material is selected to be heat-resistant. The core material may also have other benefits – e.g. be weather-resistant, or corrosion-resistant.

Preferably, the first sheet metal stamping and the second sheet metal stamping are solid, non-perforated sheets, and the piercing members are formed on the surface of the first sheet metal stamping and the second sheet metal stamping without piercing or perforating through the stamping.

The first sheet metal stamping and the second sheet metal stamping may be precut to required dimensions for a finished brake backing plate shape prior to assembly with the core material.

Alternatively, at least one of the first sheet metal stamping and the second sheet metal stamping may be precut larger than required dimensions for a finished brake backing plate shape. At least a portion of this excess may be bent to at least partially cover an edge surface of the core material after assembly.

In one such embodiment, the brake backing plate shape has abutment ends, and the excess is provided in the form of at least one tab at each abutment end. This at least one tab is bent to at least partially cover the core material at the abutment end. This at least one bent tab provides a

substantially smooth and flat abutment surface for the brake backing plate (e.g. to transfer load and allow sliding movement where it engages the caliper body).

BRIEF DESCRIPTION OF THE FIGURES

Fig. 1 shows isometric top and front views of a disc brake pad (prior art).

Figs. 2-4 are side views showing formation of a sandwich between metal stampings **1, 2** and core material **7**.

Fig. 5 is a detail view of one piercing member **5**.

Fig. 6 is a perspective view of a portion of array **10** of piercing members **5**.

Fig. 7 is a top view of stamping **2** prior to assembly with core material **7**.

Fig. 8 is a side view of a second embodiment of the sandwich having friction material **20** attached by a second array **10** of piercing members **5**.

Fig. 9 is a side view of Fig. 8 shown in partial assembly wherein abutment tab bending process is illustrated.

Fig. 10 is a side view of a third embodiment (similar to that shown in Fig. 8) having multiple stamping layers.

Fig. 11 is a top view of a stamping having embossed areas **20**.

Fig. 12 is a cross-sectional view along lines 12-12 of Fig. 11.

Fig. 13 is a top view of a stamping having a radial pattern of embossed areas **21**.

Fig. 14 is a detailed view of surface **11** with detail of one embodiment of piercing member **5.**

Fig. 15 is a side perspective view of an embodiment of assembly (friction material **20** and a portion of core material **7** removed to show detail).

Fig. 16 is a side view of Fig. 15 showing abutment tabs.

Fig. 17 is a top perspective view of Fig. 15.

DETAILED DESCRIPTION

As shown in Figure 1 (in isometric top and front views), the prior art brake pad is made up of a friction material cake **A** that is joined to a backing plate **B**.

The friction material is an ablative material that contacts the rotor in the course of braking. Friction materials are generally composite materials, whose components may include metallic, semi-metallic, inorganic (e.g. ceramic) and organic compounds. In some formulations, friction material may include particles, filaments, shavings or fibers dispersed in the material. A pre-form cake of friction material is molded onto the backing plate using a heat pressure molding system whereby the cake flows into and around various features on the backing plate. When cooled, the friction material becomes fully hard and bonded to the backing plate.

Prior art backing plates are solid, typically steel, plates that may have holes or other features for retaining friction material. There are many different shapes of backing plates, but many applications include abutment ends **C**, which are used for mounting and alignment in the caliper bracket.

In the present invention, a lightweight alternative backing plate is provided. The weight is saved by using relatively thin metal stampings that are permanently joined in a sandwich with a lightweight core material. The overall laminated structure displays equivalent strength and

rigidity to solid steel backing plates, and accordingly, there is no loss of function for the decrease in weight.

The plate is referred to as a "composite" backing plate by virtue of the fact that it is composed of heterogeneous materials with inferior properties on their own, which are enhanced and made superior by virtue of their joining.

Figures 2-4 illustrate in general outline the process for forming a composite backing plate according to the present invention. A first (upper) sheet metal stamping (generally designated **1**) and a second (lower) sheet metal stamping (generally designated **2**) are placed so as to sandwich between them a lamina of non-compressible core material **7**. Each metal stamping has an inward facing textured surface and an outer surface (which may be plain, as shown in Figs. 2-4 or may have an exposed texture as shown in Fig. 8, 9). On the stamping **1**, the textured (inward) face is **12**, and the outward face is **11**. On stamping **2**, the textured (inward) face is **13**, and the outward face is **14**. Generally speaking, the orientation of the entire sandwich is reversible.

As shown in Figure 6, the textured faces **12, 13** feature an array **10** of piercing members **5**.

As shown in Fig. 3, as the stampings **1, 2** are brought together, the piercing members **5** bite into and begin to penetrate the core material **7**. Finally, as shown in Figure 4, when the flat portions of the textured surfaces **12, 13** touch down at the surfaces **15, 16** of the non-compressible core material **7**, the piercing structures have reached maximum penetration and by embedment are locked to the core material.

As used herein, "piercing member" describes any type of nail- or pin-like structure (or hooked or barbed structure) raised on the surface of a material (for embedding or piercing). The piercing members **5** may be raised from the surface by carving, gouging or scraping an integral projection from the surface of the material itself. One method of forming such piercing members

is described in co-pending Canadian Patent Application No. 2,778,455, by the present applicants, filed May 29, 2012, which is entitled "Bulk Textured Material Sheeting." Related processes are also described in Canadian Patent Nos. 1,330,521; 1,337,622; or 2,127,339. The foregoing disclosures are incorporated herein by reference.

The gouging or scraping process may result in a piercing member **5** having a configuration as shown in Figures 5 and 6, where each piercing member **5** has an adjacent surface trench **6** from which material has been removed. The piercing member may be somewhat hook-shaped as shown in Figure 5 (and in Figure 14, in which the hooks are shown having a tip portion **5a** opposite root portion **5b**), or a more straight upright (e.g. nail-like) member may be provided.

To form each stamping **1, 2**, a continuous length of pre-textured material (i.e. having such piercing members already formed) may be stamped into finished composite plate profiles. Alternatively, precut workpieces may be textured individually. The second method may be preferred to obtain a more customized outline of piercing members on the surface. Further, prior to assembly in the sandwich, the stampings may undergo other forming operations, including embossing areas of the stamping (e.g. to provide additional friction material attachment surfaces, and/or to provide additional stiffness of the stamping). At this stage, the properties of the metal stamping are easily controlled. For example, as shown in Figure 11 (whose cross-sectional view is provided in Figure 12), embossings **20** may be press-formed on stamping **2**. Embossing provides a way for the piston's high force to be distributed across the stamping **2** (not just in the small central patch struck by the piston). In turn, the entire surface of the brake pad **A** contacts the rotor to provide maximum braking performance. Figure 13 shows another embodiment with a radial pattern of embossing **21** to spread the piston's force in all directions.

In one embodiment, as shown in Figure 8, a dual-sided metal sheet may be used for at least one of the stampings (i.e. having piercing member texturing **10** over at least a portion of each surface). This allows for the formation of the composite backing plate, and also allows for an exposed textured surface on which friction material may be joined. As shown in Figure 10, multiple sheets may be sandwiched together with core material. Other variations are possible.

The sandwich of material formed by the present method is able to provide an extremely stiff and rigid laminate because of the unique locking effect of the piercing members. The piercing members want to stay at a right angle to the lamina face. However, the tips of the piercing members (being embedded in the core material) are prevented from converging, and thus the entire sandwich of material cannot flex or bend. In this way, an exceptionally stiff laminate is created from what would otherwise be a relatively flexible sheet of metal (due to the relative thinness). Various types, qualities and grades of metals may used (e.g. stainless steel, regular steel, aluminum), including cheaper or lower grade metals that might not ordinarily be considered for backing plate use.

The core material can be any non-compressible (preferably lightweight) material. Such materials may be selected to have specific properties beneficial for brake pad use (e.g. heat resistance (to limit heat transfer), weather-resistance, corrosion-resistance, etc.) Such materials need not be stiff or rigid on their own and may in fact be somewhat brittle. One presently preferred material is friction material which is already tested and has known performance under braking conditions. Friction material has the additional advantage of being lightweight for its size.

As a weight comparison, consider the following example of a backing plate:

	Overall thickness	Steel thickness	Core thickness (using friction material core)	Overall weight
Standard steel backing plate	0.650" (16.5mm)	0.260" (6.6mm)	n/a	0.656 pound (295 gram)
Composite backing plate	0.650" (16.5mm)	0.040"(1mm) and 0.040" (1mm)	0.181" (4.6mm)	0.400 pound (0.182 gram)

The sandwich may be rolled or pressed to achieve full embedment of the piercing members in the core material. Application of heat or pressure may also be necessary in certain circumstances. Where a two-sided (i.e. 2 textured surfaces) stamping is used (e.g. Fig. 8, 9), the rolling or pressing may be done with very localized application to avoid breaking or crushing the piercing members that are exposed (e.g. the roller may follow tracks between rows of piercing members).

The height of the piercing members and the thickness of the core material will govern the degree of embedment. In some cases, as shown in Figs. 15-17, the piercing members may extend only partway into the core material. The shape of the piercing members as hooks may aid in this case to provide pull-apart resistance. The hook tips may also grip onto fibers, etc. in the core material (e.g. if fibrous material is used – such as certain formulations of friction material).

Clinching of the tips adds a further increase in pull-apart or peel resistance. As used herein, "clinch" (clinching, clinchable, clinched) describes the act of bending over the exposed tip of a pin- or nail that has pierced through two or more layers and extends therefrom. Clinching is a common practice in the wood construction trade. Clinching is analogous to riveting in metal work, or to any other deformation of a fastener to prevent its easy withdrawal. The purpose of

clinching is to impart greater cohesion between the two laminate layers that are so joined. "Co-clinched" refers to the piercing members interengaging with each other and with the core material (from above and below) to form a fully criss-crossed web of pierced material. In the present case, piercing members may clinch by contact with opposing textured surfaces and may co-clinch by contact with other piercing members.

Figure 7 and 9 show a further embodiment in which abutment end covers are formed as a secondary operation. The sandwich by itself leaves exposed stamped metal edges, which may lead to undesirable scraping or drag in the caliper bracket. To avoid this, a surface of enhanced smoothness and flatness can be provided by using tabs of the metal stamping to cover the core material at each abutment end. One embodiment is shown in Figure 7, in which a blank of metal is provided with the general outline of the finished backing plate shape plus tab extensions **2b-2d** at the abutment ends. These tabs can be bent down (or up) to cover the abutment end and its sides (as shown in Figure 9), enclosing the core material **7** at these ends. The abutment ends can be submitted to further flattening, grinding, sanding or coating operations to ensure an even smoother, flatter surface. It will also be appreciated that other overhanging portions of the stampings (besides the abutment ends) may also be bent up or down to achieve various effects (including full encasement of all sides of the core material).

The foregoing description illustrates only certain preferred embodiments of the invention. The invention is not limited to the foregoing examples. That is, persons skilled in the art will appreciate and understand that modifications and variations are, or will be, possible to utilize and carry out the teachings of the invention described herein. The scope of the claims shoud not be limited by the preferred embodiments set forth in the examples, but should be given the broadest purposive construction consistent with the description as a whole.

CLAIMS

What is claimed is:

1. A brake backing plate comprising:

a first sheet metal stamping;

a second sheet metal stamping;

a non-compressible core material sandwiched between the first sheet metal stamping and the second sheet metal stamping;

the first sheet metal stamping and the second sheet metal stamping each having a textured face with a plurality of integrally formed piercing members, the textured faces of each of the stampings having been rolled or pressed into the core material such that the piercing members are co-clinched with each other via the core material, thus locking the first sheet metal stamping, the second sheet metal stamping and the core material together.

2. The brake backing plate of claim 1, wherein at least one of the first sheet metal stamping and the second sheet metal stamping is steel.

3. The brake backing plate of claim 1, wherein the core material is a lightweight composite material.

4. The brake backing plate of claim 1, wherein the core material is a friction material.

5. The brake backing plate of claim 1, wherein the core material is a curable material, the first sheet metal stamping and the second sheet metal stamping having been assembled

together while the core material was in an uncured or partially cured state, before allowing the core material to cure or finish curing.

6. The brake backing plate of claim 1, wherein the first sheet metal stamping includes a second textured face with a plurality of integrally formed piercing members for attaching to a friction material to form a brake pad.

7. The brake backing plate of claim 1, wherein the first sheet metal stamping includes at least one embossment.

8. The brake backing plate of claim 1, wherein the piercing members have a hook shape.

9. The brake backing plate of claim 1, wherein at least some of the piercing members extend through the core material to contact the opposing textured face.

10. The brake backing plate of claim 9, wherein the piercing members are clinched by contact with the opposing textured face.

11. The brake backing plate of claim 9, wherein at least some opposing piercing members are co-clinched with each other.

12. The brake backing plate of claim 1, wherein the core material is a fibrous material and the piercing members engage with and catch on fibers of the fibrous material.

13. The brake backing plate of claim 1, wherein the core material is selected to be heat-resistant, weather-resistant, or corrosion-resistant.

14. The brake backing plate of claim 1, wherein the first sheet metal stamping and the second sheet metal stamping are solid, non-perforated sheets, and the piercing members are formed on the surface of the first sheet metal stamping and the second sheet metal stamping without piercing or perforating through the stamping.

15. The brake backing plate of claim 1, wherein the first sheet metal stamping and the second sheet metal stamping are precut to required dimensions for a finished brake backing plate shape prior to assembly with the core material.

16. The brake backing plate of claim 1, wherein at least one of the first sheet metal stamping and the second sheet metal stamping is precut larger than required dimensions for a finished brake backing plate shape, at least a portion of the excess being bent to at least partially cover an edge surface of the core material after assembly.

17. The brake backing plate of claim 16, wherein the brake backing plate shape has abutment ends, and the excess is provided in the form of at least one tab at each abutment end, the at least one tab being bent to at least partially cover the core material at the abutment end.

18. The brake backing plate of claim 17, wherein the bent tab provides a substantially smooth and flat abutment surface for the brake backing plate.

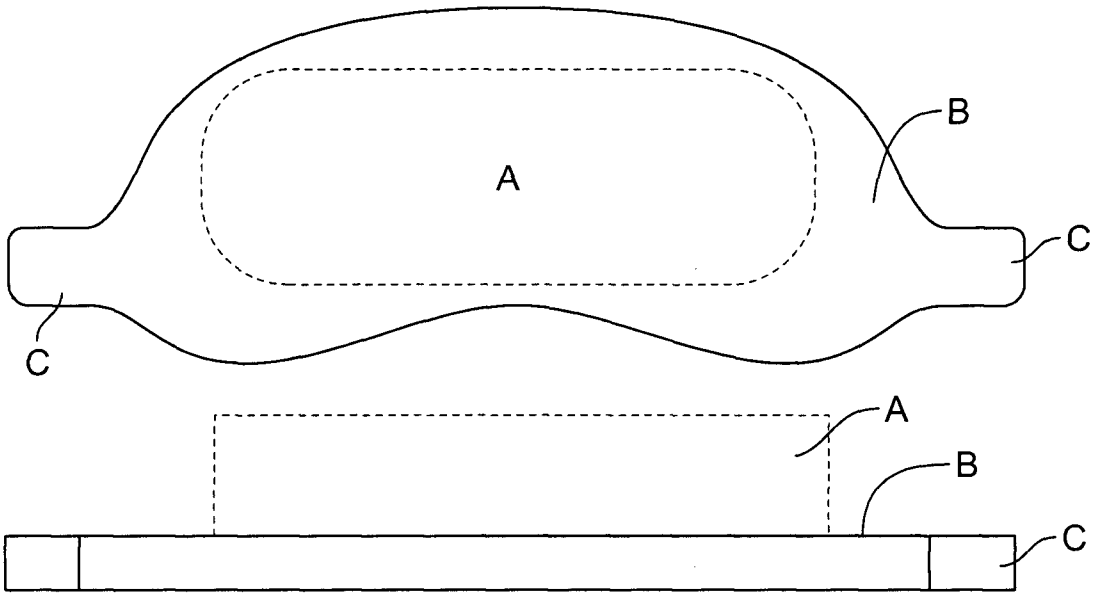

FIG. 1
(Prior Art)

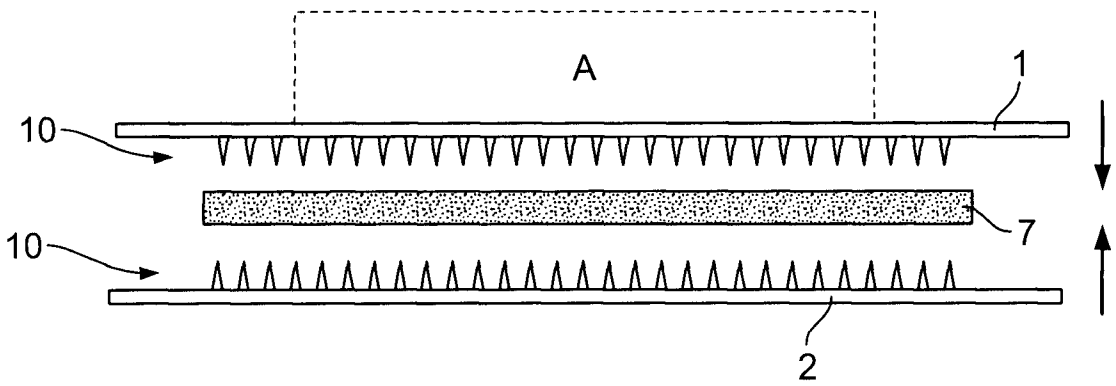

FIG. 2

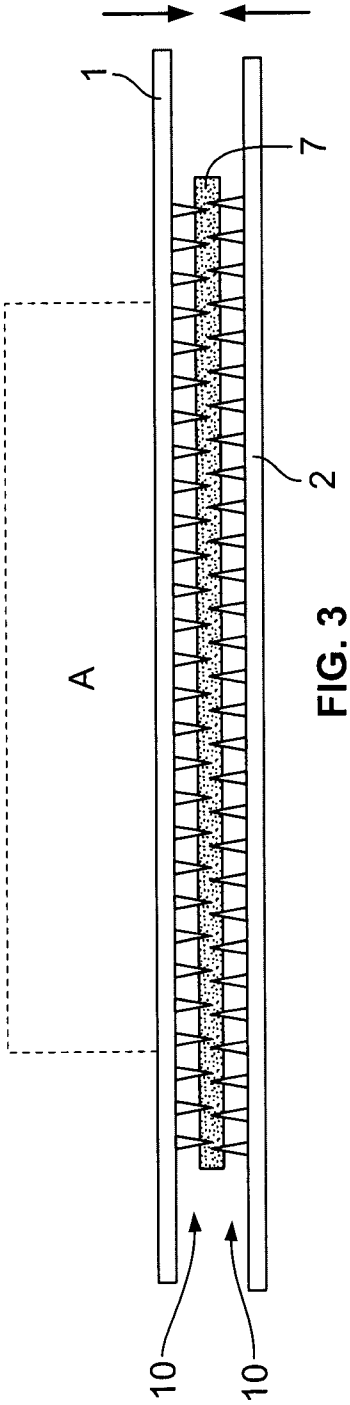

FIG. 3

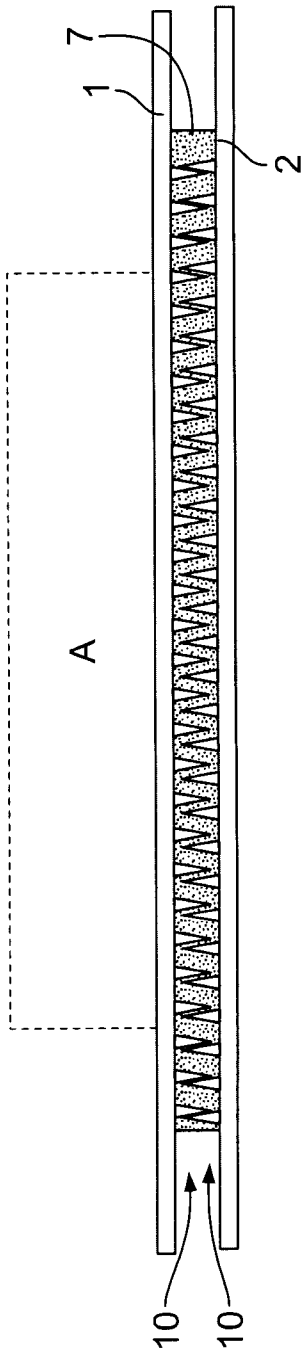

FIG. 4

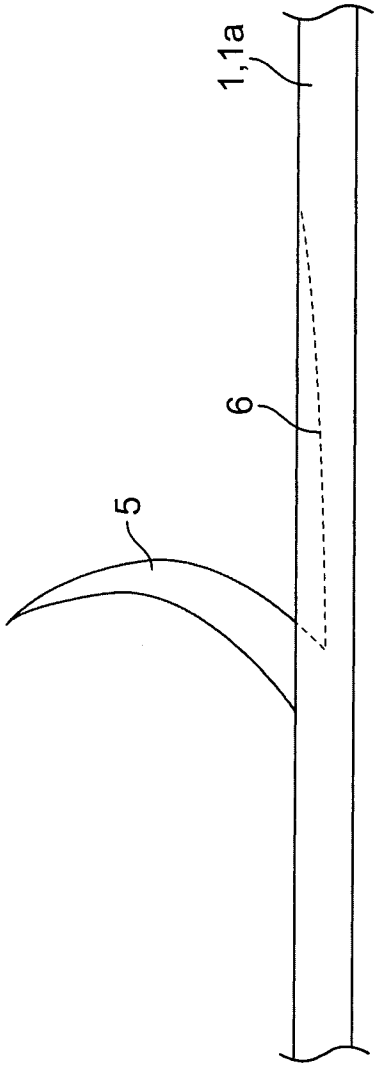

FIG. 5

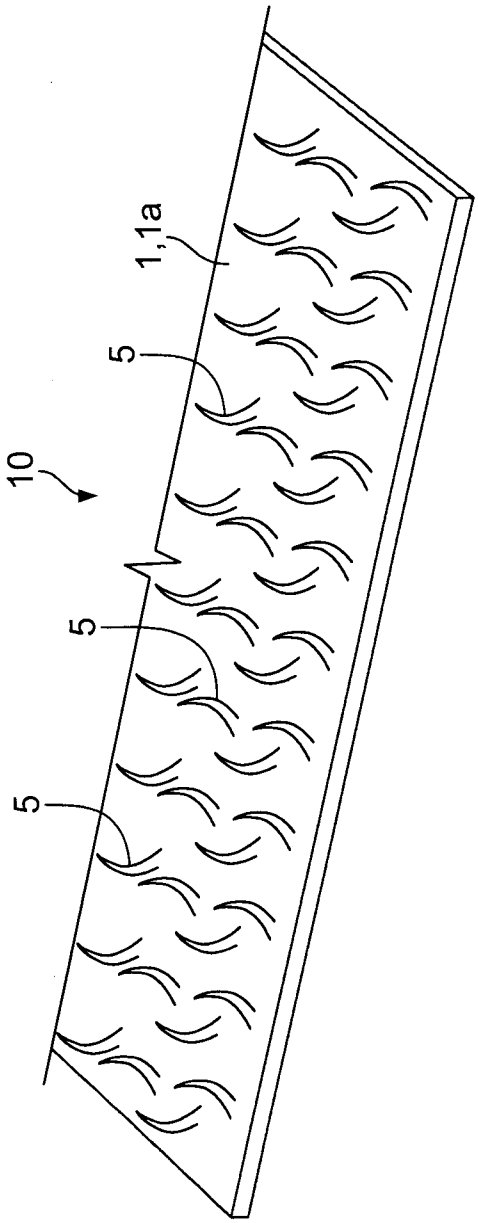

FIG. 6

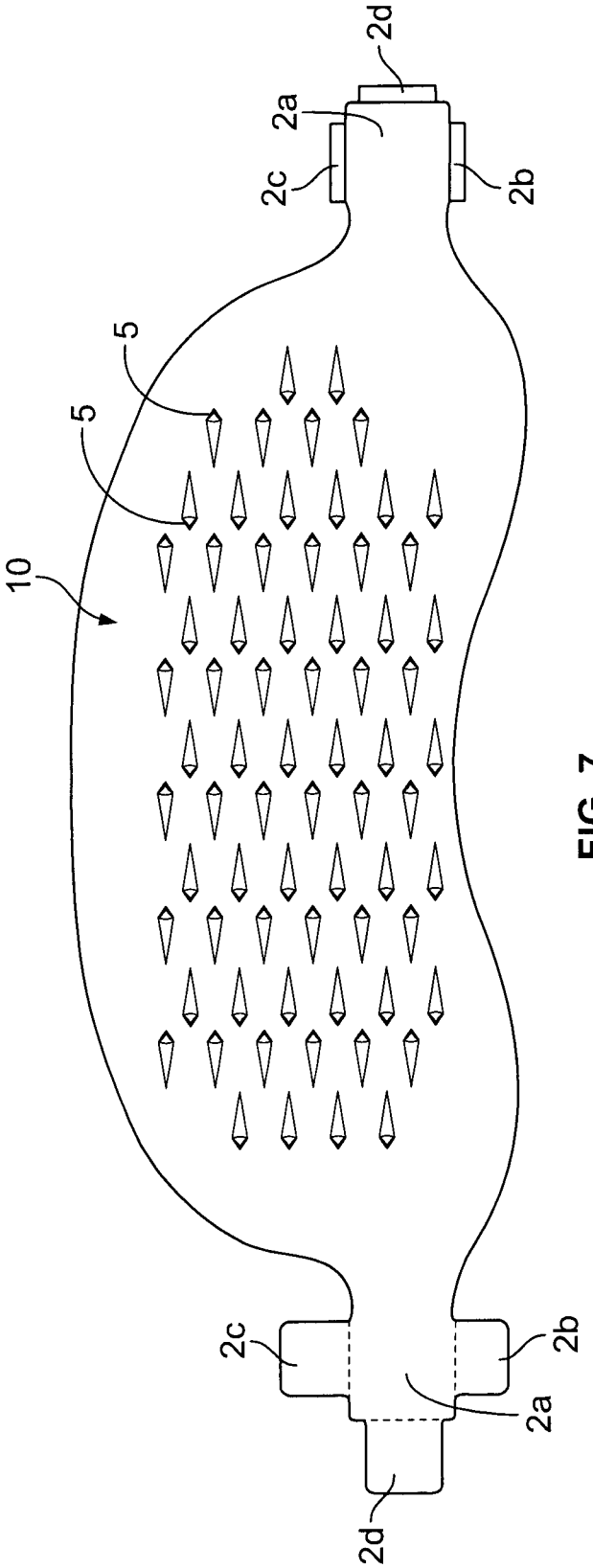

FIG. 7

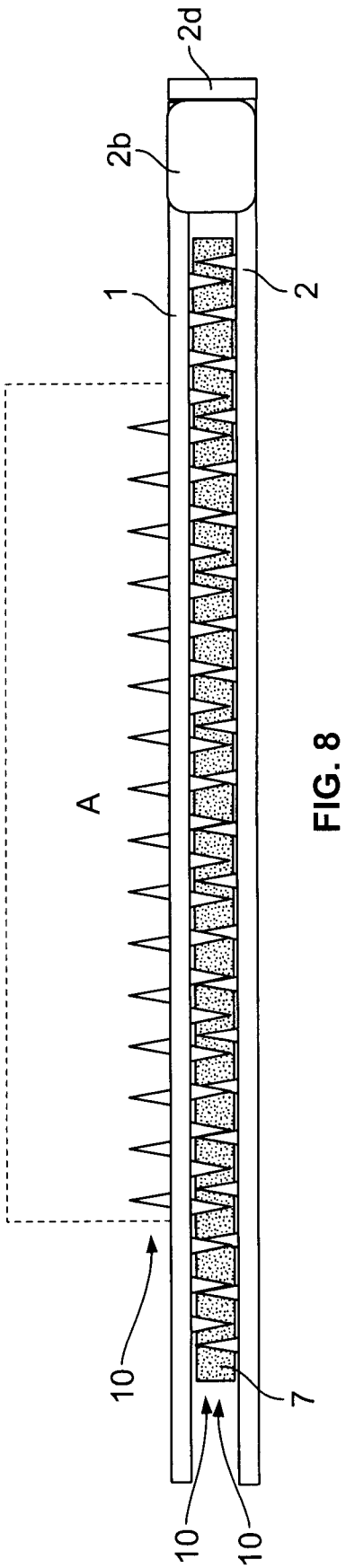

FIG. 8

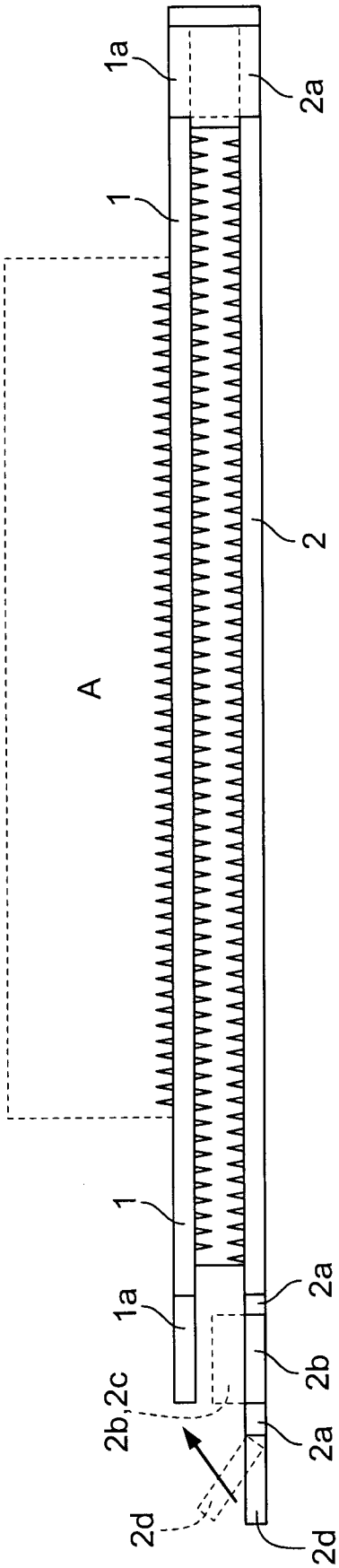

FIG. 9

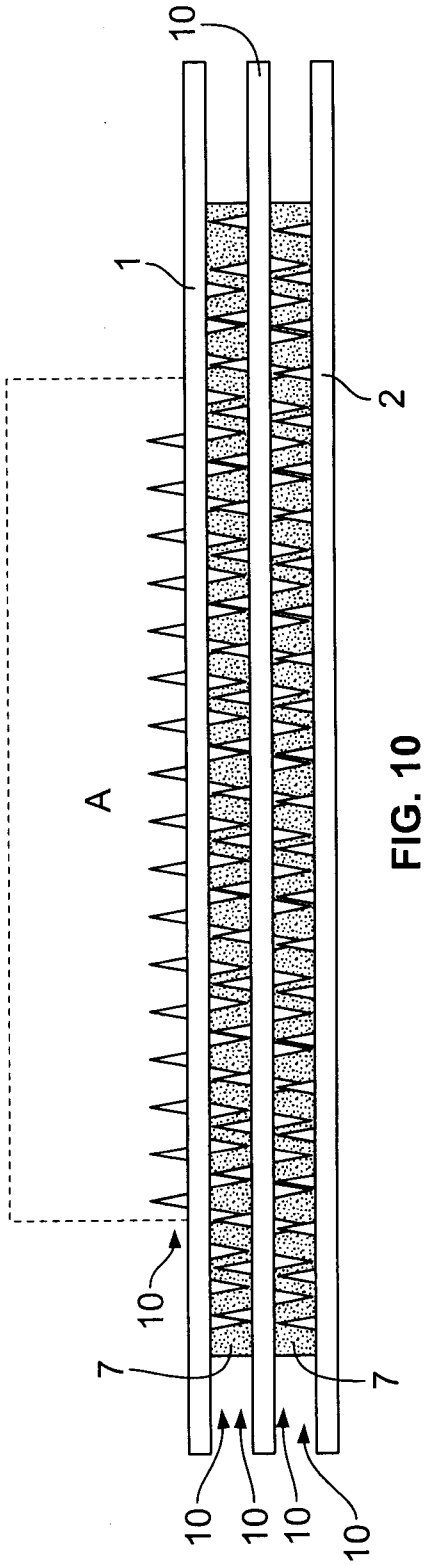

FIG. 10

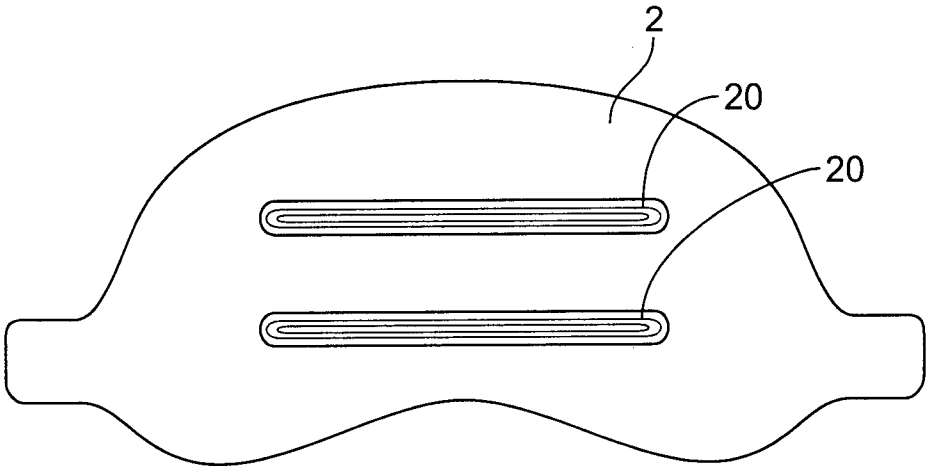

FIG. 11

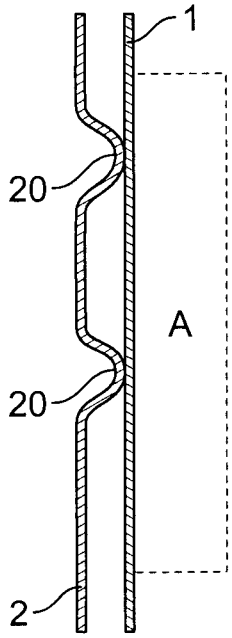

FIG. 12

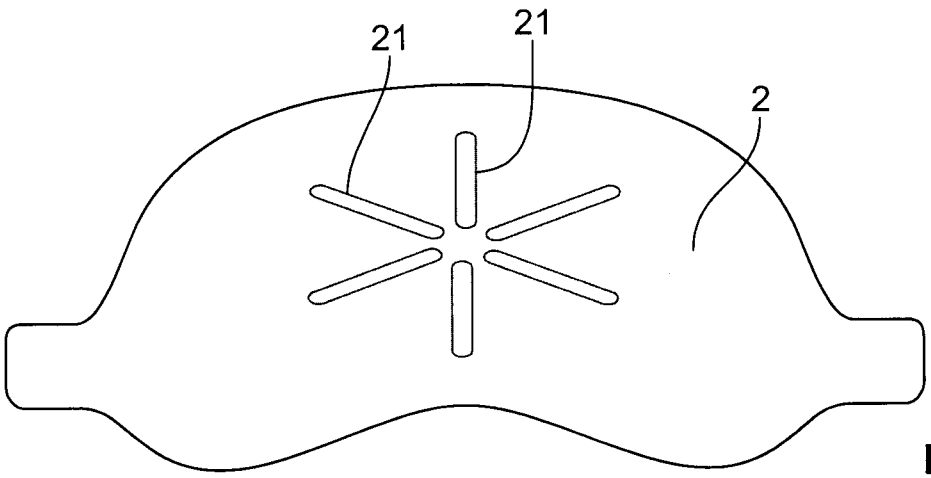

FIG. 13

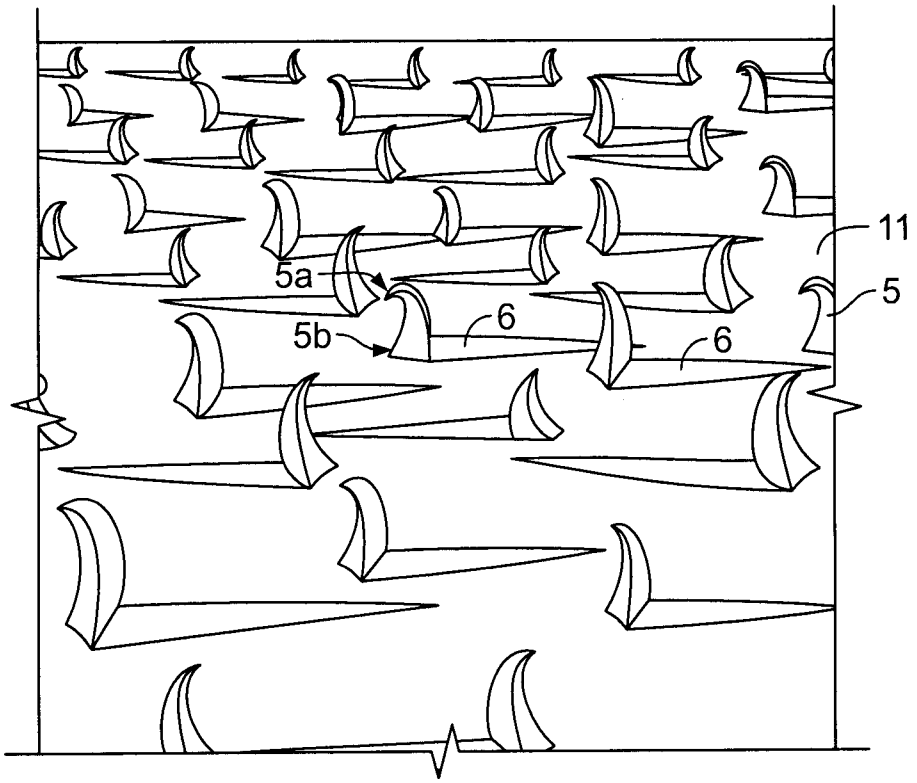

FIG. 14

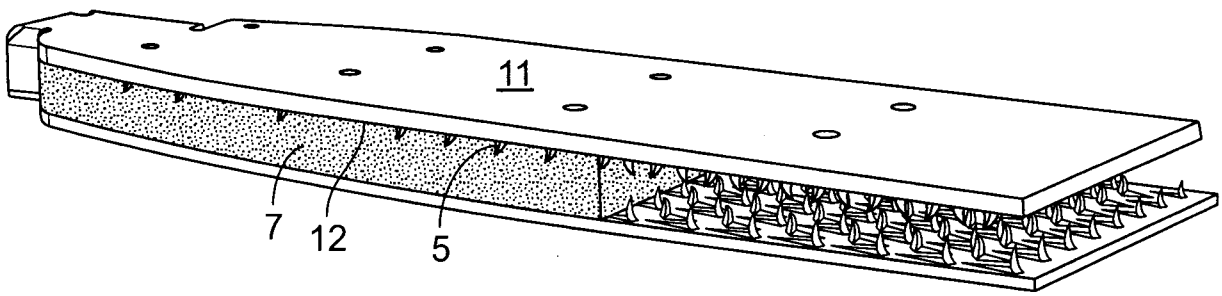

FIG. 15

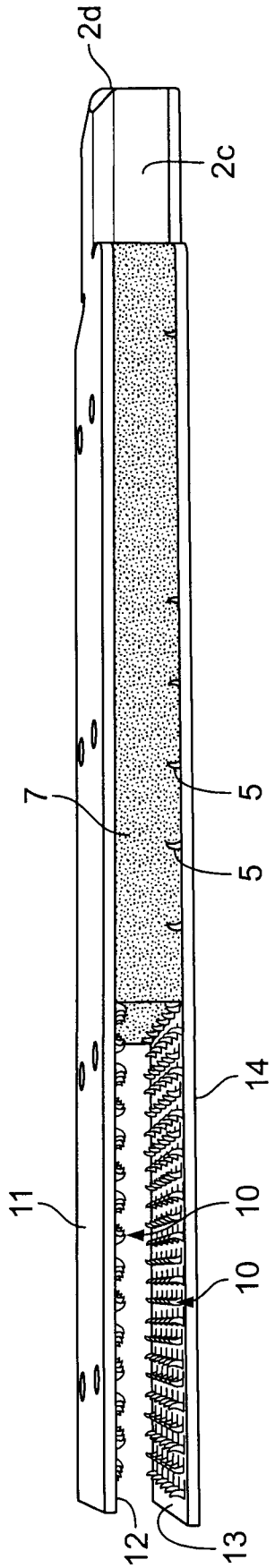

FIG. 16

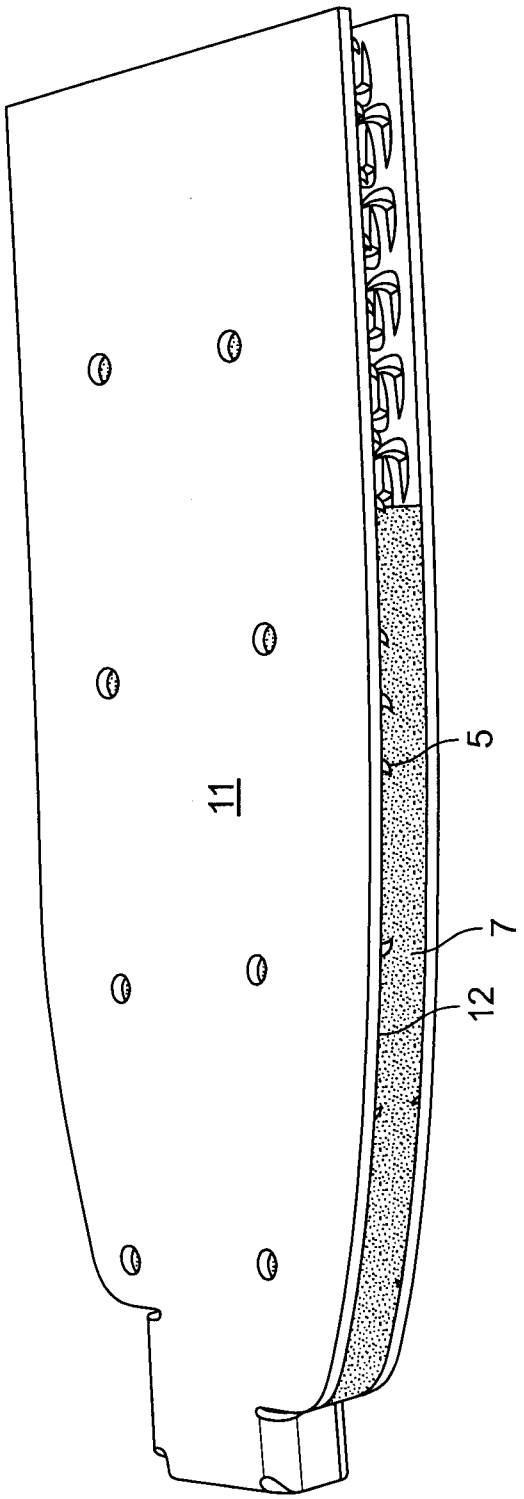

FIG. 17

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2013/002968

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16D65/092
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16D

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 859 163 A1 (ITT MFG ENTERPRISES INC [US]) 19 August 1998 (1998-08-19) paragraph [0016] - paragraph [0023]; figures 2,3	1-18
Y	US 2004/016608 A1 (GUTOWSKI VLADYSLAW [CA]) 29 January 2004 (2004-01-29) paragraph [0016] - paragraph [0022]	1-18
A	DE 197 54 740 A1 (ITT MFG ENTERPRISES INC [US]) 11 March 1999 (1999-03-11) abstract; figure 1	1
A	US 6 431 331 B1 (ARBESMAN RAY [CA]) 13 August 2002 (2002-08-13) figures 6b,6c	1,8

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
8 April 2014	17/04/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	van Koten, Gert

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2013/002968

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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