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(54) **METHOD FOR THE PRODUCTION OF A SEMI-FINISHED PRODUCT FOR A WING-SHAPED ELEMENT AND A WING-SHAPED ELEMENT**

VERFAHREN ZUR HERSTELLUNG EINES HALBZEUGS FÜR EIN FLÜGELFÖRMIGES PRODUKT
UND EIN FLÜGELFÖRMIGES PRODUKT

PROCEDE DE PRODUCTION D'UN PRODUIT SEMI-FINI DESTINE A UN ELEMENT EN FORME
D'AILERON ET UN ELEMENT EN FORME D'AILERON

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DE-B- 1 137 710 **GB-A- 856 473**
US-A- 3 045 327 **US-A- 3 057 393**
US-A- 4 531 270

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Description

[0001] The invention relates to a method for the production of a semi-finished product for a wing-shaped element as per the preamble of claim 1 and of the wing-shaped element itself as per the preamble of claim 6. Such wing-shaped elements are found in many different embodiments. A so-called vane, which is fixed to a flap of an aircraft wing, is mentioned as an example. The method and the element of the preamble of claims 1 and 6 are known from US-A-3057393.

[0002] Various production methods for such wing-shaped elements are known. Extrusion of the element is mentioned first. In such a case the element does not have to be made up of separate components, which is quick and relatively inexpensive. The disadvantage, however, is that the dimensional tolerance is poor. This arises, in particular, in the case of relatively small thicknesses. According to a further known method the element is produced from sheet material. After pre-forming the sheet material, this is stretched on a stretcher leveller for making sections that has a bottom block and top block. A mandrel is incorporated in the pre-formed sheet material. The whole is clamped at the longitudinal ends and then stretched. The disadvantage of this known method is that the surface obtained has irregularities.

[0003] The aim of the invention is to provide a method for the production of a semi-finished product for a wing-shaped element that does not have these disadvantages. Said aim is achieved by means of a method for the production of a semi-finished product for a wing-shaped element having, in cross-section, a front edge, an arched bottom wall and an arched top wall that extend some distance apart between the front edge and the free rear ends of the walls, comprising the following steps:

- providing a metal sheet,
- bending the sheet with the formation of two panels as well as a curved region which the panels adjoin,
- providing a former, the exterior of which has the shape of the internal surface of the finished section,
- placing the former in the bent sheet with the front edge of the former positioned in the curved region,
- providing an edge press provided with a pressure member and a rubber cushion located opposite,
- fixing the former to the pressure member,
- forcing the pressure member towards the rubber cushion with the bent sheet enclosed between them and deforming said sheet between the former and the rubber cushion,
- removing the former with shaped sheet from the edge press,
- placing these in a rubber press provided with a bottom block having a cavity which has a shape that at least approximately corresponds to the external shape of one of the walls of the shaped sheet,
- pressing the shaped sheet with former between the bottom block and a rubber mat,

- removing the semi-finished product from the rubber press.

[0004] With the method according to the invention the semi-finished product is shaped by exerting pressing forces thereon via rubber elements. In combination with the former acting as a mandrel that has the correct contour, an extremely accurate shape is obtained by this means which has a surface that has the smoothness desired for aircraft for aerodynamic reasons.

[0005] The two panels are preferably arched after, or before, or at the same time as bending the sheet. The arching can be oriented in the same direction in order to obtain a relatively strong curved element. However, the archings can also be oriented away from one another.

[0006] Bending and optionally arching the panels can be effected by means of roller forming or by means of rolling. The rear edge of the element can be made as a section that is fixed to the top wall and the bottom wall. Furthermore, the wing-shaped element can be subjected to a heat treatment, for example stress-free annealing or solution annealing.

[0007] The invention is also related to a wing-shaped element, comprising a product obtained by the method as described before, said product having, in cross section, a front edge, an arched bottom wall and an arched top wall that extend some distance apart between the front edge and the free rear ends of the walls.

[0008] Such a wing-shaped element is disclosed in US-A-3057393. The free rear edges of the walls of said prior art wing-shaped elements are directly connected to each other.

[0009] According to the invention, the wing-shaped element is characterised by a section having a body extending between the walls and provided with surfaces facing away from one another in accordance with the run of the walls.

[0010] Reference is made to the wing-shaped element that is disclosed in US-A 4 531 270. This element is produced from a relatively flat section that comprises two panels that form a whole and in which the arching of the ultimate walls has been pre-produced by a locally greater material thickness. The element is obtained from this by simply folding the panels onto one another, after which the element is ready. The element concerned here is in the form of a blade for turbines.

[0011] The invention will be explained in more detail below with reference to an illustrative embodiment shown in the figures.

Fig. 1 shows a curved and arched sheet that serves as starting material for the method according to the invention.

Fig. 2 shows the element in an edge press.

Fig. 3 shows the result after performing a treatment in the edge press.

Fig. 4 shows a perspective view of the rubber press block of a rubber press, with the mandrel.

Fig. 5 shows the product obtained after rubber pressing.

Fig. 6 shows the finished wing-shaped element.

[0012] When carrying out the method according to the invention the starting material used is the bent sheet 1 shown in Fig. 1, which has been bent with the formation of a bent front edge 2, a concave arched panel 3 and a convex arched panel 4. This bent sheet 1 is placed in the edge press 5 shown in Fig. 2, which has a base 6 with rubber cushion 7 as well as a pressing member 8 that can be moved up and down and to which the former 10 is fixed by means of the supports 9. This former 10 or mandrel 10 is also shown in a perspective view in Fig. 4. It has the shape of the internal surface of the finished wing-shaped element, that is to say with a front edge, rear edge and arched top surface and bottom surface. The former can have a prismatic shape but also a twisted shape.

[0013] When pressing the bent sheet 1 in the edge press, the front edge of the former 10 is pushed into the curved region 2 of the sheet 1. By this means this curved region is curved more severely around the front edge of the former 10, under the influence of the even inward pressure by the rubber cushion 7. As a consequence of this, the arched panels 3 and 4 come closer together, as shown in Fig. 3.

[0014] The sheet 1 further shaped in this way is then placed in a rubber press, the rubber press block 11 of which can be seen in Fig. 4, the interior shape of which corresponds to the front edge and an arched surface of the wing-shaped element. Together with mandrel 10, the sheet 1, which now has the shape as shown in Fig. 3, is placed in this rubber press block 11. The rubber mat 12 is then placed on top of the whole of this, after which the sheet 1 with the mandrel 10 therein is compressed between the rubber press block 11 and the rubber mat 12 by a press (not shown).

[0015] After rubber pressing, the semi-finished product 13 shown in Fig. 5 is obtained, which has a curved front edge 2, a convex arched top surface 4 and a concave arched bottom surface 3. Finally, the section indicated in its entirety by 14 is fixed to the rear, free ends of the walls 4, 3. For this purpose the section has a body 15 with sides 16, 17 tapering down with respect to one another that are oriented in accordance with the run of the top wall 4 and the bottom wall 3. The section 14 is fixed to the semi-finished product 13 by means of rivets 18 driven through the top wall 4, the body 15 and the bottom wall 3, after which the wing-shaped element is ready.

Claims

1. Method for the production of a semi-finished product (13) for a wing-shaped element having, in cross-section, a front edge (2), an arched bottom wall (3) and an arched top wall (4) that extend some distance

apart between the front edge (2) and the free rear ends of the walls, comprising the following steps:

- providing a metal sheet (1),
- bending the sheet (1) with the formation of two panels (3, 4) as well as a curved region which the panels (3, 4) adjoin,
- providing a former (10), the exterior of which has the shape of the internal surface of the semi-finished product (13),
- placing the former (10) in the bent sheet (1) with the front edge of the former (10) positioned in the curved region, **characterised in**
- providing an edge press (5) provided with a pressure member (8) and a rubber cushion (7) located opposite,
- fixing the former (10) to the pressure member (8),
- forcing the pressure member (8) towards the rubber cushion (7) with the bent sheet (1) enclosed between them and deforming said sheet between the former (10) and the rubber cushion (7),
- removing the former (10) with shaped sheet from the edge press (5),
- placing the shaped sheet in a rubber press provided with a bottom block having a cavity which has a shape that at least approximately corresponds to the external shape of one of the walls (3, 4) of the shaped sheet,
- pressing the shaped sheet with former (10) between the bottom block (11) and a rubber mat (12),
- removing the semi-finished product (13) from the rubber press.

2. Method according to Claim 1, wherein the two panels (3, 4) are arched after, or before, or at the same time as bending the sheet (1).

3. Method according to one of the preceding claims, comprising bending the curved region and optionally arching the panels (3, 4) by means of roller forming.

4. Method according to one of the preceding claims, comprising constructing the rear edge using a section (14) that is fixed to the free rear end of the top wall (4) and the free rear ends of the bottom wall (3) with the formation of a wing-shaped element.

5. Method according to one of the preceding claims, including a heat treatment step, such as stress-free annealing or solution annealing of the semi-finished product (13).

6. Wing-shaped element, comprising a product (13) obtained by the method according to any of claims 1-5, said product having, in cross section, a front edge

- (2), an arched bottom wall (3) and an arched top wall (4) that extend some distance apart between the front edge (2) and the free rear ends of the walls, **characterised by** a section (14) having a body (15) extending between the walls (3, 4) and provided with surfaces (16, 17) facing away from one another in accordance with the run of the walls (3, 4). 5
7. Element according to Claim 6, wherein the walls (3,4) and the body (19) are fixed to one another by rivets (18), bonding and the like. 10
8. Element according to Claim 6 or 7, wherein the surfaces (16, 17) of the body (15) facing away from one another run obliquely with respect to one another in accordance with the run of the walls (3, 4). 15
9. Element according to one of Claims 6-9, comprising a sheet (1) with a thickness in the range of 0.8 - 2.0 mm. 20
10. Element according to one of Claims 9, comprising a sheet (1) with a thickness in the range of 1.4 - 1.6 mm.
11. Element according to one of Claims 9 or 10, comprising a sheet (1) with a thickness in the region of 1.6 mm. 25
12. Element according to one of Claims 6-11, comprising a sheet material consisting of Al, Ti, Sc, Cu, Mg, Li and/or alloys thereof and/or steel and/or stainless steel. 30

Patentansprüche 35

1. Verfahren zur Herstellung eines Halbfertigproduktes (13) für ein flügelartiges Element, das im Querschnitt eine vordere Kante (2), eine gewölbte untere Wand (3) und eine gewölbte obere Wand (4) aufweist, die sich um einen bestimmten Abstand voneinander zwischen der vorderen Kante (2) und den freien Enden der Wände erstrecken, umfassend die folgenden Schritte: 40
- Bereitstellen eines Metallblattes (1),
 - Biegen des Blattes (1) mit der Bildung von zwei Platten (3, 4) sowie eines gewölbten Bereichs, an den die Platten (3, 4) angrenzen,
 - Bereitstellen eines Formers (10), dessen Außenseite die Form der inneren Oberfläche des Halbfertigproduktes (13) aufweist;
 - Anordnen des Formers (10) in dem gebogenen Blatt (1), wobei die vordere Kante des Formers (10) in dem gewölbten Bereich positioniert wird; 45
- gekennzeichnet durch**
- Bereitstellen einer Kantenpresse (5), die mit einem Druckglied (8) und einem gegenüber an-

geordneten Gummikissen (7) bereitgestellt ist,

- Befestigen des Formers (10) an dem Druckglied (8),
- Pressen des Druckglieds (8) zu dem Gummikissen (7), wobei das gebogene Blatt (1) zwischen ihnen eingeschlossen wird und das Blatt zwischen dem Former (10) und dem Gummikissen (7) verformt wird,
- Entfernen des Formers (10) mit dem geformten Blatt von der Kantenpresse (5),
- Anordnen des geformten Blattes in einer Gummipresse, die mit einem unteren Block bereitgestellt ist, der einen Hohlraum aufweist, der eine Form hat, die mindestens ungefähr der Form der äußeren Form einer der Wände (3, 4) des geformten Blattes entspricht,
- Pressen des geformten Blattes mit dem Former (10) zwischen den unteren Block (11) und einer Gummimatte (12),
- Entfernen des Halbfertigproduktes (13) von der Gummipresse.

2. Verfahren nach Anspruch 1, wobei die zwei Platten (3, 4) nach oder vor oder gleichzeitig mit dem Biegen des Blattes (1) gewölbt werden.
3. Verfahren nach einem der vorhergehenden Ansprüche, umfassend das Biegen des gewölbten Bereichs und wahlweise Wölben der Platten (3, 4) mittels Walzenformen.
4. Verfahren nach einem der vorhergehenden Ansprüche, umfassend das Konstruieren der hinteren Kante mittels eines Abschnitts (14), der an dem freien hinteren Ende der oberen Wand (4) und an dem freien hinteren Ende der unteren Wand (3) befestigt ist, mit der Bildung eines flügelartigen Elements.
5. Verfahren nach einem der vorhergehenden Ansprüche mit einem Wärmebehandlungsschritt wie Spannungsfreiglühen oder Lösungsglühen des Halbfertigproduktes (13).
6. Flügelartiges Element, umfassend ein Produkt (13), das durch das Verfahren nach einem der Ansprüche 1 bis 5 erhalten wird, wobei das Produkt im Querschnitt eine vordere Kante (2), eine gewölbte untere Wand (3) und eine gewölbte obere Wand (4) aufweist, die sich um einen bestimmten Abstand voneinander zwischen der vorderen Kante (2) und den freien hinteren Enden der Wände erstrecken, **gekennzeichnet durch** einen Profil (14) mit einem Körper (15), der zwischen den Wänden (3, 4) verläuft und mit Oberflächen (16, 17) bereitgestellt ist, die in Übereinstimmung mit dem Verlauf der Wände (3, 4) voneinander weg zeigen.

7. Element nach Anspruch 6, wobei die Wände (3, 4) und der Körper (19) durch Nieten (18), Binden und dergleichen aneinander befestigt sind.
8. Element nach Anspruch 6 oder 7, wobei die Oberflächen (16, 17) des Körpers (15), die voneinander weg zeigen, in Übereinstimmung mit dem Verlauf der Wände (3, 4) schräg zueinander verlaufen.
9. Element nach einem der Ansprüche 6 bis 8, umfassend ein Blatt (1) mit einer Dicke im Bereich von 0,8 bis 2,0 mm.
10. Element nach Anspruch 9, umfassend ein Blatt (1) mit einer Dicke im Bereich von 1,4 bis 1,6 mm.
11. Element nach einem der Ansprüche 9 oder 10, umfassend ein Blatt (1) mit einer Dicke im Bereich von 1,6 mm.
12. Element nach einem der Ansprüche 6 bis 11, umfassend ein Blattmaterial, bestehend aus Al, Ti, Sc, Cu, Mg, Li und/oder Legierungen davon und/oder Stahl und/oder Edelstahl.

Revendications

1. Procédé pour la production d'un produit semi-fini (13) pour un élément en forme d'aile ayant, en coupe, un bord avant (2), une paroi inférieure arquée (3) et une paroi supérieure arquée (4) qui s'étendent sur une certaine distance entre le bord avant (2) et les extrémités arrière libres des parois, comprenant les étapes suivantes consistant à :

- prévoir une tôle (1),
- plier la tôle (1) avec la formation de deux panneaux (3, 4) ainsi qu'une région incurvée au niveau de laquelle les panneaux (3, 4) sont attenants,
- prévoir un formeur (10) dont l'extérieur a la forme de la surface interne du produit semi-fini (13) ;
- placer le formeur (10) dans la tôle (1) pliée avec le bord avant du formeur (10) positionné dans la région incurvée,

caractérisé par les étapes consistant à :

- prévoir une presse de bord (5) prévue avec un élément de pression (8) et un coussin en caoutchouc (7) situé à l'opposé,
- fixer le formeur (10) sur l'élément de pression (8),
- forcer l'élément de pression (8) vers le coussin en caoutchouc (7) avec la tôle (1) pliée enfermée entre eux et déformer ladite tôle entre le formeur

- (10) et le coussin en caoutchouc (7),
- retirer le formeur (10) avec la tôle formée de la presse de bord (5),
- placer la tôle formée dans une presse en caoutchouc prévue avec un bloc inférieur ayant une cavité qui a une forme qui correspond au moins approximativement à la forme externe de l'une des parois (3, 4) de la tôle formée,
- comprimer la tôle formée avec le formeur (10) entre le bloc inférieur (11) et un mât en caoutchouc (12),
- retirer le produit semi-fini (13) de la presse en caoutchouc.

2. Procédé selon la revendication 1, dans lequel les deux panneaux (3, 4) sont arqués après ou avant ou en même temps que le pliage de la tôle (1).

3. Procédé selon l'une des revendications précédentes, comprenant l'étape consistant à plier la région incurvée et à arquer facultativement les panneaux (3, 4) au moyen de rouleaux de formage.

4. Procédé selon l'une des revendications précédentes, comprenant l'étape consistant à construire le bord arrière en utilisant une section (14) qui est fixée sur l'extrémité arrière libre de la paroi supérieure (4) et l'extrémité arrière libre de la paroi inférieure (3) avec la formation d'un élément en forme d'aile.

5. Procédé selon l'une des revendications précédentes, comprenant une étape de traitement thermique tel qu'un recuit dépourvu de tension ou une solution de recuit du produit semi-fini (13).

6. Élément en forme d'aile, comprenant un produit (13) obtenu par le procédé selon l'une quelconque des revendications 1 à 5, ledit produit ayant, en coupe, un bord avant (2), une paroi inférieure arquée (3) et une paroi supérieure arquée (4) qui s'étendent sur une certaine distance entre le bord avant (2) et les extrémités arrière libres des parois, **caractérisé par** une section (14) ayant un corps (15) s'étendant entre les parois (3, 4) et prévu avec des surfaces (16, 17) orientées en sens opposé selon l'étendue des parois (3, 4).

7. Élément selon la revendication 6, dans lequel les parois (3, 4) et le corps (19) sont fixés entre eux par des rivets (18), collage et similaire.

8. Élément selon la revendication 6 ou 7, dans lequel les surfaces (16, 17) du corps (15) orientées en sens opposé s'étendent obliquement les unes par rapport aux autres selon l'extension des parois (3, 4).

9. Élément selon l'une des revendications 6 à 8, comprenant une tôle (1) avec une épaisseur de l'ordre

de 0,8 - 2,0 mm.

10. Élément selon la revendication 9, comprenant une tôle (1) avec une épaisseur de l'ordre de 1,4 - 1,6 mm.

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11. Élément selon l'une quelconque des revendications 9 ou 10, comprenant une tôle (1) avec une épaisseur de l'ordre de 1,6 mm.

12. Élément selon l'une des revendications 6 à 11, comprenant un matériau de tôle se composant de Al, Ti, Sc, Cu, Mg, Li et/ou leurs alliages et/ou l'acier et/ou l'acier inoxydable.

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Fig 1

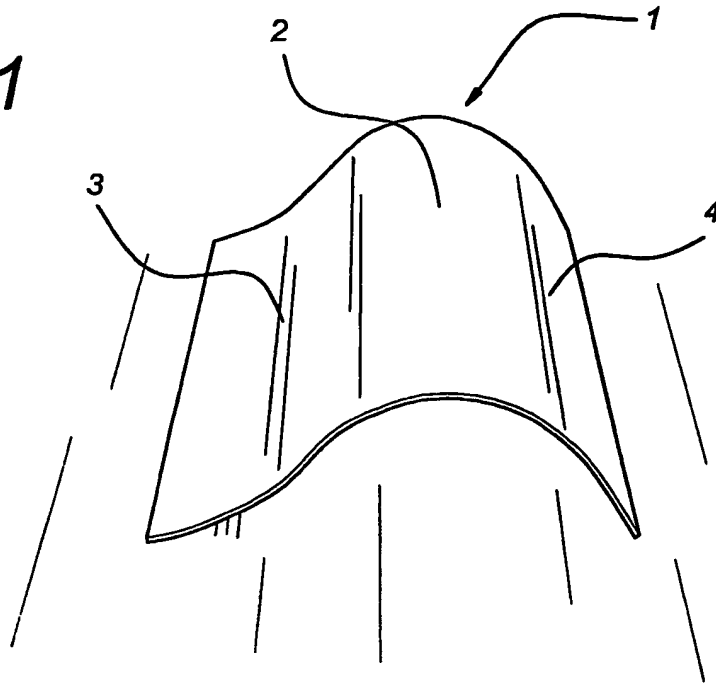


Fig 2

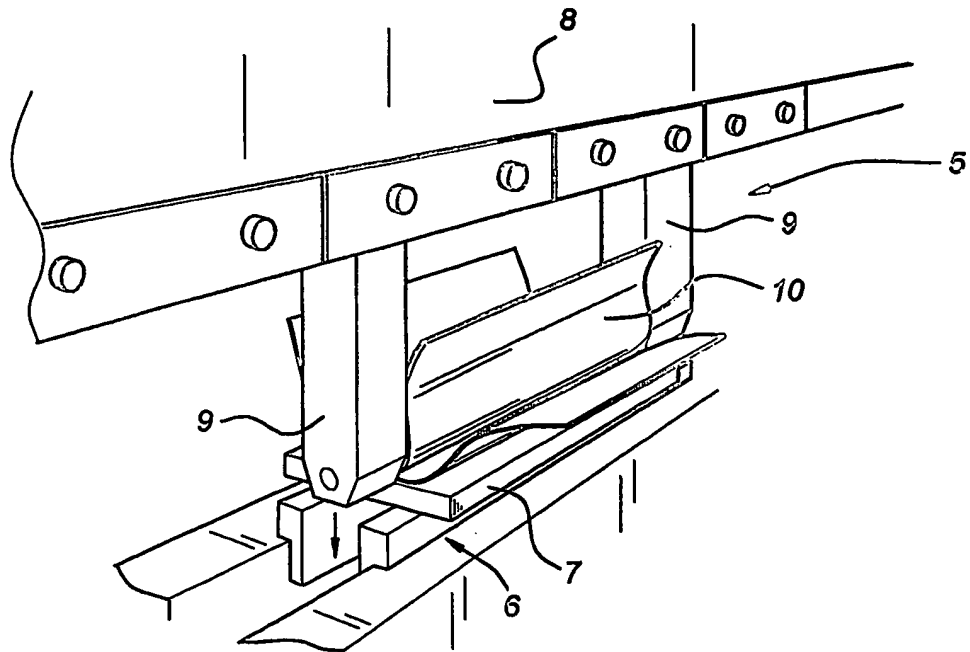


Fig 3

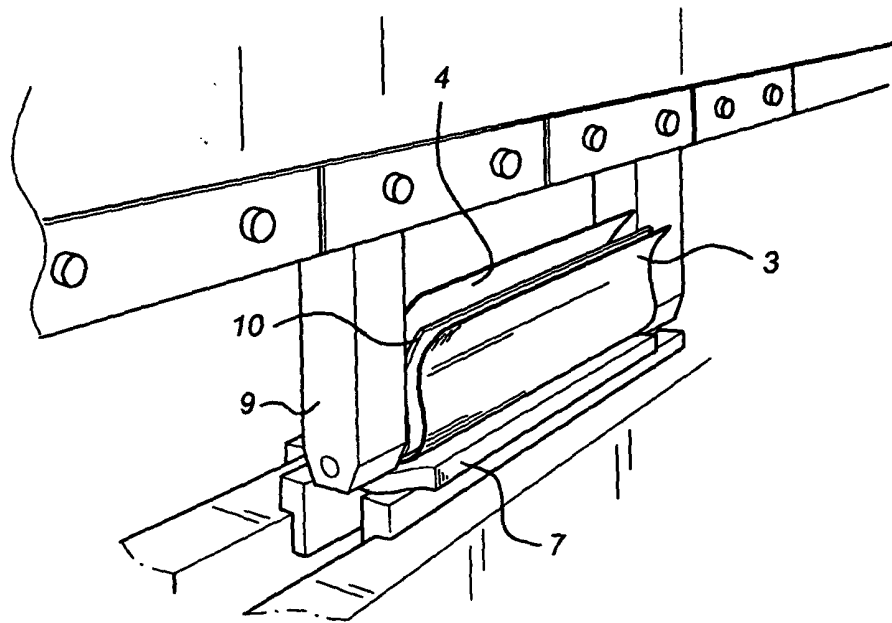


Fig 4

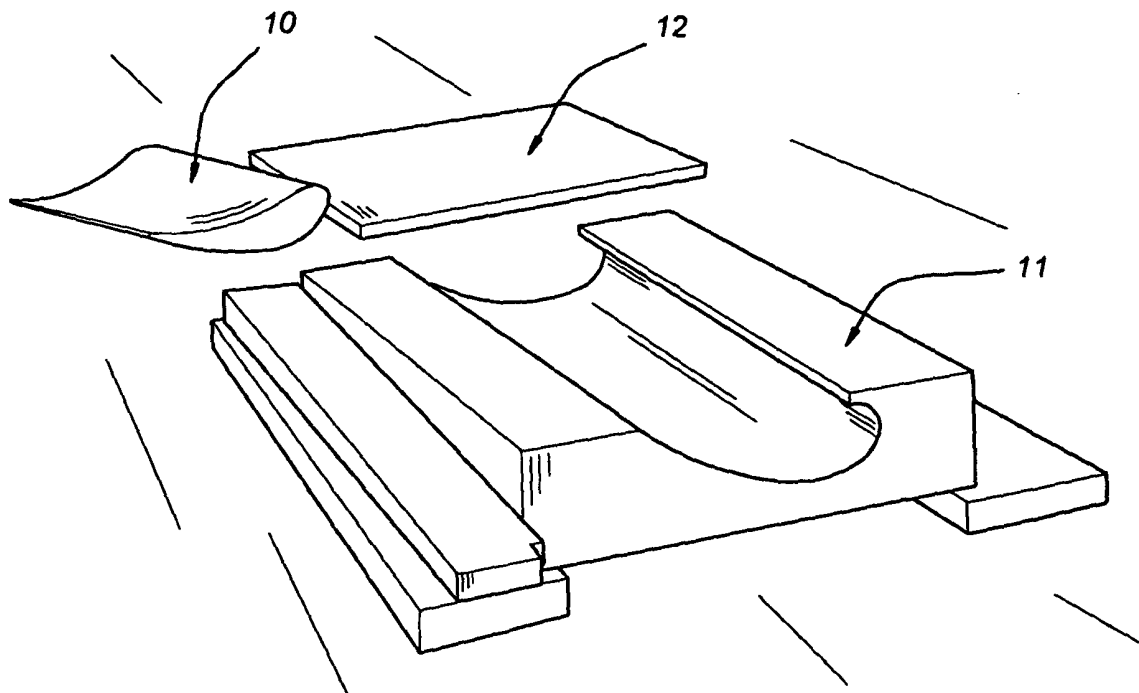


Fig 5

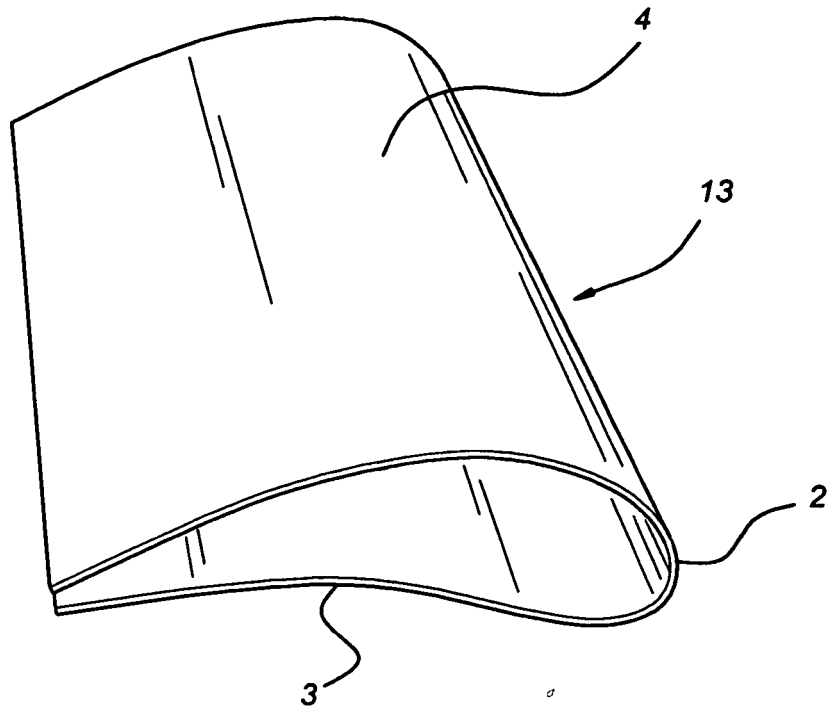
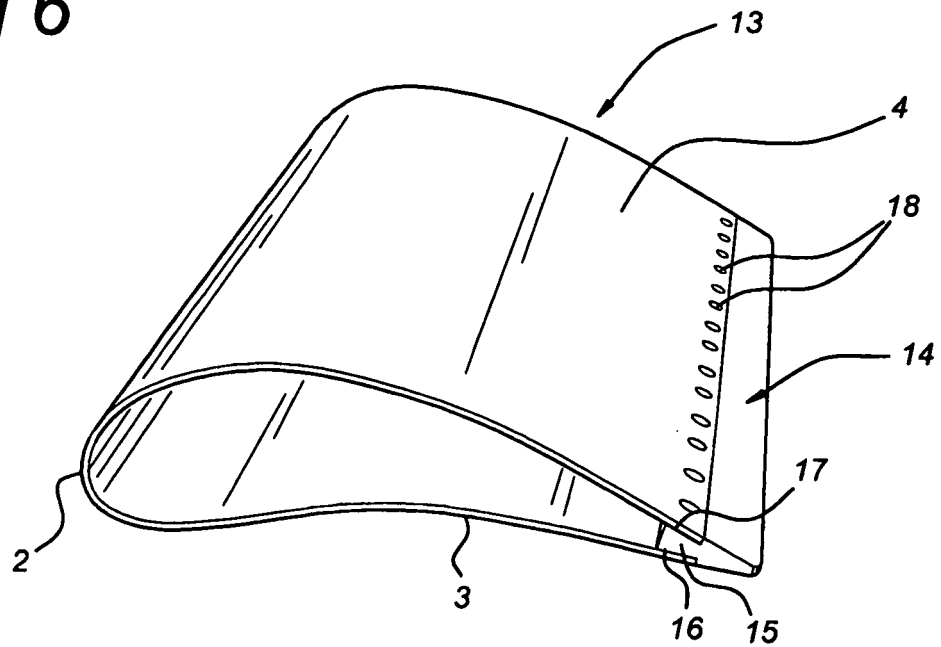


Fig 6



REFERENCES CITED IN THE DESCRIPTION

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