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ROTATABLE PRE–MOULD FOR A PREFORM

Description

[0001] The invention relates to a method for producing a rotor blade half–shell. The invention also relates to a production arrangement for carrying out a method for producing a rotor blade half–shell.

[0002] Rotor blades are shell components, usually laminate components, which are preferably assembled from two half–shells. The two half–shells can be produced separately from one another and can be connected to one another, for example adhered to one another, after completion.

[0003] To produce rotor blade half–shells, use is made of half–moulds. One problem with the half–moulds is that they have very steep support surfaces, especially in the region of the blade root and in the region adjacent thereto at the aerodynamic leading edge and trailing edge, that is to say the region corresponding to the rotor blade leading edge and the rotor blade trailing edge. The support surfaces may have slopes of almost or even exactly 90° relative to the ground. To produce the rotor blade half–shells, various fibre layers, for example fabric layers or scrim layers, and/or sandwich–core materials, such as foams and/or balsa wood for example, are layered one on top of the other on the support surfaces. Since this layering takes place in the dry state of the fabric layers and scrim layers, the fabric layers and scrim layers readily slip, particularly at the steep points of the half–mould. The layers must therefore be fixed relative to one another and relative to the mould by means of fixing means. It is possible for example, and is also carried out, to provisionally adhere the layers to one another by means of an adhesive, but this is very laborious.

[0004] WO 2010/097657 A1 discloses a method for producing a rotor blade half–shell according to the preamble of claim 1.

[0005] It is therefore an object of the present invention to provide a method for producing a rotor blade half–shell which avoids or at least reduces the aforementioned disadvantages. In a second aspect, it is an object of the present invention to provide a production arrangement for carrying out such a method.

[0006] The object is achieved in its first aspect by a method having the features of claim 1.

[0007] First, a partial pre–mould is provided with a preliminary support surface and a production mould is provided with a support surface for the rotor blade half–shell. The partial pre–mould with its preliminary support surface is moved into a first position in which the preliminary support surface is oriented horizontally. Here, "horizontal" is to be understood to mean that the greatest slope of the preliminary support surface relative to the ground is at most 50°, preferably at most 40°, particularly preferably at most 30°, or any other number of degrees between the stated numbers of degrees. It is therefore not necessary that every point of the preliminary support surface has a horizontal slope; it is sufficient if only some points of the preliminary support surface are oriented horizontally. In principle, however, it is not necessary for any point to be oriented exactly horizontally. What is necessary, however, is that the preliminary support surface as a whole and at every point is arranged largely horizontally in the sense mentioned above.

[0008] A preform is produced on the preferably substantially horizontally oriented preliminary support surface.

[0009] A preform is a prefabricated component for the rotor blade half–shell. After being produced, the preform is installed in the rotor blade half–shell. The preform is a component that can be produced in two different ways:

Variant A:

1. Fibre layers are surface–coated with an adhesive, in particular consisting of an epoxy resin that is solid at room temperature, and these fibre layers are made available.

2. The fibre layers coated with an adhesive are laid in the partial pre–mould in the predetermined order and number. In addition, materials such as foams and/or balsa wood, for example, may also be laid between the fibre layers, these materials being suitable for forming a sandwich structure together with the fibre layers. In addition, it may be provided that a film is placed between the first laid fibre layer or a sandwich material and the surface of the partial pre–mould, in order to facilitate the subsequent removal of the preform from the partial pre–mould.

3. Once all the fibre layers and sandwich materials have been laid in the partial pre–mould, the structure is covered with a film, which is then connected to the partial pre–mould, along the edge thereof, in a vacuum–tight manner, wherein at

least one outlet is provided, by means of which the air present can be evacuated from the layer structure of the preform.

4. Evacuating the air from the layer structure of the preform in the partial pre–mould, thereby achieving a negative pressure of at least 80% of the ambient pressure.

5. Heating the preform in the partial pre–mould by means of a heating device to a temperature above the melting point of the adhesive. The heating device may be integrated in the wall or shell of the partial pre–mould, it may be arranged below the shell of the partial pre–mould, which heats the preform from below, and, in addition to this heating device, further heating devices may be arranged on the upper side of the preform.

6. Cooling the preform after a predetermined time that is sufficient to adhere all the layers in the preform to one another.

7. Removing the vacuum film introduced in method step 3.

Variant B:

1. So–called prepregs, i.e. fibre layers that are already impregnated with an uncured resin/curing agent mixture, are made available.

2. The fibre layers described in method step 1 are laid in the partial pre–mould in the predetermined order and number. In addition, materials such as foams and/or balsa wood, for example, may also be laid between the fibre layers, these materials being suitable for forming a sandwich structure together with the fibre layers. In addition, it may be provided that a film is placed between the first laid fibre layer or the sandwich material and the surface of the partial pre–mould, in order to facilitate the subsequent removal of the preform from the partial pre–mould.

3. Once all the fibre layers and sandwich materials have been laid in the partial pre–mould, the structure is covered with a film, which is then connected to the partial pre–mould, along the edge thereof, in a vacuum–tight manner, wherein at least one outlet is provided, by means of which the air present can be evacuated from the layer structure of the preform.

4. Evacuating the air from the layer structure of the preform in the partial pre–mould, thereby achieving a negative pressure of at least 80% of the ambient pressure.

5. Removing the vacuum film introduced in method step 3.

[0010] The partial pre–mould with the preform located therein is then pivoted into a second position in which the preform, in terms of its rotational position, corresponds to its end position in the production mould. The partial pre–mould is thus rotated with the preform prefabricated in the partial pre–mould and present therein. One or more rotational movements may in principle take place about all three axes of rotation. However, it is essential that, at the end of the rotation or pivoting process, the preform has a position in the space that corresponds to its end position in the production mould. The preform is then moved out of the second position in the partial pre–mould into an end position in the production mould by (purely) translational movements. The preform is placed onto the support surface of the production mould.

[0011] The core concept of the invention is therefore that, first of all, the steep points in the production mould during the lamination process are avoided by separately manufacturing these regions by producing preforms. The separately produced preform, which is rotated into a horizontal position in order to avoid steep regions, is pivoted back once the preform has been produced. According to the invention, however, this pivoting movement takes place by pivoting the partial pre–mould itself. As a result, the preform is pivoted in a fully supported and protected manner. Only once the preform has reached its end position in relation to the axes of rotation is it transferred from the partial pre–mould into the production mould by means of a translation device, i.e. a combined lifting and moving device.

[0012] By virtue of the invention, cycle times for manufacturing a rotor blade can be considerably shortened.

[0013] Preferably, the maximum slope of the majority of the preliminary support surface in the first position is at most 50°, preferably at most 40°, particularly preferably at most 30°. Preferably, the maximum slope of the preliminary support surface in the second position is at least 70°, preferably up to 90°. All intermediate numbers of degrees are also hereby disclosed. The preliminary support surface may also have a slope in one of the intermediate numbers of degrees.

[0014] Since the preform is produced in the first position and the aim is to prevent any slipping of the still–dry layers relative to one another, the maximum slopes must be particularly small. Once the preform is complete, a pivoting even into a very steep second position can take place. This is even necessary since, particularly along the aerodynamic rotor blade leading edge, but also along the rotor blade trailing edge, vertical or almost vertical orientations of the preform are necessary when using trailing edge terminating webs.

[0015] Advantageously, layers which are already coated with an adhesive, for example a resin powder, or which are provided with a resin powder and adhered to one another while heat is supplied, are laid onto the preliminary support surface. This adhering of the layers according to the described variant A leads to production of the preform, but this is then not yet a fully infused laminate component. The final lamination process or curing process for preforms according to variant B does not take place until the preform has been placed into the production mould.

[0016] Preferably, the partial pre–mould is pivoted about a horizontal axis. However, it is also conceivable that the partial pre–mould is pivoted about a differently oriented axis, possibly even about a plurality of axes in succession or simultaneously. This depends on how the partial pre–mould and the production mould are arranged relative to one another.

[0017] Advantageously, the translational movement takes place in such a way that the preform is lifted off from the support surface of the partial pre–mould, then is translationally moved above the production mould and then set down onto the support surface of the production mould. In principle, however, it is not only purely linear movements that are conceivable, but also arcuate movements; however, the latter are composed of purely translational components.

[0018] Preferably, at least one further partial pre–mould is provided in which at least one further preform is produced. Using translational movements, the further preform is lifted out of the further partial pre–mould and is moved into a further end position in the production mould by placing the further preform onto the support surface of the production mould. In this way, for example, a respective partial pre–mould is provided for the leading edge and trailing edge of the rotor blade. The method according to the invention also includes at least one further partial pre–mould, by means of which a preform is produced which, for example, connects the preforms of the leading edge and trailing edge to one another.

[0019] A plurality of preforms, in particular two, three or any greater number of preforms, can therefore be used to produce a rotor blade half–shell. Advantageously, the preforms cover the entire surface of the rotor blade in regions, but it is also possible for only smaller regions of the rotor blade surface to be covered by the preforms, for example along the leading edge and trailing edge of the rotor blade and especially the terminating web.

[0020] The object in its second aspect is achieved by a production arrangement having the features of claim 8.

[0021] The production arrangement is particularly suitable for carrying out one or more of the methods mentioned above.

[0022] The production arrangement comprises at least one partial pre–mould with a preliminary support surface for a preform and a production mould with a support surface for a rotor blade half–shell and a pivoting mechanism on the partial pre–mould by which the partial pre–mould with its preliminary support surface can be moved into a first position in which the preliminary support surface is oriented horizontally, and the preform can be produced on the preferably substantially horizontally oriented preliminary support surface, and by which the partial pre–mould can be pivoted by the pivoting mechanism into a second position in which the preform, in terms of its rotational position or rotational orientation, corresponds in the space to its end position in the production mould. The production arrangement additionally comprises a translation mechanism or device by which the preform can be moved out of the second position of the partial pre–mould into an end position on the support surface of the production mould by purely translational movements.

[0023] What is essential to the invention in the case of the production arrangement is that the preform is produced separately, i.e. outside of the production mould for the rotor blade half–shell, and the preform is oriented by separate rotational and translational movements. The rotational orientation of the preform takes place by means of a pivoting mechanism on the partial pre–mould, while the translational movement takes place by means of a separate translation mechanism or a device. This may be a lifting/lowering mechanism, for example cables which are guided over rollers and the ends of which are temporarily fastened to the preform, and a horizontal movement mechanism. This may be, for example, a runner which is movable back and forth horizontally on rails. Of course, other designs of a translation mechanism are also conceivable.

[0024] In one particularly advantageous embodiment of the method according to the invention, the translation mechanism consists of a steel tubing framework with cantilevers, which spans the surface of the preform in a substantially horizontal manner.

Attached vertically to this steel tubing framework are cables, chains or rods, which are adjustable in terms of their vertical position or length such that they all simultaneously touch the surface of the preform. Mounted on these vertical elements are holding devices, for example vacuum cups or needle grippers, which are suitable for lifting the preform out of the partial pre–mould. The number of vertical elements and holding devices is adapted to the weight of the preform. Also attached to the steel tubing framework are securing elements, for example straps, which, once the preform has been lifted out of the partial pre–mould, are placed around the preform in order to be able to catch it if the holding devices fail. The translation mechanism can be moved by means of an overhead crane and is supplied with electricity via the latter in order to supply energy to the necessary subsystems for the holding devices, for example vacuum blowers and/or compressed air, which are mounted on the translation mechanism. Preferably, the partial pre–mould has a maximum slope of the majority of the preliminary support surface in the first position of at most 50°, preferably at most 40°, particularly preferably at most 30°, while the partial pre–mould has a maximum slope of the preliminary support surface in the second position of at least 70°, preferably at least 80°, particularly preferably up to 90°.

[0025] With particular preference, the production arrangement comprises at least one further partial pre–mould in which at least one further preform can be produced, and at least one further translation mechanism, although the latter may also coincide with the translation mechanism; wherein the further translation mechanism is provided for moving the at least one further preform by translational movement out of a further first position into a further second position. In the further second position, which corresponds to the second position of the preform, the further preform has assumed its second end position in terms of its rotational position. Without further rotational movement, therefore, the further preform can be placed from the further partial pre–mould into its assigned place in the production mould.

[0026] It may be advantageous to have an individual translation device for each preform. However, the method according to the invention also includes the possibility that the vertical elements of the one translation device are adjustable in such a way that the translation device is suitable and can be used to move a plurality of preforms from the respective partial pre–mould into the production mould.

[0027] The invention will be described on the basis of an exemplary embodiment in six figures, in which:

Fig. 1 shows a schematic side view of a partial pre–mould with a preform in a first position,

Fig. 2 shows the partial pre–mould with a preform in a second position, with a translation device,

Fig. 3 shows a production mould with a translation device and with a first preform placed in the production mould,

Fig. 4 shows a further preform in a further first position of the partial pre–mould, the partial pre–mould not being shown,

Fig. 5 shows the further preform in a further second position of the partial pre–mould, the partial pre–mould not being shown,

Fig. 6 shows the further preform in the further end position in the production mould, the production mould not being shown.

[0028] Figs. 1, 2 and 3 show a production arrangement according to the invention. The production arrangement comprises a production mould 1, shown in Fig. 3, for a rotor blade half–shell in a cross–section perpendicular to a longitudinal direction L of the rotor blade, as well as a first partial pre–mould 2, which is shown in Figs. 1 and 2. The partial pre–mould 2 is shown in a first position in Fig. 1 and in a second position in Fig. 2. The partial pre–mould 2 is mounted such as to be pivotable about an axis 3. To this end, a hydraulic, pneumatic and optionally also electric drive (not shown) is provided.

[0029] Of course, in order to produce a complete rotor blade, a further production arrangement is also required, comprising at least one further production mould in which the complementary rotor blade half–shell can be produced.

[0030] In the pre–mould 2, a preform 4 is produced, whereas in the production mould 1 – the actual main mould – the preform 4 is brought together with further preforms (not shown), which are produced in further partial pre–moulds (not shown), as well as with further fabric layers or scrim layers and further sandwich materials and further prefabricated and cured fibre composite components (e.g. the straps), and the rotor blade half–shell is manufactured in a lamination process from the preforms 4 and the further components listed above.

[0031] The production mould 1 shown in Fig. 3 is an example of a production mould 1 in which a rotor blade half–shell or a rotor blade part–shell or other sections and regions of a rotor blade shell are produced.

[0032] What is essential to the invention is that some regions of the production mould 1 run very steeply, almost or even exactly vertically relative to the ground. In the production mould 1 for a rotor blade half–shell in Fig. 3, these are the regions arranged on the right and on the left in Fig. 3, i.e. the regions along the rotor blade leading edge and the rotor blade trailing edge.

[0033] When producing the rotor blade half–shell using the lamination method in the conventional manner, first a plurality of layers, for example fibre–containing fabric layers, fibre–containing scrim layers, foams, balsa wood, etc., are laid one on top of the other and/or one next to the other. Particularly the fabric layers and scrim layers, but also the other layers, are initially dry and therefore readily slip on one another. Therefore, particularly at the vertical regions of the rotor blade leading edge and the rotor blade trailing edge of the production mould 1 shown in Fig. 3, measures must be taken so that the layers placed one on top of the other do not slip towards the centre of the production mould 1. By way of example, the layers must first be provisionally adhered to one another by means of adhesive. Other fixing aids may also be used where necessary. The partial pre–mould 2 shown in Figs. 1 and 2 is provided in order to avoid these measures. The partial pre–mould 2 is provided in order to create a region which is largely vertical, but at least very steep, in the production mould 1, said region encompassing the rotor blade half–shell. In Fig. 1, this is the rotor blade leading edge, for example. The partial pre–mould 2 may also be the partial pre–mould 2 for producing the rotor blade trailing edge. Modern rotor blades in particular have a rotor blade trailing edge which no longer runs out in a flat manner, but rather have at least in the root region a trailing edge terminating web 20 which runs substantially perpendicular to a rotor blade chord of the rotor blade. In order to produce a rotor blade trailing edge terminating web as well, it is therefore necessary in principle, if the latter is manufactured simultaneously and integrally with a rotor blade half–shell, to arrange the individual layers, which extend largely vertically, or at least very steeply, one next to the other for the lamination process and to fix them in advance relative to one another and relative to the production mould in order to avoid any slipping of the layers.

[0034] The invention makes use of the idea of manufacturing regions of the rotor blade half–shells separately as preforms 4 and of rendering pivotable the partial pre–moulds 2 required for producing the steep regions of the rotor blade half–shell. As a result, it is possible, inter alia, to prefabricate the first preform 4 in a position oriented substantially horizontally. The individual layers of the laminate can therefore be layered one on top of the other largely horizontally relative to the ground, so that there is no longer any risk of the layers slipping relative to one another.

[0035] Fig. 1 shows the partial pre–mould 2 for producing the preform 4, in this case the rotor blade leading edge, in a first horizontal position. Here, "horizontal" is to be understood to mean a position in which the slope of the preliminary support surface is at most 30°, preferably at most 20°, particularly preferably at most 10°, or any number of degrees between these specified numbers of degrees, or even fewer degrees. It is therefore not necessary that every region of the preliminary support surface is formed or arranged strictly horizontally. The number of degrees of the greatest slope of the preliminary support surface also depends on the materials used to produce the preform 4. The slope should be selected such that, when the layers of the laminate lie one on top of the other in the dry state, the friction between the layers is great enough to prevent the layers from automatically slipping relative to one another.

[0036] As shown in Fig. 1, the dry layers are prefabricated in the partial pre–mould 2 to form a semi–finished product, i.e. the layers are provided with an adhesive and are heated in vacuo (without heating in the case of preforms of variant B) and thus are adhered to one another without the layers having to be fixed in advance relative to one another or relative to the partial pre–mould for this process.

[0037] However, it is also conceivable that the preform 4 is already completely laminated by placing a plurality of layers, for example fibre–containing fabric layers, fibre–containing scrim layers, foams, balsa wood, etc., one on top of the other and/or one next to the other in order to produce the preform 4 in the partial pre–mould 2. The layers thus arranged form a preferably dry semi–finished product. The semi–finished product is infused with a resin system in methods such as resin injection moulding (RIM method) or resin transfer moulding (RTM method). The resin system cures in an initially exothermic chemical reaction, followed by heat being supplied within the semi–finished product. After passing through a so–called exothermic peak in the exothermic reaction, heat is externally supplied to the resin–impregnated semi–finished product in order to keep it at a low process temperature. At the process temperature, the resin system then cures completely and crosslinks. Usually, the semi–finished product is positioned in the specified layering on the preliminary support surface of the partial pre–mould 2 and, once the layering is complete, is sealed with a vacuum film at the edges of the partial pre–mould 2. The vacuum film and/or partial pre–mould 2 have a plurality of inlets and outlets, through which the liquid resin system can be sucked into the semi–finished product. The resin system is preferably a two–component adhesive.

[0038] By pivoting the partial pre–mould 2 as shown in Fig. 2, the prefabricated preform 4 is first brought into a position which, in terms of the three axes of rotation, corresponds exactly to the position that the preform 4 will have in the production mould 1. Only once the partial pre–mould 2 has been pivoted into the second position is the preform 4 connected to a translation device 6. The translation device 6 is a combined lifting/moving device, by which the preform 4 can first be lifted out of the partial pre–mould 2, perpendicularly to the ground, then moved above the production mould 1, parallel to the ground, and once over the production mould 1 can subsequently be lowered into the production mould 1, again perpendicularly to the ground, until the preform 4 is in contact with the support surface of the production mould 1 as shown in Fig. 3. What is advantageous in this method is that the problematic rotation or pivoting of the preform 4 no longer has to take place by means of a translation device 6 itself, but instead takes place in a secure and well–supported manner in the partial pre–mould 2.

[0039] In order to produce the complete rotor blade half–shell, a further preform can then be produced for example in a further partial pre–mould and can then analogously be lifted out of the further partial pre–mould, moved and lowered using the same translation device 6 or another translation device. The preform 4 and the further preform would then be positioned one next to the other or in an overlapping manner, for example along a section of the rotor blade leading edge and along a section of the rotor blade trailing edge, perpendicularly to the longitudinal direction L, and together with further fibre layers and further sandwich material form a rotor blade half–shell. The two preforms 4 are laminated together with the further fibre layers and further sandwich material in a lamination process in the production mould 1 in order to form the rotor blade half–shell, provided that the lamination process has not yet been completely carried out in the partial pre–mould 2, the layers in particular having only been fixed to one another.

[0040] Figs. 4, 5 and 6 show the trailing edge terminating web 20. The trailing edge terminating web 20 is illustrated in its actual spatial position. The trailing edge terminating web 20 comprises a first and a second core material 21, 22, which are arranged one next to the other, and an inner strip 23 attached to the inside of the first core material 21. The trailing edge terminating web 20 is covered on the inside and outside of the rotor blade by an inner skin 24 and an outer skin 25, respectively. The core materials 21, 22 may be a first and a second foam, but other core materials 21, 22 are also conceivable.

[0041] Fig. 4 shows the arrangement of the first core material 21 and the second core material 22 and of the inner skin 24 and the outer skin 25 in the first position in the first partial pre–mould 2. The partial pre–mould 2 itself is not shown. It can clearly be seen that the first core material 21 and the second core material 22 are arranged substantially horizontally one next to the other. Furthermore, the inner strip 23 is arranged above the first core material 21 perpendicular to the ground. The inner strip 23, the first core material 21 and the second core material 22 are covered by the inner skin 24, which likewise has a substantially horizontal orientation. Here, too, horizontal is to be understood to mean that the greatest slope relative to the ground is at most 30°, preferably at most 20°.

[0042] The trailing edge terminating web 20 shown in Fig. 4 is formed into a preform according to variant A or B. The trailing edge terminating web 20 is then pivoted in the counter–clockwise direction into its second position shown in Fig. 5. The rotational movement therefore does not correspond to the rotational movement shown in Figs. 1 and 2, but is instead a rotational movement in the opposite direction. The trailing edge terminating web 20, pivoted into the second position shown in Fig. 5, is then lifted by means of the translation device 6 shown in Figs. 2 and 3 and then is moved from a position above the further partial pre–mould into a position above the production mould 1 and lowered from its position above the production mould 1 onto the production mould 1 until the trailing edge terminating web 20 is in contact with the support surface of the production mould 1. Here and also in the application as a whole, the terms “above” and “below” are to be understood in relation to the ground.

[0043] The trailing edge terminating web 20 can then be placed onto the preform 4, which has already been produced in the production mould 1 or likewise lifted into the production mould 1, or can be positioned next to the preform 4, and then can be laminated together with the latter and with further fibre layers and/or sandwich material.

In principle, it is of course conceivable that, when a plurality of preforms 4 are applied to the production mould 1, the preforms 4 are not all placed entirely directly on the support surface of the production mould 1; instead, overlaps may also occur or individual preforms 4 may also be placed entirely or largely on an inner side of already placed preforms 4.

List of reference signs

[0044]

1	production mould
2	partial pre–mould
3	axis
4	preform
6	translation device
20	trailing edge terminating web
21	first core material
22	second core material
23	inner strip
24	inner skin
25	outer skin
L	longitudinal direction

PATENTKRAV

1. Fremgangsmåde til fremstilling af en rotorbladsdelskål, idet

der tilvejebringes mindst én delforform (2) med en forstøtteflade og en fremstillingsform (1) med en støtteflade til rotorbladsdelskålen, og

delforformen (2) bringes med sin forstøtteflade til en første position, i hvilken forstøttefladen orienteres horisontalt, og

der på den horisontalt orienterede forstøtteflade fremstilles en preform (4), delforformen (2) drejes i en anden position, i hvilken preformen (4) hvad angår sin drejeposition svarer til en slutposition i fremstillingsformen (1), og preformen (4) via translatoriske bevægelser bringes ud af den anden position af delforformen (2) til en slutposition i fremstillingsformen (1), og preformen (4) lægges på fremstillingsformens (1) støtteflade, **kendetegnet ved, at** der anvendes en maksimal stigning af forstøttefladen i forhold til jorden i den første position på højst 50 °, og forstøttefladen er udformet konkavt.

2. Fremgangsmåde ifølge krav 1,

kendetegnet ved, at der anvendes en maksimal stigning af forstøttefladen i forhold til jorden i den første position på højst 40 °.

3. Fremgangsmåde ifølge krav 1 eller 2,

kendetegnet ved, at der anvendes en maksimal stigning af forstøttefladen i den anden position på mindst 70 °, foretrukket mindst 80 °, foretrukket op til 90 °.

4. Fremgangsmåde ifølge et af kravene 1 til 3,

kendetegnet ved, at der på forstøttefladen lægges lag, som forsynes med et klæbemiddel og klæbes sammen med hinanden ved varmetilførsel.

5. Fremgangsmåde ifølge krav 1 eller 2,

kendetegnet ved, at delforformen (2) drejes om en horisontal akse (3).

6. Fremgangsmåde ifølge et af kravene 1 eller 2,

kendetegnet ved, at preformen (4) løftes fra delforformens (2) støtteflade, bringes hen over fremstillingsformen (1) og sænkes ned på fremstillingsformens (1) støtteflade.

7. Fremgangsmåde ifølge et af foregående krav,

kendetegnet ved, at der tilvejebringes mindst én yderligere delforform (2), i hvilken der fremstilles mindst én yderligere preform (4),

den yderligere preform (4) via translatorisk bevægelse bringes ud af delforformen (2) til en yderligere slutposition i fremstillingsformen (1), idet den yderligere preform (4) lægges på fremstillingsformens (1) støtteflade.

8. Fremstillingsindretning til gennemførelse af en af fremgangsmåderne ifølge krav 1 til 7,

med mindst én delforform (2) med en forstøtteflade til en preform (4) og en fremstillingsform (1) med en støtteflade til en rotorbladsdelskål og en drejemekanisme på delforformen (2), med hvilken delforformen (2) med sin forstøtteflade kan bringes til en første position, i hvilken forstøttefladen er orienteret horisontalt, hvor

preformen (4) kan fremstilles på den horisontalt orienterede forstøtteflade, og med hvilken delforformen (2) kan drejes i en anden position, i hvilken preformen (4) hvad angår sin drejeposition svarer til en slutposition i fremstillingsformen (1), og en translationsmekanisme, med hvilken preformen (4) kan bringes ud af den anden position af delforformen (2) til en slutposition i fremstillingsformen (1), hvor delforformen (2) har en maksimal stigning af forstøttefladen i forhold til jorden i den første position på højst 50 °, og forstøttefladen er udformet konkavt.

9. Fremstillingsindretning ifølge krav 8,

kendetegnet ved, at delforformen (2) har en maksimal stigning af forstøttefladen i forhold til jorden i den første position på højst 40 °.

10. Fremstillingsindretning ifølge krav 8 eller 9,

kendetegnet ved, at delforformen (2) har en maksimal stigning af forstøttefladen i den anden position på mindst 70 °, foretrukket mindst 80 °.

11. Fremstillingsindretning ifølge krav 8, 9 eller 10,

kendetegnet ved mindst én yderligere delforform (2), i hvilken der kan fremstilles mindst én yderligere preform (4), mindst én yderligere translationsmekanisme, med hvilken

den mindst yderligere preform (4) via translatorisk bevægelse kan bringes ud af den mindst én yderligere delforform (2) til en slutposition i fremstillingsformen (1), hvor den yderligere preform (4) ligger på fremstillingsformens (1) støtteflade.

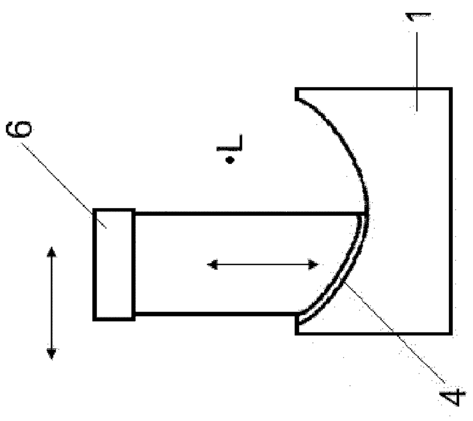

Fig. 3

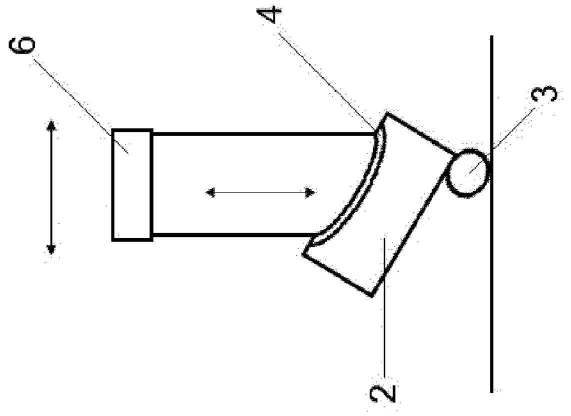

Fig. 2

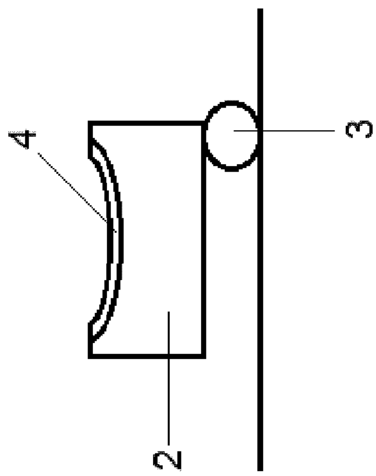

Fig. 1

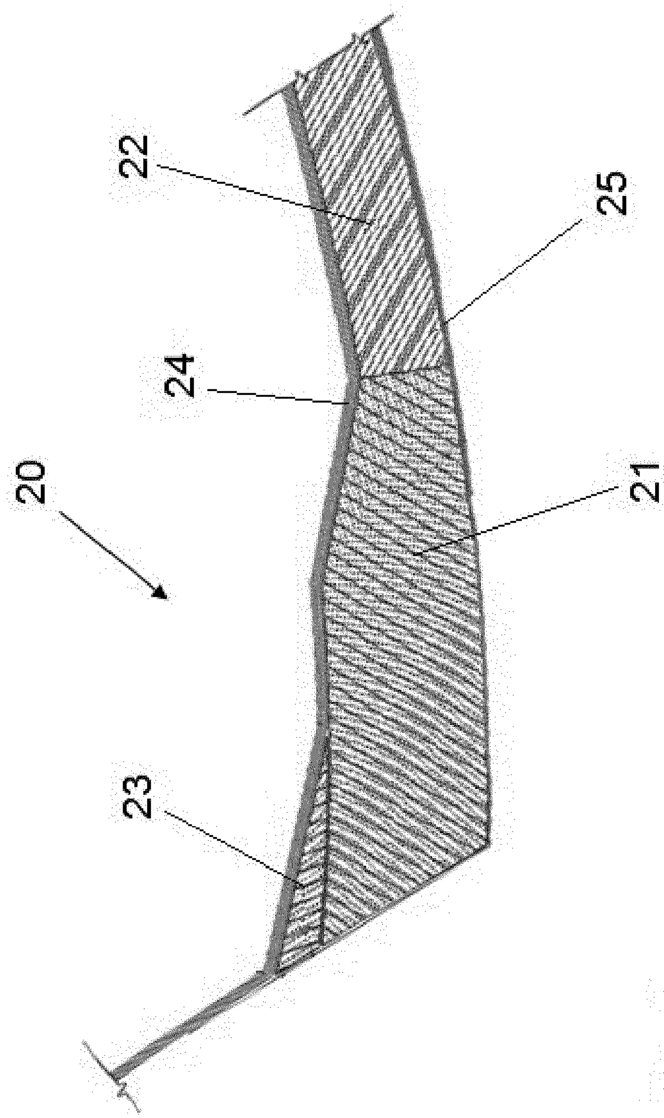

Fig. 4

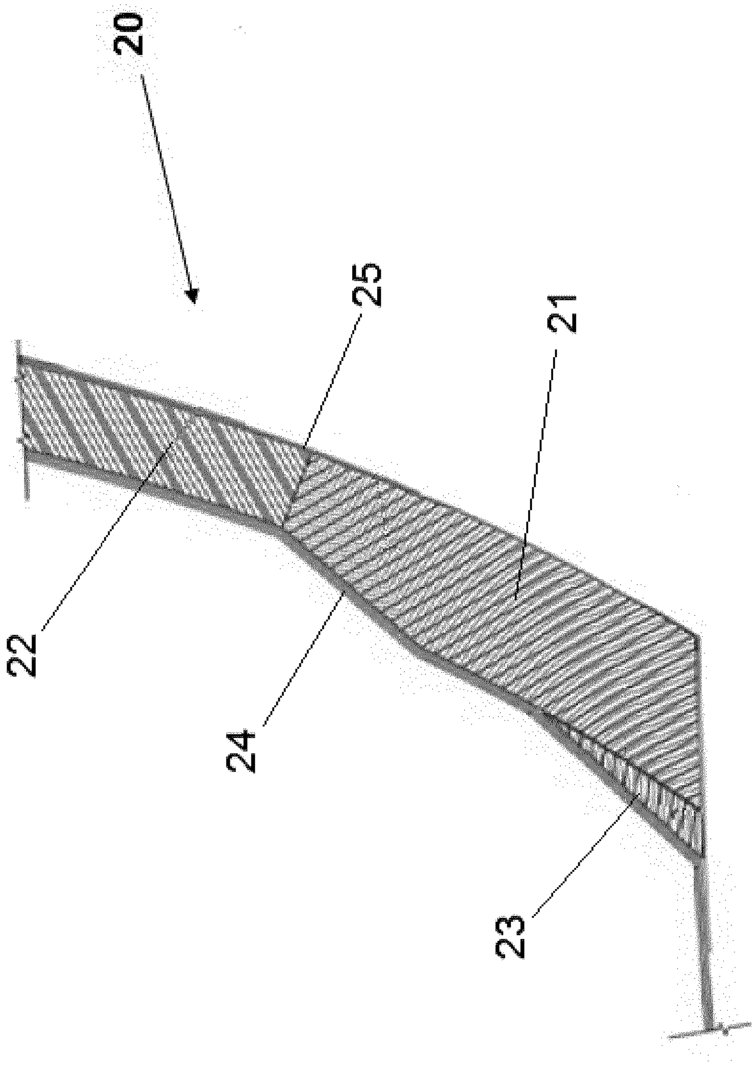

Fig. 5

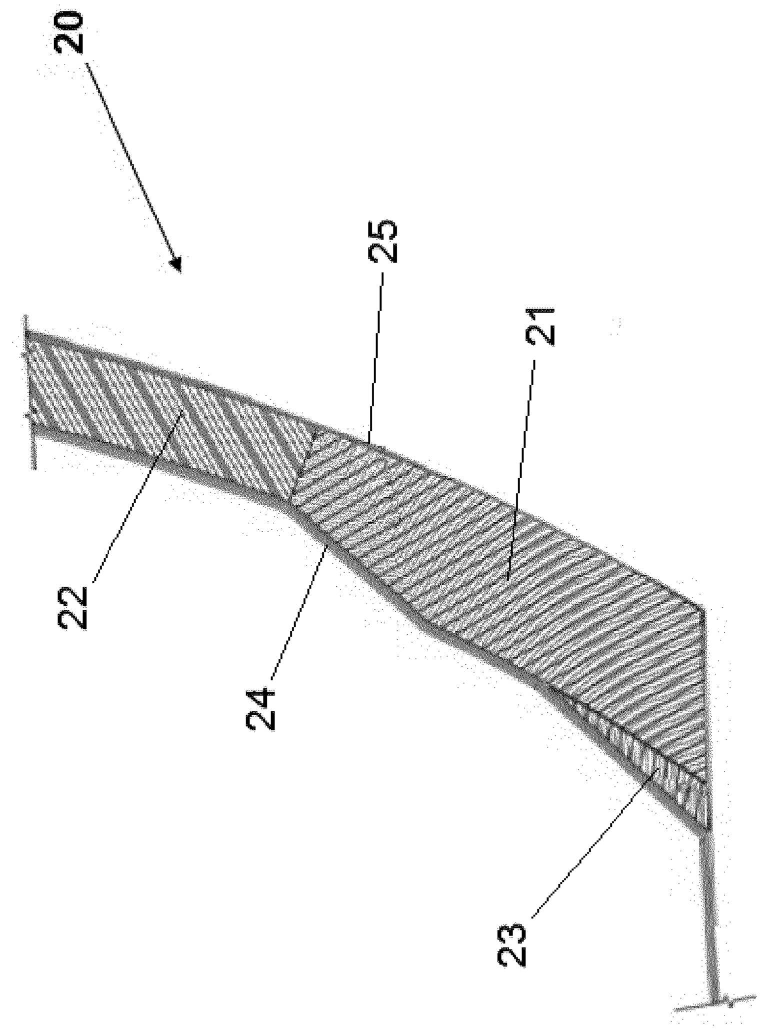

Fig. 6