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DESCRIPTION

[0001] The invention relates to a method of manufacturing fibre-reinforced blades for wind power plants. The invention also relates to an apparatus for laying fibre material on a mould adapted for the manufacture of a fibre-reinforced blade for a wind power plant.

[0002] According to one aspect, the invention relates to a method of manufacturing fibre-reinforced blades for wind power plants whereby a number of layers of material comprising fibre are arranged on a curved surface of an elongated open mould, so that some of the layers of material overlap at least partially.

Background

[0003] In the context of manufacturing fibre-reinforced parts for wind power plants such as blades, a manufacturing process is typically employed in which a part is moulded in two halves in each their open mould, wherein a coat e.g. of gelcoat is initially applied onto the interior surface of the open mould.

[0004] A number of layers of fibre material, or mats, are subsequently arranged in the mould, typically by hand, following which resin is finally applied, typically by injection into the closed mould, to attach the individual layers of fibre material to each other. The resin can be applied to the layers manually by RTM (resin transfer moulding), VARTM (vacuum assisted resin transfer moulding) or other suitable methods. Alternatively the resin can be applied to the laminate layers prior to laying the layers (Prepeg). In the context of this, gelcoat will harden and form the surface of the product.

[0005] Arranging the layers of fibre material, or mats, within the interior of a mould is today a time-consuming and labour intensive process. Depending of the size of the part to be manufactured, and thereby the size of the mould, walkways may be arranged alongside and/or above the mould such that the workers are allowed to walk along the edge or periphery of the mould and/or above the mould in order to arrange the layers of fibre material as required.

[0006] Multiple rolls of fibre material comprising different types of fibre material are arranged on the walkways, such that the workers may pick suitable rolls comprising the required materials and arrange the materials on the form.

[0007] During the layup of fibre material, combined efforts of several workers are required, as the fibre material is heavy and not easy manipulable. Some workers assist in the rollout of material, while other workers positioned along the edge of the mould make sure that the layers are laid up correctly.

[0008] In order to secure a desired strength and stability of the part to be manufactured, it is

of utmost importance that the layers are arranged correctly and without dents or wrinkles and the like.

[0009] Depending on the application and structure of the part to be manufactured, multiple layers of fibre material may be arranged within the mould and the layers are typically arranged on top of each other or next to each other possibly with overlapping edges.

[0010] The parts typically consist of as many as fifty or more layers of material, i.e. mats, and the parts are typically built up from a main laminate provided in the centre of the mould.

[0011] After a layer which is provided from a roll is arranged on the mould, the material is cut from the roll. Manufacturing of parts having curvature throughout the length of the part, such as a blade for a wind power plant, may require very long cuts along the edges of the mould. the length of the part, such as a blade for a wind power plant, may require very long cuts along the edges of the mould.

[0012] Moulds for manufacturing such parts may be very large, and the moulds are as a consequence expensive. The time required for the arrangement of material on the mould should be kept at a minimum such that the form time (the time which a part occupies the mould) required by a part to be manufactured is kept at a minimum, thus increasing the overall productivity of the mould.

[0013] US 2007107189 A (PRICHARD et al./Boeing) suggests a method of manufacturing composite aircraft wings of varying sizes and forms by means of a tool assembly comprising a tool plate encompassing a movable surface configured to support the material from which the wing will be manufactured. An automated tape-laying machine applies the material to the tool surface to form the product. The material may constitute fibre-reinforced resin materials including graphite/epoxy and/or other composite materials commonly used in the manufacture of structural components, including, for example, glass, carbon, and/or aramid fibres carried in a polymer matrix of epoxy, vinyl ester, or polyester thermosetting plastic. The tape-laying machine applies the fibre material in a predetermined number of layers, and in a predetermined pattern and orientation which corresponds to the particular type of product to be manufactured. After the various pieces of fibre material have been applied to the tool surface, the composite lay-up is evacuated and compressed under a suitable vacuum system for curing.

[0014] US 4699683 A (MCCOWIN/Boeing) teaches a fibre laminator for simultaneously laying down a strip of parallel, flat fibre rovings (a long and narrow bundle of fibre with a twist to hold the fibre together). A head for dispensing the rovings to be laid down is supported by a gantry which includes mechanisms for moving the dispensing head longitudinally along three orthogonal axes and rotationally about a vertical axis. The head for dispensing comprises a tack down roller applying pressure, via an air insulator cushion, onto the rovings towards the underlying contoured surface of the tool, such that constant pressure over slight elevation changes is maintained.

[0015] The fibre material is preferably arranged substantially even and flush, which is why any developed dents, wrinkles or curls etc. should be smoothed out. Further, as one layer is typically applied on top of a preceding layer, the lower layer incl. possible additional layers arranged below the lower layer, tend to move or slide within the mould causing the entire layup of fibre material to move away from an intended position within the mould.

[0016] It is thus an object of the invention to provide a solution to the above drawbacks.

[0017] This is accomplished by the method of manufacturing a fibre-reinforced part as per the introductory part of this specification, wherein each layer of material is positioned on the mould by means of a number of rollers provided on a cart being conveyed along the open mould, whereby at least some of the rollers are displaced mutually during the conveyance of the cart so that the rollers substantially follow a intended contour of the layer of material.

[0018] The method according to the present invention substantially reduces the required form time required by the manufacturing of a part, and further, the method is able to reduce the efforts required by workers in order to lay up the fibre material.

[0019] Finally, the method significantly increases the overall quality of the parts being manufactured as the layup of layers is greatly improved by inter alia by the rollers being displaceable towards and away from the mould such that stretch and applying angle is controllable.

[0020] According to one embodiment, the material comprising fibre is unrolled from one or more rolls comprising material while the rolls comprising material are conveyed along the mould.

[0021] According to one embodiment, the material comprising fibre is unrolled from one or more rolls comprising material by means of an unrolling arrangement drawing the material from one or more rolls.

[0022] According to one embodiment, the rolls comprising material incl. the displaceable rollers are at least partially accommodated by a dispenser provided on the cart such that the material is arranged on the mould simultaneously with the material being unrolled from one or more rolls comprising material.

[0023] According to one embodiment, the dispenser is pivoted during conveyance, such that the rolls comprising material and the rollers assume different angular orientations.

[0024] According to one embodiment, the displaceable rollers are displaced towards or away from the mould by means of actuators.

[0025] According to one embodiment, the displacement of the rollers is controlled by

processing means such as a computer.

[0026] According to one embodiment, processing means controls the displacement of rollers according to a prescribed procedure.

[0027] According to one embodiment, the processing means utilizes distance or height measurements provided by one or more sensors adapted to read a height of a layer of material arranged on the mould with respect to a reference and/or a total thickness of the layers arranged on the mould.

[0028] According to one embodiment, the layers of material are cut automatically from the roll comprising material upon the layer being arranged on the mould.

[0029] According to one embodiment, the layers are provided in the form of a number of pre-cut pieces rolled onto a single or a plurality of rolls comprising material.

[0030] According to one embodiment, a plurality of rolls is arranged as a "revolver drum" comprising a number of rolls comprising material with different properties.

[0031] In an embodiment, a mutual angle formed between axes of rotation of neighbouring rollers is changed during the conveyance of the cart along the open mould. Thereby, it may be possible to continuously adapt the orientation of the rollers to the actual configuration of the mould. Furthermore, it may be possible, during the conveyance of the cart along the open mould, to spread the layer of material outward from a central area in order to avoid wrinkles or the like.

[0032] In an embodiment, the layers of material, during the conveyance of the cart along the open mould, by means of varying orientation of roller axes of different rollers in a row formed by the rollers, are spread outward from a central area of said row formed by the rollers in the direction of end areas of said row formed by the rollers. Thereby, wrinkles or the like of the layer of material laid out may be avoided.

[0033] In an embodiment, the layers of material, during the conveyance of the cart along the open mould, by means of rollers having varying diameter along their roller axes, are spread outward from a central area of a row formed by the rollers in the direction of end areas of said row formed by the rollers. Thereby, wrinkles or the like of the layer of material laid out may be avoided.

[0034] In an embodiment, during the conveyance of the cart along the open mould, rollers in a central area of a row formed by the rollers are being advanced in front of rollers in end areas of said row formed by the rollers. Thereby, it may be possible, during the conveyance of the cart along the open mould, to spread the layer of material outward from a central area in order to avoid wrinkles or the like.

[0035] The invention further relates to an apparatus for manufacturing fibre-reinforced parts such as blades for wind power plants, the apparatus being adapted to arrange a number of layers of material comprising fibre on a curved surface of an elongated open mould, so that some of the layers of material overlap at least partially, said apparatus comprising a cart adapted to be conveyed along the open mould.

[0036] The apparatus is characterized in that a number of rollers are provided on the cart and are adapted to position each layer of material on the mould, and in that at least some of the rollers are mutually displaceable during the conveyance of the cart so that the rollers substantially may follow an intended contour of the layer of material.

[0037] According to one embodiment, the apparatus comprises an applicator, pivotally connected to the cart, and accommodating rollers being displaceable towards and away from the mould.

[0038] According to one embodiment, the rollers are displaceable by means of actuators.

[0039] According to one embodiment, the actuators are controlled by processing means such as a computer or equivalent.

[0040] According to one embodiment, the processing means comprises software allowing the processor to control the displacement of the rollers according to a prescribed procedure.

[0041] According to one embodiment, the apparatus further comprises one or more sensors adapted to read a height of a layer of material arranged on the mould with respect to a reference and/or a total thickness of the layers arranged on the mould.

[0042] According to one embodiment, applicator accommodates a roll comprising material to be arranged on said mould.

[0043] According to one embodiment, the applicator accommodates an unrolling arrangement adapted to facilitate unrolling of material to be arranged on the mould.

[0044] According to one embodiment, the applicator accommodates a roll comprising material in the form of a "revolver drum" comprising a number of rolls each comprising material with different properties.

[0045] According to one embodiment, the actuators constitute pneumatic actuators.

[0046] In an embodiment, at least some of the rollers are arranged so that the orientations of their axes of rotation are individually adjustable. Thereby, it may be possible to continuously adapt the orientation of the rollers to the actual configuration of the mould. Furthermore, it may be possible, during the conveyance of the cart along the open mould, to spread the layer of material outward from a central area in order to avoid wrinkles or the like.

[0047] In an embodiment, at least some of the rollers are arranged so that the orientations of their axes of rotation are individually adjustable seen from above the apparatus. Thereby, it may be possible, during the conveyance of the cart along the open mould, to spread the layer of material outward from a central area in order to avoid wrinkles or the like.

[0048] In an embodiment, seen from above the apparatus, the rollers are arranged on the cart so that rollers in a central area of a row formed by the rollers are positioned at an advanced position, seen in the direction of conveyance of the cart, relative to rollers in end areas of said row formed by the rollers. Thereby, it may be possible, during the conveyance of the cart along the open mould, to spread the layer of material outward from a central area in order to avoid wrinkles or the like.

[0049] In an embodiment, seen from above the apparatus, the rollers are arranged on the cart in a row substantially having the form of a V.

[0050] In an embodiment, seen from above the apparatus, the rollers are arranged on the cart in a row substantially having the form of a semi-circle.

[0051] In an embodiment, seen from above the apparatus, the rollers are arranged on the cart in a row so that an angle between a transverse direction to the direction of conveyance of the cart and the direction of the axis of rotation of the individual rollers is increasing from a central area of the row of rollers towards end areas of the row of rollers. Thereby, it may be possible, during the conveyance of the cart along the open mould, to spread the layer of material outward from a central area in order to avoid wrinkles or the like.

[0052] In an embodiment, the rollers are arranged on the cart in a row, and in that at least some of the rollers are substantially conical with a cone angle of the individual rollers that is increasing from a central area of the row of rollers towards end areas of the row of rollers. Thereby, it may be possible, during the conveyance of the cart along the open mould, to spread the layer of material outward from a central area in order to avoid wrinkles or the like.

Brief description of the figure

[0053] The invention will now be explained in more detail below by means of examples of embodiments with reference to the very schematic drawing, in which

Figure 1 shows a cross-section through a part, such as a root part, of an open mould and an apparatus incl. an applicator in one position.

Figure 2 shows a cross-section through a part of an open mould and an apparatus incl. an applicator in a position being different from the position as illustrated in figure 1.

Figure 3 shows a cross-section through a part, such as an airfoil part, of an open mould and

the applicator of the apparatus shown in Figs 1 and 2.

Figure 4 to 6 show different embodiments of a row of rollers of the apparatus of Fig. 1.

Detailed description with reference to the figures

[0054] Figure 1 shows a sectional view of an open mould 1, which in the illustrated scenario accommodates a plurality of layers, or mats, 10 of fibre material.

[0055] The layers 10 are illustrated as having a width or breadth corresponding substantially to the breadth of interior surface of the mould 1. The layers 10 could however equally have been illustrated as juxtaposed or overlapping layers. The mould 1 may typically constitute an elongated mould having a length corresponding substantially to the length of the part or sub-part to be manufactured inter alia from the layers 10.

[0056] The layers 10 may constitute pre-cut pieces intended for a particular site of application within the mould 10 and the pre-cut pieces may, prior to being arranged on the mould 1, be rolled onto a roll 90. As an equal alternative, the fibre material applied to the mould 1 may simply constitute an "endless" length of material being rolled onto a roll 90 which upon the material being arranged within or on the mould 1, is cut from the roll 90.

[0057] The roll 90 may constitute a "revolver drum" (not shown) configured for accommodating two or more rolls, such that fibre material with different properties, such as dimensions and the like, may be arranged onto the mould 1 without disturbing the process of laying up one or more layers of fibre material.

[0058] Within the mould 1, an applicator 50 is suspended from an arm 60 of a cart 70. The cart 70 may comprise wheels 75 allowing the cart 70 to move along the sides of the mould 1. Alternatively, other means for conveying the cart 70 along the mould may be applied. According to one not illustrated embodiment, the cart 70 is conveyed along the mould by means of a dedicated track-system arranged directly or indirectly on the mould 1.

[0059] The applicator 50 may be rotationally connected to the arm 60 via pivot 55, such that the applicator 50 may, freely or not, assume various angular positions. The axis of the pivot 55 may be oriented substantially in a longitudinal axis of the mould and/or substantially parallel to the direction of conveyance of the cart 70.

[0060] The applicator 50 and/or the cart 60 may be provided with means (not shown) for rotating the applicator 50 about the pivot 55.

[0061] The cart 70 and/or the arm 60 may be provided with means allowing the pivot 55 to

move or shift between any position above the mould 1 such that the applicator 50 is allowed to facilitate arrangement of fibre material, or mats, on a mould, or a part of a mould which is not substantially circular as shown in figure 1 & 2. Typically a mould for manufacturing blades for wind power plants is in one end substantially circular, such as shown in figure 1 & 2 which illustrates a section of a mould for manufacturing the end of the blade, the root section, facing the hub. The blade, and thereby the mould continuously changes form along a longitudinal axis of the mould. Fig. 3 shows a cross-section through a part of the mould for a compound curved blade profile for the airfoil section of the blade.

[0062] The means allowing the pivot 55 to move or shift between positions may constitute further pivots 67 and/or telescopic portions 65 or equivalent provided in the arm 60 and/or a portion of the cart 70, such that the pivot 55 is allowed to assume any position above the mould.

[0063] As can be seen in figure 1, the applicator 50 is provided with rollers 20 which at least some of which are displaceable towards and away from the inner surface of the mould 1.

[0064] The directions of displacement of the rollers 20 are such that the rollers 20 displaces at least substantially perpendicular to the surface of the mould 1.

[0065] Numeral 25 refers to actuators adapted to provide displacement of the rollers 20. The actuators may comprise different means, such as springs, pressurized mediums, magnets and the like in order to cause the abovementioned displacement. Further, the actuators, or a system connected to the actuators, may be able to control the pressure applied to the material which is in contact with the rollers 20.

[0066] As indicated in Figs. 1 to 3, by means of the actuators 25, the position of the individual rollers 20 may be adapted to the actual form of the mould at the cross-section of the mould where the applicator 50 is situated at the moment. Thereby, in Fig. 1 and 2, whereby the applicator 50 is situated at the root section of the mould, the rollers 20 are positioned substantially along a section of a circle. However, in Fig. 3, whereby the applicator 50 is situated at the airfoil section of the mould, the rollers 20 are positioned along a path curving up and down.

[0067] The axis of the displacement of the actuators 25 may be substantially perpendicular to the axis of pivot 55, however according to some embodiments, the axis of displacement of the actuators 25 and/or rollers 20 may be displaceable, e.g. in order to obtain predetermined and dynamic angles between the axis of displacement of the rollers 20 and the material being arranged on the mould 1.

[0068] As indicated in Figs. 5 and 6, the axis of displacement of the rollers 20 and/or the actuators 25 may be mutually displaceable, whereby the material to be applied to the mould may be smoothened.

[0069] Further, the rollers 20 may be displaced in any direction and independently from each other.

[0070] Although not shown, one or more of the rollers 20 may be able to swivel or pivot about an axis being substantially parallel with the direction or axis of conveyance.

[0071] According to one not shown embodiment, only a part of the rollers 20 may be used under the process of arranging the material on the mould. Any not used rollers 20 may be totally or partially retracted during the process of laying the material.

[0072] The illustrated applicator is provided with a total of seven rolls 25, each provided with an actuator 25 which may be able to apply different displacements of and/or pressures onto the material and with respect to each other. Although not illustrated, it may be preferred to provide the applicator 50 with another number of rolls 20 and/or actuators 25, and the number of actuators 25 may not necessarily correspond to the number of rolls 20. Depending on the actual configuration, it may be sufficient to provide the applicator 50 with only one actuator 25 applying pressure to a plurality of rolls 20.

[0073] The illustrated rolls 20 are partially rounded or spherical, however, the applicator may be provided with one or more elongated rollers of substantially barrel shape or cylindrical form, as indicated in the embodiments shown in Figs. 4 to 6. Further, the rollers 20 may or may not be made from a material being somewhat flexible, such that the rollers' 20 contact with the material does not inflict damage to the material.

[0074] Fig. 4 shows an embodiment wherein the rollers 20 are arranged in a row, so that at least some of the rollers 20 are substantially conical with a cone angle of the individual rollers 20 that is varying from a central area 100 of the row of rollers 20 towards end areas 110 of the row of rollers 20. In fact, in the embodiment shown, a first, central roller 120 is cylindrical, second rollers 130 neighbouring the first roller 120 are conical so that they taper in the direction of the end areas 110, third rollers 140 neighbouring the second rollers 130 are conical and tapering in the direction of the end areas 110, but with a cone angle that is smaller than that of the second rollers 130, and fourth rollers 150 neighbouring the third rollers 140 are conical and tapering in the direction of the end areas 110, but with a cone angle that is larger than that of the second rollers. However, in another, not shown embodiment, the cone angle of the third rollers 140 is larger than that of the second rollers 130 and smaller than that of the fourth rollers 150. In that case, the cone angle of the individual rollers 20 is increasing from a central area 100 of the row of rollers 20 towards end areas 110 of the row of rollers 20. Many combinations of rollers with different cone angles are possible. Although the rollers are shown as substantially conical, other configurations of rollers having an increasing diameter along their axis are possible, such as for instance a kind of deformed or asymmetrical barrel shape. More than just the first, central roller may be cylindrical. As a consequence of the varying cone angle or diameter increase of the rollers, during the conveyance of the cart 70 along the open mould 1, the layers 10 of material are by means of the rollers 20 spread outward from the central area 100 in the direction of the end areas 110. Thereby, wrinkles or the like of the layer

of material laid out may be avoided.

[0075] Fig. 5 shows a top view of another embodiment of the arrangement of the rollers 20 in a row. In the embodiment shown, the individual rollers are identical with those in the above described embodiment shown in Fig. 4; however, the rollers 20 may just as well have different configurations such as cylindrical or for instance barrel shaped. In the embodiment of Fig. 5, the rollers are arranged so that, during the conveyance of the cart 70 along the open mould 1, rollers 120, 130 in the central area 100 are being advanced in front of rollers 140, 150 in the end areas 110. In the specific configuration shown in the figure, the rollers 20 are arranged on the cart 70 in a row substantially having the form of a V. The top angle of the V could be different. As a consequence of this arrangement of the rollers, during the conveyance of the cart 70 along the open mould 1, the layers 10 of material are by means of the rollers 20 spread outward from the central area 100 in the direction of the end areas 110. Thereby, wrinkles or the like of the layer of material laid out may be avoided.

[0076] Fig. 6 shows a top view of another embodiment of the arrangement of the rollers 20 in a row. In the embodiment shown, the individual rollers are identical with those in the above described embodiments shown in Figs. 4 and 5; however, the rollers 20 may just as well have different configurations. In the embodiment of Fig. 6, seen from above the apparatus, the rollers 20 are arranged on the cart 70 in a row so that an angle A between a transverse direction T to the direction C of conveyance of the cart 70 and the direction of the axis of rotation of the individual rollers is increasing from a central area of the row of rollers 20 towards end areas of the row of rollers 20. In the figure, the axis R of rotation of the second roller 130 is indicated. As a consequence of this arrangement, the rollers are arranged on the cart in a row substantially having the form of a semi-circle. As a consequence of this arrangement of the rollers, during the conveyance of the cart 70 along the open mould 1, the layers 10 of material are by means of the rollers 20 spread outward from the central area 100 in the direction of the end areas 110. Thereby, wrinkles or the like of the layer of material laid out may be avoided.

[0077] At least some of the rollers 20, 120, 130, 140, 150 may be arranged so that the orientations of their axes of rotation are individually adjustable, that is their axes of rotation may be displaced or rotated in any suitable way. The adjustment may be adapted to be performed during or before advancement of the cart 70. In this way, the apparatus according to the invention may, for instance, be adapted to be able to shift the configuration of rollers between the configurations shown in Figs. 4 to 6. Further, each roller 20, 120, 130, 140, 150 may be arranged somewhat flexible on an axle of rotation on which the roller is carried, so that the direction of its actual axis of rotation may vary slightly in relation to the direction of its axle of rotation.

[0078] Although not shown in the figures, the rollers 20 and/or the actuators 25 may be resiliently arranged onto or within the dispenser 50, and the axis of displacement of the rollers 20 may be offset or angled from the axis of the actuators 25.

[0079] The actuators employed throughout the apparatus according to the present invention may be controlled by not shown processing means such as a computer or equivalent.

[0080] Although not shown in the figures, a main laminate having a relatively great thickness, possibly as much as 100 mm or more and a width of about 800 mm may be arranged in the mould 1, possibly as a first layer.

[0081] Further, and not shown in the figures, between the layers of material, balsa wood may be interposed in order to obtain a desired distance between the layers of fibre material. The balsa wood may also be subjects to the method of manufacture according to this specification.

[0082] The apparatus incl. the applicator 70 or the arm 60 etc. may be provided with means for recording pictures such that the layup of material may be documented and stored.

[0083] The processing means may be configured to control the apparatus according to predetermined settings such that the layers may be laid according to an automated process.

[0084] Further, and not shown in the figures, the method and apparatus according to the present invention may comprise steps or means which process, by means of cutting, one or more layers of material.

[0085] The fibre material may be cut into mats of predetermined size and shape such that the mats or material may be arranged on the mould without requiring further modification. As an equal alternative, the method and apparatus according to the present invention may be able to cut the fibre material or mats upon the material being arranged on the mould.

[0086] It will be understood that the invention as disclosed in the present description and figures can be modified or amended while continuing to be comprised by the protective scope conferred by the following claims.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

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- US4699683A [0014]

Krav

1. En fremgangsmåde til fremstilling af fiberforstærkede vinger til vindenergi-anlæg, hvorved et antal måtter (10) af materiale, som omfatter fibre, placeres
5 på en kurvet overflade på en langstrakt åben støbeform (1), så nogle af måtterne (10) af materiale i det mindste delvist overlapper hinanden, hvor hver måtte (10) af materiale er placeret på støbeformen (1) ved hjælp af et antal ruller (20), der er tilvejebragt på en vogn (70), som transporteres langs den åbne støbeform (1), hvorved i det mindste nogle af rullerne (20) indbyrdes
10 forskydes under transport af vognen (70), så rullerne (20) i hovedsagen følger en tiltænkt kontur for måtten (10) af materiale, hvor nævnte materiale, som omfatter fibre, rulles ud fra en eller flere materialeruller, der omfatter materiale (90), og hvor materialerullerne, som omfatter materiale (90), transporteres langs støbeformen (1), alternativt rulles materialet ud fra en eller flere
15 materialeruller, som omfatter materiale (90), ved hjælp af et udrulningsarrangement, som trækker materialet fra en eller flere materialeruller, der omfatter materiale (90), og hvor en eller flere materialeruller, som omfatter materiale (90), og rullerne (20) i det mindste delvist er optaget af en dispenser (50), som er ophængt fra en arm (60) på vognen (70), hvor dispenseren (50) er
20 rotationsmæssigt forbundet til armen (60) via pivot (55) så materialet placeres på støbeformen (1) samtidigt med, at materialet udrulles fra den ene eller flere materialeruller, som omfatter materiale (90), og hvor dispenseren (50) pivoteres omkring pivoten (55) under transport, så materialerullerne, som omfatter materiale (90), og rullerne (20) indtager forskellige vinkelorienteringer, hvor en pivotakse (55) er orienteret i hovedsagen i støbeformens langs-
25 gående akse og/eller i hovedsagen parallel med en transportretning af vognen (70).
2. En fremgangsmåde ifølge ethvert af de foregående krav, hvor rullerne (20)
30 forskydes imod og væk fra støbeformen (1) ved hjælp af aktuatorer.

3. En fremgangsmåde ifølge ethvert af de foregående krav, hvor forskydningen af rullerne (20) styres af processormidler, såsom en computer, og i henhold til en foreskrevet procedure.
- 5 4. En fremgangsmåde ifølge krav 3, hvor processormidlerne udnytter afstands- og højdemålinger fra en eller flere sensorer, der er indrettet til at udlæse højde af et lag (1) i forhold til en reference og/eller en total tykkelse af lag (10), der er placeret på støbeformen.
- 10 5. En fremgangsmåde ifølge ethvert af de foregående krav, hvor lagene (10) er tilvejebragt i form af et antal forudskårede stykker, der er rullet op på en eller flere materialeruller, der omfatter materiale.
- 15 6. En fremgangsmåde ifølge ethvert af de foregående krav, hvor flere materialeruller er placeret på en "revolvertromle", der omfatter et antal materialeruller, som omfatter materiale med varierende egenskaber.
- 20 7. En fremgangsmåde ifølge ethvert af de foregående krav, hvor en indbyrdes vinkel, som dannes af rotationsakser for ved siden af hinanden placerede ruller (20), ændres under transport af vognen (70) langs den åbne støbeform (1).
- 25 8. En fremgangsmåde ifølge ethvert af de foregående krav, hvor lagene (10) af materiale, under transport af vognen (70) langs den åbne støbeform (1), ved hjælp af varierende orientering af rulleakser for forskelligere ruller (20) i en række dannet af rullerne, spredes udad fra et centralt område i rækken, der er dannet af rullerne (20), i retning mod endesområder af rækken, der er dannet af rullerne (20).
- 30 9. En fremgangsmåde ifølge ethvert af de foregående krav, hvor lagene (10) af materiale under transport af vognen (70) langs den åbne støbeform (1)

ved hjælp af ruller (20) med varierende diameter langs deres rulleakser spredtes udad fra et centralt område i en række, som er dannet af rullerne (20), i retning mod endeområder af rækken, der er dannet af rullerne (20).

- 5 10. En fremgangsmåde ifølge ethvert af de foregående krav, hvor rullerne (20) under transport af vognen (70) langs den åbne støbeform (1) i et centralt område af en række, dannet af rullerne (20), føres foran rullerne (20) i endeområder af rækken, der er dannet af rullerne (20).

- 10 11. Et apparat til fremstilling af fiberforstærkede vinger til vindenergianlæg, idet apparatet er indrettet til at placere et antal matter (10) af materiale, som omfatter fibre, på en kurvet overflade på en langstrakt åben støbeform (1), så
- 15 nogle af måtterne (10) af materiale i det mindste delvist overlapper hinanden, hvor apparatet omfatter en vogn (70), der er indrettet til transport langs den
- 15 åbne støbeform (1), **kendetegnet ved, at** et antal ruller (20) er tilvejebragt på vognen og er indrettet til at positionere hver måtte (10) af materiale på støbeformens, og ved, at i det mindste nogle af rullerne (20) er indbyrdes forskydelige under transport af vognen (70), så rullerne (20) i hovedsagen følger en
- 20 tiltænkt kontur for måtten (10) af materiale, hvor apparatet omfatter en applikator (50), som er ophængt fra en arm (60) på vognen (70), hvor dispenseren (50) er rotationsmæssigt forbundet til en arm (60) via pivot (55), og som optager rullerne (20), idet ruller (20) er forskydelige mod og væk fra støbeformens (1), hvor en pivotakse (55) er orienteret i hovedsagen i en langsgående
- 25 akse for støbeformens (1) og/eller i hovedsagen parallel med en transportretning for vognen (70).

12. Et apparat til oplægning af fibermateriale ifølge krav 11, hvor applikatoren optager en materialerulle, som omfatter materiale (90) til at blive lagt på støbeformens (1).

13. Et apparat til oplægning af fibermateriale på en støbeforme ifølge ethvert af kravene 11-12, hvor applikatoren (50) optager en materialerulle, der omfatter materiale, i form af en "revolvertromle", som omfatter et antal materialeruller, som hver omfatter materiale, med varierende egenskaber.

5

14. Et apparat til oplægning af fibermateriale på en støbeform ifølge ethvert af kravene 11-13, hvor rullerne (20), set fra oven over apparatet, er placeret på vognen (70), så rullerne (20) i et centralt område i en række, dannet af rullerne (20), er positioneret i en fremadrettet position, set i vognens (70) transportretning, i forhold til rullerne i endeområder af rækken, der er dannet af rullerne (70), og hvor rullerne, set fra oven over apparatet, er placeret på vognen (70) i en række, som har form som et V eller en halvcirkel.

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15. Et apparat til oplægning af fibermateriale på en støbeform ifølge ethvert af kravene 11-14, hvor rullerne (20) er placeret på vognen (70) i en række, og hvor i det mindste nogen af rullerne (20) er i hovedsagen koniske med en koningsvinkel for de individuelle ruller, hvilken varierer, fortrinsvist stigende, fra et centralt område af rullerne (20) mod endeområder i rækken af ruller (20).

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DRAWINGS

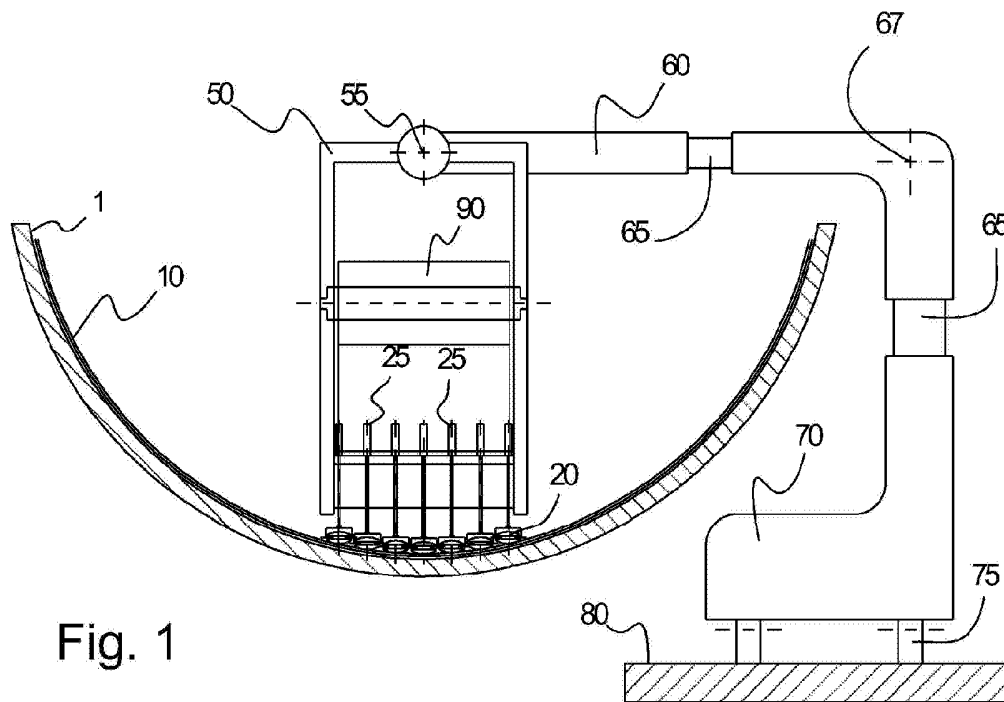


Fig. 1

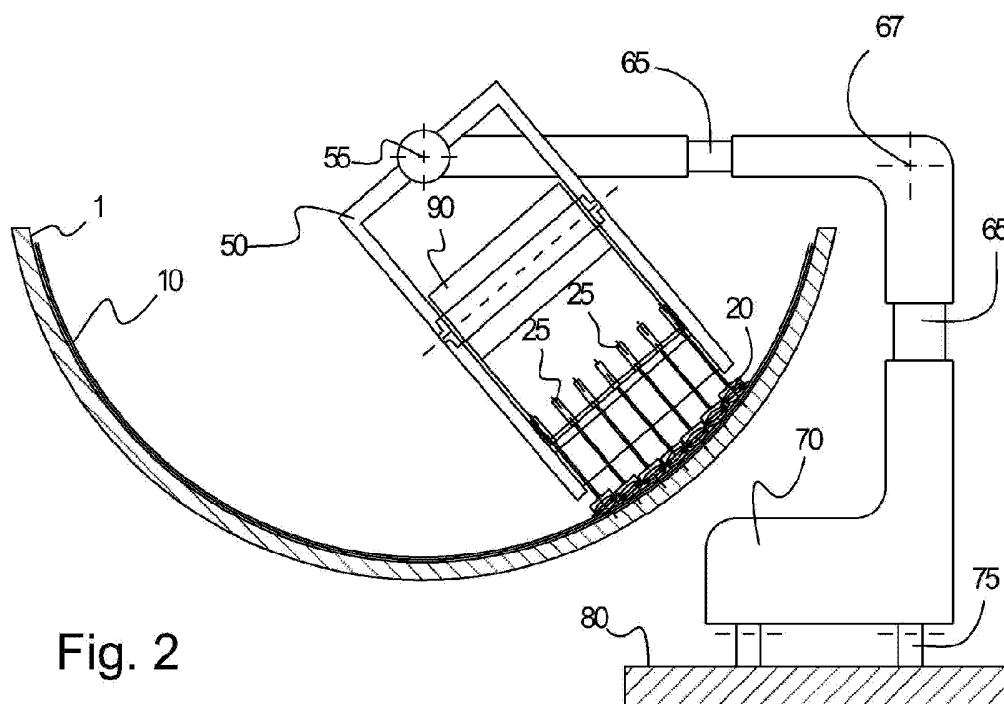


Fig. 2

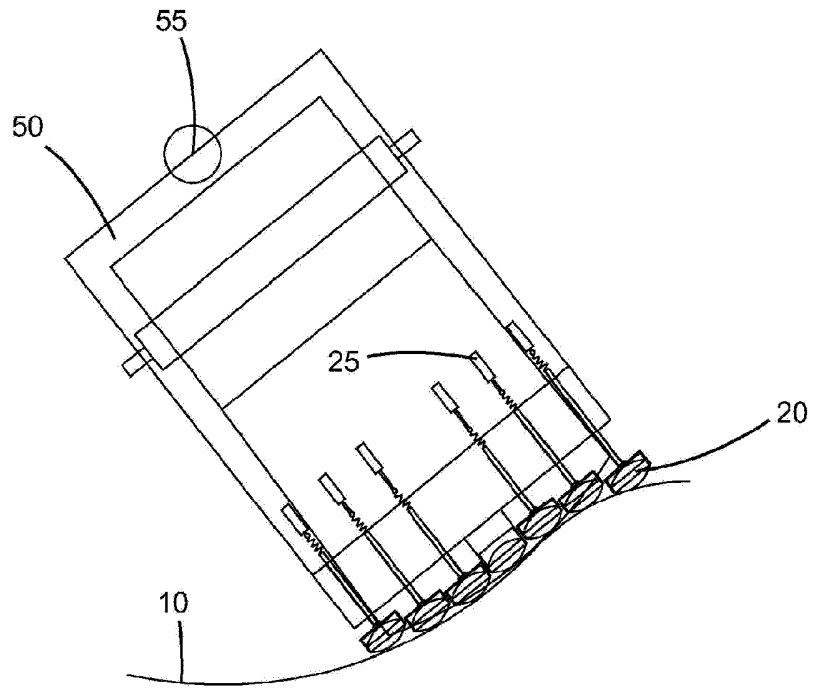


Fig. 3

