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(54) LAMINATE SHEET-CUTTING METHOD AND CUTTING DEVICE FOR FIBER-REINFORCED PLASTIC

LAMINATFOLIENSCHNEIDVERFAHREN UND SCHNEIDVORRICHTUNG FÜR FASERVERSTÄRKTEN KUNSTSTOFF

PROCÉDÉ ET DISPOSITIF DE COUPE DE FEUILLE DE STRATIFIÉ POUR PLASTIQUE RENFORCÉ DE FIBRES

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a method of cutting a laminate sheet including reinforced fiber, an apparatus for cutting the same.

BACKGROUND

[0002] Fiber-reinforced plastic, a composite material including reinforced fibers and resin, has been increasingly applied to members of wind turbine blades, main wings of airplanes, automobiles, ships, rail vehicles and the like in recent years, for its high strength and light weight. The fiber-reinforced plastic normally includes a stack of a plurality of laminate sheets (intermediate substrates) including reinforced fibers, so as to have a laminate structure with strength and stiffness required for the members. Each one of the laminate sheets constituting the fiber-reinforced plastic is an integrated piece of a stack of a plurality of thin sheet members including unidirectional fibers or woven fibers. For instance, a partially-hardened prepreg material including a fiber-reinforced substrate impregnated with resin, a direct roving sheet including bundles of reinforced fibers impregnated with resin formed in a sheet shape, a dry cloth not impregnated with resin, etc., is used as a laminate sheet.

[0003] The above fiber-reinforced plastic has a disadvantage that delamination is likely to occur at a thickness-changing portion where the thickness of a member changes discontinuously. This is considered to be due to stress concentration generated at the thickness-changing portion, and it is known that the risk of delamination rises with an increase in the amount of change in the thickness. Thus, in conventional techniques, thin laminate sheets are stacked in a stair shape when manufacturing fiber-reinforced plastic, or laminate sheets including taper portions at the ends formed by machine processing are stacked (as in Patent Documents 1 and 2) in order to restrict delamination at the thickness-changing portion of the fiber-reinforced plastic. Further, Patent Document 3 discloses cutting a laminate sheet so that the end of the laminate sheet is formed in a stair shape.

Citation List

Patent Literature

[0004]

Patent Document 1: US Patent Application Pub. No. 2011/0143081
Patent Document 2: US Patent Application Pub. No. 2011/0143082
Patent Document 3: US Patent Application Pub. No. 2008/0145615

SUMMARY

[0005] In a case where thin laminate sheets are stacked in a stair shape to manufacture fiber-reinforced plastic, however, it is necessary to stack a number of laminate sheets in accordance with the thickness of a member, which results in spending much time and effort during the lamination work. Further, in a case where a tapered portion is formed on a laminate sheet by machine processing, it is very difficult to form a tapered portion by machine processing on a laminate sheet having a thickness of e.g. a few millimeters or less. Moreover, in a case where a tapered portion is formed on fiber-reinforced plastic after lamination, it is necessary to mount the laminate sheet carefully so that damage such as delamination is not caused to the fiber-reinforced plastic. As a result, longer time is spent in a processing step, and quality management also becomes necessary.

[0006] On the other hand, it is possible to reduce the thickness-changing amount by providing stepped portions for the laminate sheet itself, as described in Patent Document 3. However, Patent Document 3 discloses no specific technique of cutting an end of a thin laminate sheet in a stepped shape.

[0007] An object of at least one embodiment of the present invention is to provide a method of cutting a laminate sheet for reinforced fiber and an apparatus for cutting the same, capable of providing a laminate sheet that can be suitably used as a material of fiber-reinforced plastic which can reduce the burden of the work of manufacturing fiber-reinforced plastic, and that is less likely to cause delamination.

[0008] A method of cutting a laminate sheet according to at least one embodiment of the present invention is for a laminate sheet in which a plurality of sheet members is assembled to form fiber-reinforced plastic. The method includes: a cutter-placing step of placing at least one cutter which extends in a thickness direction of the laminate sheet, on the laminate sheet at a plurality of positions in a longitudinal direction of the laminate sheet; and a cutting step, after the cutter-placing step, of cutting the laminate sheet by pressing the at least one cutter into the laminate sheet in the thickness direction. In the cutting step, at the plurality of positions, respective pressing-in amounts by which the at least one cutter is pressed into the laminate sheet are varied from one another so that an end of the laminate sheet is cut to have a stair shape.

[0009] In the above method of cutting a laminate sheet, the laminate sheet is cut by pressing the cutter into the laminate sheet at the plurality of positions in the longitudinal direction of the laminate sheet. At this time, the cutter is pressed in the thickness direction of the laminate sheet. Thus, the cutting work is facilitated as compared to a case where the laminate sheet is cut to have a tapered shape, because it is sufficient if the cutter is pressed in a direction perpendicular to the surface of the laminate sheet. Further, the pressing-in amounts of the cutter are differentiated at the respective positions, so that the end of the laminate sheet is cut to have a stair shape, which makes it possible to easily obtain a laminate sheet having an end of a stair shape. If fiber-reinforced plastic is manufactured by stacking laminate sheets obtained as described above, it is possible to provide fiber-reinforced plastic that is less likely to cause delamination.

[0010] In some embodiments, the method of cutting a laminate sheet for fiber-reinforced plastic further includes, before the cutter-placing step, a jig-positioning step of positioning a cutting jig on the laminate sheet with respect to the thickness direction. In the cutting step, a traveling amount traveled by the at least one cutter in the thickness direction may be restricted by the cutting jig, so as to differentiate the respective pressing-in amounts of the at least one cutter at the plurality of positions.

[0011] As described above, the cutting jig for restricting the traveling amount of the cutter in the thickness direction of the laminate sheet is used to determine the position of the cutting jig in the thickness direction with respect to the laminate sheet, which makes it possible to form each of the steps at the end of the laminate sheet at a desired height.

[0012] In some embodiments, in the cutter-placing step, the at least one cutter may be placed on the laminate sheet so that a blade surface of the at least one cutter is diagonal with respect to a width direction of the laminate sheet. In the cutting step, the laminate sheet may be cut in a diagonal direction with respect to the width direction by the at least one cutter.

[0013] As described above, the laminate sheet is cut in a diagonal direction with respect to the width direction, which makes it possible to reduce the amount of change in the cross sectional area of the laminate sheet with respect to the longitudinal direction of the laminate sheet. As a result, it is possible to reduce the amount of stress change in the laminate sheet, which makes it possible to manufacture fiber-reinforced plastic that is even less likely to cause delamination by stacking a plurality of the above laminate sheets. Here, the cross sectional area of the laminate sheet refers to the cross sectional area of the laminate sheet in the width direction.

[0014] In some embodiments, in the cutting step, the laminate sheet is cut along a cutting line of a V shape.

[0015] In this way, the laminate sheet is cut symmetrically about a center line in the width direction, which makes it possible to obtain a sheet structure with little bias in distribution of strength and stiffness in the width direction

[0016] In some embodiments, an angle between the width direction and the cutting line of the laminate sheet may be more than 0 degree and not more than 60 degrees.

[0017] In this way, with the angle between the width direction and the cutting line of the laminate sheet being more than 0 degree, the laminate sheet is cut diagonally, which makes it possible to change the cross sectional area of the laminate sheet smoothly with respect to the longitudinal direction of the laminate sheet. Thus, it is possible to restrict delamination of the laminate sheet even further.

[0018] Further, with the angle between the width direction and the cutting line of the laminate sheet being not more than 60 degrees, it is possible to restrict the amount of waste even if a portion adjacent to a fiber roll that has been cut diagonally is to be discarded. Further, with the angle between the width direction and the cutting line of the laminate sheet being not more than 60 degrees, it is possible to prevent the cutter from becoming too long even though the length of the cutter is required to be longer in a case where the laminate sheet is cut diagonally than in a case where the laminate sheet is cut parallel to the width direction (i.e., at a right angle from the longitudinal direction of the laminate sheet). Thus, it is possible to cut the forming cost.

[0019] In some embodiments, a difference in the pressing-in amounts between adjacent two of the plurality of positions may be not less than 0.1mm and not more than 5mm.

[0020] If a difference in the pressing-in amounts between two adjacent positions, i.e., the height of steps on the laminate sheet after the cutting, is less than 0.1mm, it is necessary to provide a number of steps, which reduces work efficiency. On the other hand, if the height is more than 5mm, the amount of change in the cross sectional area of the laminate sheet with respect to the longitudinal direction of the laminate sheet increases, which makes it difficult to prevent delamination when fiber-reinforced plastic is manufactured by stacking a plurality of the above laminate sheets. Thus, with the difference in the pressing-in amounts being not less than 0.1mm and not more than 5mm, the work is facilitated in manufacture of fiber-reinforced plastic and thus productivity is enhanced. In addition, it is possible to manufacture fiber-reinforced plastic that is less likely to cause delamination.

[0021] A laminate-sheet cutting apparatus for cutting a laminate sheet for fiber-reinforced plastic according to at least one embodiment of the present invention is a cutting apparatus for a laminate sheet in which a plurality of sheets are assembled to form fiber-reinforced plastic. The cutting apparatus includes: at least one cutter for cutting the laminate sheet; a positioning part configured to be capable of positioning the at least one cutter at a plurality of positions in a longitudinal direction of the laminate sheet; and a traveling-amount restricting part for restricting traveling amounts traveled by the at least one cutter in a thickness direction of the laminate sheet. The traveling-amount restricting part is configured to differentiate the respective traveling amounts at the plurality of positions from one another so that an end of the laminate sheet is cut to have a stair shape.

[0022] With the above laminate-sheet cutting apparatus, the positioning part determines the position of the cutter at the plurality of positions in the longitudinal direction of the laminate sheet, which makes it possible to appropriately set the position of each stepped portion in the longitudinal direction of the laminate sheet. Further, the traveling-amount restriction part restricts the traveling amount of the cutter so that the end of the laminate sheet is cut to have a stair shape, which makes it possible to manufacture fiber-reinforced plastic that is less likely to cause delamination, by stacking a plurality of the above laminate sheets.

[0023] In some embodiments, the laminate-sheet cutting apparatus for fiber-reinforced plastic further includes a base including a reference surface on which the laminate sheet is placed. The traveling-amount restriction part is configured to restrict the traveling amounts of the at least one cutter with respect to the reference surface.

[0024] As described above, the traveling-amount restriction part restricts the traveling amount of the cutter with respect to the reference surface on which the laminate sheet is placed, which makes it possible to adjust the relative position between the cutter and the laminate sheet at high accuracy. Thus, it is possible to appropriately set the position of each stepped portion of the laminate sheet in the thickness direction.

[0025] In some embodiments, the traveling-amount restriction part may include: a pair of side walls stood up on the base at opposite sides of the reference surface in the width direction of the laminate sheet, the pair of side walls including an upper surface of a stair shape; and a cutter holder attached to the at least one cutter, the cutter holder including a contact surface of a stair shape which is configured to contact the upper surface of the stair shape.

[0026] In the above embodiment, the upper surface of the pair of side walls arranged on the opposite sides of the laminate sheet is formed in a stair shape, and the contact surface of the cutter holder is brought into contact with the upper surface of the stair shape, which results in restriction of the traveling amount of the cutter. In this way, it is possible to press in the cutter reliably by a pressing-in amount that has been set.

[0027] In some embodiments, the positioning part may be an engaging part between a protrusion disposed on one of the pair of side walls or the cutter holder, and a recess disposed on the other one of the pair of side walls or the cutter holder. The engaging part may be disposed at each of the plurality of positions in the longitudinal direction of the laminate sheet.

[0028] As described above, the protrusion disposed on one of the pair of side walls or the cutter holder and the recess disposed on the other one of the pair of side walls or the cutter holder engage with each other, which makes it possible to determine the position of the cutter accurately and easily in the longitudinal direction of the laminate sheet. Further, it is possible to easily attach and remove the cutter (cutter holder) to and from the side walls, which makes it possible to improve work efficiency.

[0029] In some embodiments, the laminate-sheet cutting apparatus for fiber-reinforced plastic may further include: a pair of side walls stood up on the base at opposite sides of the reference surface in the width direction of the laminate sheet, the pair of side walls including an upper surface of a stair shape, and an upper casing rotatably attached to a lower casing about a rotation shaft, the lower casing including the base and the pair of side walls, and the upper casing including an insertion aperture for a cutter holder which is attached to the at least one cutter. The traveling-amount restricting part includes a flange portion which restricts an insertion depth to which the cutter holder is inserted through the insertion aperture.

[0030] According to the above embodiment, the upper casing and the lower casing are attached rotatably to each other about the rotation shaft. Further, the cutter holder contacts the insertion aperture at the flange portion so that the positions of the cutter and the upper casing are determined with respect to each other. Thus, it is possible to determine the positions of the cutter attached to the cutter holder and the laminate sheet placed on the base with respect to each other accurately by assembling the lower casing and the upper casing. As a result, it is possible to form the stepped portions of a stair shape on the laminate sheet at high accuracy.

[0031] A fiber-reinforced plastic includes at least one layer having an end of a stair shape. Each layer of the fiber-reinforced plastic includes a laminate sheet which is cut by at least one cutter which is configured to be placed on the laminate sheet at a plurality of positions in a longitudinal direction of the laminate sheet in a thickness direction of the laminate sheet and pressed into the laminate sheet in the thickness direction. At the plurality of positions, respective pressing-in amounts by which the at least one cutter is pressed into the laminate sheet are differentiated from one another when cutting the laminate sheet, so that laminate sheet is cut to have an end of a stair shape.

[0032] The above fiber-reinforced plastic includes at least one laminate sheet with an end that is cut to have a stair shape by pressing in the cutter at the plurality of positions in the longitudinal direction of the laminate sheet, so that the pressing-in amounts of the cutter in the thickness direction are varied from one another. Thus, it is possible to reduce the amount of change in the cross sectional area at the end of the fiber-reinforced plastic, and thus it is possible to reduce the stress concentration at the end, which makes it possible to provide fiber-reinforced plastic that is less likely to cause delamination even if a plurality of the laminate sheets are stacked.

[0033] According to at least one embodiment of the present invention, the cutter is pressed into the laminate sheet in the thickness direction of the laminate sheet, at the plurality of positions in the longitudinal direction of the laminate sheet. Thus, the cutting work is facilitated as compared to a case where the laminate sheet is cut to have a tapered shape, because it is sufficient if the cutter is pressed in a direction perpendicular to the surface of the laminate sheet. Further, the respective pressing-in amounts of the cutter are differentiated at the plurality or positions, so that the end of the laminate sheet is cut to have a stair shape, which makes it possible to easily obtain a laminate sheet having an end of a stair shape. If fiber-reinforced plastic is manufactured by stacking the laminate sheets obtained as described above, it is possible to provide fiber-reinforced plastic that is less likely to cause delamination.

BRIEF DESCRIPTION OF DRAWINGS

[0034] FIGs. 1A to 1C are diagrams illustrating a process of a method of cutting a laminate sheet according to one embodiment.

FIGs. 2A to 2C are diagrams illustrating a process of a method of cutting a laminate sheet according to another embodiment.
FIG. 3 is a perspective view of an exemplary configuration of fiber-reinforced plastic including a stack of a plurality of laminate sheets illustrated in FIG. 1.
FIG. 4A is a perspective view of a laminate sheet with stepped portions in the width direction. FIG. 4B is a perspective view of a laminate sheet with stepped portions in a diagonal direction. FIG. 4C is a perspective view of a laminate sheet with no stepped portion.
FIG. 5 is a specific side view of an exemplary configuration of a laminate-sheet cutting apparatus according to one embodiment.
FIG. 6 is a view of the laminate-sheet cutting apparatus from FIG. 5 as seen in the direction of the arrow A.
FIG. 7 is a side view of an example of an ultrasonic cutter.
FIG. 8 is a specific perspective view of an exemplary configuration of a laminate-sheet cutting apparatus according to another embodiment.
FIG. 9A is a specific perspective view of an exemplary configuration of a laminate-sheet cutting apparatus according to another embodiment, and FIG. 9B is a side cross-sectional view of the same.

DETAILED DESCRIPTION

[0035] Embodiments of the present invention will now be described in detail with reference to the accompanying drawings. It is intended, however, that unless particularly specified, dimensions, materials, shapes, relative positions and the like of components described in the embodiments shall be interpreted as illustrative only and not limitative of the scope of the present invention.

[0036] FIGs. 1A to 1C are diagrams illustrating a process of a method of cutting a laminate sheet according to one embodiment. FIGs. 2A to 2C are diagrams illustrating a process of a method of cutting a laminate sheet according to another embodiment. FIG. 3 is a perspective view of an exemplary configuration of fiber-reinforced plastic including a stack of a plurality of laminate sheets illustrated in FIG. 1.

[0037] In one embodiment, the laminate sheet 1 includes a stack of a plurality of sheet members each including at least reinforced fibers. For instance, a partially-hardened prepreg material including a fiber-reinforced substrate impregnated with resin, a direct roving sheet including bundles of reinforced fibers impregnated with resin formed in a sheet shape, a dry cloth not impregnated with resin, or the like, is used as the laminate sheet 1. The laminate sheet 1 is formed in an elongated shape, and wound around a core, for instance, in a roll shape. In this case, when manufacturing fiber-reinforced plastic, the laminate sheet is pulled out from the roll, and then the end of the laminate sheet is cut so as to obtain a length required for manufacture of the fiber-reinforced plastic.

[0038] The process of a method of cutting a laminate sheet according to one embodiment will be described below.

[0039] First, as illustrated in FIG. 1A, in a cutter-placing step, a blade tip of at least one cutter 12 is placed on the laminate sheet 1 at a plurality of positions P_1, P_2, P_3 in the longitudinal direction of the laminate sheet 1. At this point, the cutter 12 is disposed along the thickness direction of the laminate sheet 1. The plurality of positions are indicated as positions P_1, P_2, P_3 in this order from an end that is to be obtained after cutting the laminate sheet. Although the example illustrates three positions herein, the number of the positions is not limited.

[0040] Before the cutter-placing step, the method may include a jig-positioning step of positioning a cutting jig 14 on the laminate sheet 1 with respect to the thickness direction. The cutting jig 14 restricts the traveling amount traveled by the cutter 12 in the thickness direction, and restricts the traveling amount of the cutter 12 at each of the plurality of positions P_1, P_2, P_3. Specifically, the cutting jig 14 includes a pair of flat-plate members disposed on opposite sides, in the width direction, of the laminate sheet 1. The pair of flat-plate members includes a plurality of cutter receiving surfaces 14a arranged in a step shape, adjacent to a surface of the laminate sheet 1 on which the cutter 12 is to be placed. Specifically, each cutter receiving surface 14a is disposed at a different position, in the thickness direction, from the position of the adjacent cutter receiving surface 14a. In the jig-positioning step, the pair of cutting jigs 14 is positioned so that the cutter receiving surfaces 14a are disposed at the same height on the opposite sides of the laminate sheet 1 in the width direction.

[0041] Next, as illustrated in FIG. 1B, in a cutting step, the cutter 12 is pressed into the laminate sheet 1 in the thickness direction of the laminate sheet 1, thereby cutting the laminate sheet 1. At this time, at the plurality of positions P_1, P_2, P_3 on the laminate sheet 1, the pressing-in amounts L_1, L_2, L_3 by which the cutter 12 is pressed into the laminate sheet 1 are differentiated from one another, respectively.

[0042] In a case where the cutting jig 14 is used, the cutter 12 is pressed to a base 15 on which the laminate sheet 1 is placed, at the position P_1 of the laminate sheet 1. At this time, a groove 16 configured to receive the blade tip of the cutter 12 may be disposed on the base 15, so that the laminate sheet 1 is cut completely through to the lowermost part. Further, a stopper 17 may be disposed in the groove 16 on the base 15 so as to prevent damage to the blade tip of the cutter 12. In this way, opposite ends of the cutter 12, which are not used for the cutting, come into contact with the stopper 17 at a position where the blade tip of the cutter 12 becomes below the base 15, which makes it possible to prevent the blade tip from contacting the base 18 to become damaged.

[0043] As described above, at the position P_1 on the laminate sheet 1, the pressing-in amount L_1 of the cutter 12 is equal to, or more than the thickness of the laminate sheet 1. Thus, at the position P_1, the laminate sheet 1 is completely cut off by pressing the cutter 12 in the thickness direction by the pressing-in amount L_1.

[0044] At the position P_2 adjacent to the position P_1, the pressing-in amount L_2 of the cutter 12 is smaller than the thickness of the laminate sheet 1. That is, the cutter receiving surfaces 14a of the cutting jig 14 are above a placement surface (reference surface) of the base 15 on which the laminate sheet 1 is placed. Similarly, at the position P_3 adjacent to the position P_2, the pressing-in amount L_3 of the cutter 12 is smaller than the pressing-in amount L_2 at the position P_2. That is, the cutter receiving surfaces 14a at the position P_3 are above the cutter receiving surfaces 14a at the position P_2. After pressing in the cutter 12 by a predetermined pressing-in amount L, the cutter 12 may be shifted in the direction of the arrow in FIG. 1B to remove an offcut of the laminate sheet 2 that has been cut off. Generally, binding force is weak in the thickness direction in many laminate sheets. In this case, an offcut of the laminate sheet 2 can be removed by cutting only in the thickness direction.

[0045] In this way, as illustrated in FIG. 1C, stepped portions 4 of a stair shape are formed in the longitudinal direction of the laminate sheet 1 from the position P_1, at which the laminate sheet 1 is completely cut off.

[0046] When using a single cutter 12, the cutter 12 is pressed into the laminate sheet 1 one after another at the plurality of positions P_1, P_2, P_3 on the laminate sheet 1. In this case, the laminate sheet 1 may be cut from the position P_1, which is to become the far end after the cutting, toward the positions P_2, P_3 in this order, or may be cut from the position P_3 toward the positions P_2, P_1 in the reversed order.

[0047] When using a plurality of cutters 12, the plurality of cutters 12 are pressed into the laminate sheet 1 simultaneously at the plurality of positions P_1, P_2, P_3 on the laminate sheet 1. At this time, the cutting jig 14 may be configured such that the plurality of cutters 12 are fixed to one another so that the blade tips of the cutters 12 form a stepped shape. In this case, it is not necessary for the cutting jig 14 to include cutter receiving surfaces 14 of a stair shape, and stepped portions of a stair shape are formed with reference to a base (not illustrated) on which the laminate sheet 1 is placed, for instance.

[0048] In some embodiments, a difference between the pressing-in amounts betweem adjacent two of the plurality of positions P_1, P_2, P_3 may be not less than 0.1mm and not more than 0.5mm.

[0049] If the difference between the pressing-in amounts at adjacent two positions, i.e., the height of the stepped portions 4 of the laminate sheet 1 after the cutting, is less than 0.1mm, it is necessary to provide a number of stepped portions 4, which leads to a decrease in work efficiency. On the other hand, if the height of the stepped portions 4 is more than 5mm, the cross-sectional area of the laminate sheet 1 varies in the longitudinal direction of the laminate sheet 1 by a great amount, which makes it difficult to prevent delamination when fiber-reinforced plastic is manufactured by stacking more than one laminate sheet 1. In view of this, with the difference in the pressing-in amounts (the height of the stepped portions 4) being not less than 0.1mm and not more than 5mm, manufacture of fiber-reinforced plastic is facilitated and productivity is improved. Also, it is possible to manufacture fiber-reinforced plastic which is less likely to cause delamination.

[0050] Further, in another embodiment, as illustrated in FIGs. 2A to 2C, in the cutter-placing step, the cutter 12' may be pressed into the laminate sheet 1 while the blade surface of the cutter 12' is disposed in a diagonal direction with respect to the width direction of the laminate sheet 1.

[0051] With reference to FIG. 2A, before the cutter-placing step, the cutting jigs 14 are disposed on both sides of the laminate sheet 1 in the width direction. In the cutter-placing step, the at least one cutter 12' is placed on the laminate sheet 1 at the plurality of positions P_1, P_2, P_3 in the longitudinal direction of the laminate sheet 1. Specifically, the cutter 12' includes a blade tip of a V shape. Thus, in the cutting step illustrated in FIG. 1B, the laminate sheet 1 is cut so as to obtain stepped portions 4' each having a V shape when pressing in the cutter 12'. Then, similarly to FIG. 1, the laminate sheet 1 is cut at the plurality of positions P_1, P_2, P_3 on the laminate sheet 1 by the respective pressing-in amounts L by which the cutter 12' is pressed into the laminate sheet 1, the respective pressing-in amounts being varied from one another. In this way, as illustrated in FIG. 12 C, stepped portions 4' each having a V shape are formed on the laminate sheet 1 in a stair-shape.

[0052] While FIG. 2 illustrates the cutter 12 including a V-shaped blade tip as an example, the shape of the cutter 12 is not limited to this.

[0053] In some embodiments, as illustrated in FIG. 4B, an angle θ formed between the width direction and the cutting line of the laminate sheet 1B, i.e., the angle of the blade tip of the cutter 12' (see FIGs. 2A to 2C) from the width direction of the laminate sheet 1B, may be more than 0 degree and not more than 60 degrees.

[0054] As described above, with the angle θ formed between the width direction and the cutting line of the laminate sheet 1B being more than 0 degree, the laminate sheet 1B is cut in a diagonal direction, which makes it possible to gradually change the cross-sectional area of the laminate sheet 1B in the longitudinal direction of the laminate sheet 1B. Thus, it is possible to further reduce the risk of delamination for the laminate sheet 1B.

[0055] Furthermore, with the angle θ formed between the width direction and the cutting line of the laminate sheet 1B being not more than 60 degrees, it is possible to restrict the amount of waste even if a portion cut off in a diagonal direction adjacent to a fiber roll is to be discarded. Moreover, with the angle formed between the width direction and the cutting line of the laminate sheet 1B being not more than 60 degrees, it is possible to prevent the cutter 12' from having a too long length, even though it is necessary to increase the length of the cutter 12' in a case where the laminate sheet 1B is to be in a diagonal direction as compared to a case where the laminate sheet 1B is cut parallel to the width direction (i.e. at a right angle from the longitudinal direction of the laminate sheet). As a result, it is possible to cut the forming cost.

[0056] As illustrated in FIG. 3 for instance, more than one laminate sheet 1 including the stepped portions 4 of a stair shape formed as described above are assembled to form fiber-reinforced plastic 100. In one embodiment, the laminate sheet 1 having the stepped portions 4 is laminated on another laminate sheet 1 so as to form another stepped shape, thereby forming the fiber-reinforced plastic 100. The number of laminate sheets 1 in a stack is not particularly limited. The fiber-reinforce plastic 100 is used as a material of members included in a wind turbine blade, main wings of an airplane, an automobile, a ship, a train vehicle, or the like, for instance.

[0057] Now, in reference to FIG. 4, a relationship between the shape of an end of the laminate sheet 1 and the stress thereof will be described. FIG. 4A is a perspective view of a laminate sheet 1A with stepped portions in the width direction. FIG. 4B is a perspective view of a laminate sheet 1B with stepped portions in a diagonal direction. FIG. 4C is a perspective view of a laminate sheet 1C with no stepped portion.

[0058] The laminate sheet 1C, illustrated in FIG. 4C as a reference example, has no stepped portion at the end 2. In contrast, the laminate sheets 1A, 1B, according to embodiments of the present invention illustrated in FIGs. 4A and 4B, both have stepped portions 4A, 4B of a stair shape. The stepped portions 4A of the above laminate sheet 1A are formed parallel to the width direction, and the stepped portions 4B of the above laminate sheet 1B are formed in a diagonal direction with respect to the width direction.

[0059] Below the perspective views of the laminate sheets, illustrated are respective graphs showing stress distribution against the position in the longitudinal direction. With reference to FIG. 4C, it can be seen that the stress concentrates on the end surface 2 in the laminate sheet 1C. In contrast, with reference to FIG. 4A, while the stress concentrates on each of the end surfaces 4A formed in a stair shape in the laminate sheet 1A, the stress is distributed over the plurality of stepped portions 4A so that the stress at each position does not become considerably large, because the stepped portions 4A are formed in a stair shape. That is, if the thickness is discontinuously changed by a small amount as in the laminate sheet 1A, stress caused at the thickness-changing positions decreases. As a result, it is possible to manufacture fiber-reinforced plastic that is less likely to cause delamination, as compared to the laminate sheet 1C illustrated in FIG. 4C. Further, with reference to FIG. 4B, the laminate sheet 1B includes a plurality of stepped portions 4B formed in a stair shape and in a diagonal direction with respect to the width direction, which results in continuously varying cross-sectional area of the cross section 8 with respect to the longitudinal direction. With the cross-sectional area continuously changing as describe above, it is possible to reduce the stress generated on the thickness-changing parts even further than in the laminate sheet 1A of FIG. 4A. Thus, it is possible to manufacture fiber-reinforced plastic that is less likely to cause delamination.

[0060] Next, referring to FIGs. 5 to 9, specific configuration of a laminate-sheet cutting apparatus according to the present embodiment will be described. FIG. 5 is a specific side view of an exemplary configuration of a laminate-sheet cutting apparatus according to one embodiment. FIG. 6 is a view of the laminate-sheet cutting apparatus from FIG. 5 as seen in the direction of the arrow A. FIG. 7 is a side view of an example of an ultrasonic cutter. FIG. 8 is a specific perspective view of an exemplary configuration of a laminate-sheet cutting apparatus according to another embodiment.

FIG. 9A is a specific perspective view of an exemplary configuration of a laminate-sheet cutting apparatus according to another embodiment. FIG. 9B is a side cross-sectional view of the same.

[0061] As illustrated in FIGs. 5 and 6, in one embodiment, the laminate-sheet cutting apparatus 20 includes a casing 21 for accommodating at least a part of the laminate sheet 1, an ultrasonic cutter 30 for cutting the laminate sheet 1, and a cutter holder 25 for holding the ultrasonic cutter 30.

[0062] The casing 21 includes a base 22 on which the laminate sheet 1 is to be placed, and a pair of side walls 23 stood up on the base 22.

[0063] The base 22 includes a flat reference surface on which the laminate sheet 1 is to be placed.

[0064] The pair of side walls 23 is stood up on the base 22 at both sides of the reference surface in the width direction of the laminate sheet 1, and includes upper surfaces 23a of a stair shape. A difference in height between adjacent two of the upper surfaces 23a corresponds to the height of the stepped portions 4 of the laminate sheet 1. Further, the pair of side walls 23 includes a plurality of slits 24 in the longitudinal direction. The interval between adjacent tow of the slits 24 corresponds to the width W of the stepped portions 4 of the laminate sheet 1. Here, the width W of the stepped portion 4 is a distance between adjacent two of the stepped portions 4, 4 in the longitudinal direction. In a case where a plurality of the stepped portions 4 is provided, the widths between the stepped portions may be either identical, or different.

[0065] As illustrated in FIG. 7, the ultrasonic cutter 30 includes an ultrasonic generation part 31 and a cutter 32. In the ultrasonic cutter 30, when ultrasonic is generated by the ultrasonic generation part 31, the cutter 32 vibrates due to the ultrasonic. As a result, it is possible to cut off a member which is difficult to cut. While the ultrasonic cutter 30 is illustrated here, a normal cutter with no ultrasonic generation part may also be used.

[0066] The cutter holder 25 includes a pair of support plates 26 sandwiching the ultrasonic cutter 30 in the width direction of the cutter 32, a pair of contact surfaces 27 disposed on ends of the pair of support plates 26, and a pair of plate members 28, 28 disposed so as to sandwich the cutter 32 in the longitudinal direction of the laminate sheet 1.

[0067] To the support plates 26, for instance, the ultrasonic generation part 31 of the ultrasonic cutter 30 is fixed by bolt fastening. The contact surfaces 27 are formed in a stair shape on the lower ends of the support plates 26 to contact with the upper surfaces 23a of a stair shape of the side walls 23.

[0068] The plate members (projections) 28 of the cutter holder 25 engage with the slits (recesses) 24 of the side walls 23, so that the position of the cutter holder 25 is determined in the longitudinal direction of the laminate sheet 1. Since the plurality of slits 24 are disposed in the longitudinal direction, it is possible to form the stepped portions 4 at desired positions on the laminate sheet 1 in the longitudinal direction by selecting positions of the slits 24 with which the plate members 28 are to be engaged. Here, while the cutter holder 25 includes the plate members 28 serving as projections and the side walls 23 include the slits 24 serving as recesses in the present example, the cutter holder 25 may include recesses and the side walls 23 may include projections in a reversed example.

[0069] As described above, projections disposed on one of the pair of side walls 23 of the casing 21 or the pair of plate members 28 of the cutter holder 25 is engaged with recesses disposed on the other of the above. In this way, it is possible to determine the position of the cutter 32 in the longitudinal direction of the laminate sheet accurately and easily. Further, it is possible to attach and remove the cutter (cutter holder) 32 to and from the side walls 23, which makes it possible to improve the work efficiency.

[0070] Further, the cutter holder 25 supporting the ultrasonic cutter 30 moves downward, so that the contact surfaces 27 of the cutter holder 25 come into contact with the upper surfaces 23a of the side walls 23. As a result, the traveling amount in the thickness direction of the laminate sheet 1 is restricted for the ultrasonic cutter 30 supported by the cutter holder 25. At this time, since the upper surfaces 23a of the side walls 23 are formed in a stair shape, the cutter 32 is pressed into the laminate sheet 1 at the positions P_1, P_2, P_3 and so on by the respective predetermined pressing-in amounts L_1, L_2, L_3 and so on, by moving the cutter holder 25 downward in the longitudinal direction of the laminate sheet 1. As a result, the laminate sheet 1 is cut to have a stair shape in the longitudinal direction. Here, the upper surfaces 23a of the side walls 23 and the contact surfaces 27 of the cutter holder 25 may be configured to restrict the traveling amount of the cutter 32 from the reference surface of the base 22.

[0071] As described above, the upper surfaces 23a of the pair of side walls 23 disposed on opposite sides of the laminate sheet 1 is formed in a stair shape, and the contact surfaces 27 of the cutter holder 25 come into contact with the upper surfaces 23a of a stair shape. As a result, the traveling amount of the cutter 32 is restricted, which makes it possible to press in the cutter 32 reliably by the determined pressing-in amounts. Here, at the position P_1, which becomes the furthermost part of the laminate sheet 1, the slit 24 may extend down beyond the reference surface so that the laminate sheet 1 is cut off completely.

[0072] As illustrated in FIG. 8, in another embodiment, the laminate-sheet cutting apparatus 40 includes a casing 42 for accommodating at least a part of the laminate sheet 1, and a cutter 48.

[0073] As the cutter 48, the ultrasonic cutter 30 illustrated in FIG. 7 is used, for instance.

[0074] The casing 42 includes a base 43 including a flat reference surface on which the laminate sheet 1 is to be placed, and a pair of side walls 44 stood up on opposite sides of the laminate sheet 1 in the width direction from the base 43. The pair of side walls 44 includes a pair of slits 45 at a plurality of positions P_2, P_3 in the longitudinal direction of the laminate sheet 1, respectively. The lengths of the slits 45, in the thickness direction of the laminate sheet 1, are varied between the positions P_2, P_3.

[0075] With the laminate-sheet cutting apparatus 40 having the above configuration, at least a part of the laminate sheet 1 is accommodated in the casing 42, and the cutter 48 is placed on the surface of the laminate sheet 1 at the positions P_2, P_3. Then, the cutter 48 placed on the laminate sheet 1 is pressed into the laminate sheet 1, so that the cutter 48 is pressed into the laminate sheet 1 by the lengths L_2, L_3 of the slits 45. By performing the above operation on the plurality of positions P_2, P_3 in series, the end of the laminate sheet 1 is cut to have a stair shape. Here, the position P_1, which is to be the farther most part of the laminate sheet 1 after the cutting, is not illustrated in the drawing.

[0076] As described above, the slits 45 having varied lengths are formed on the side walls 44 of the casing 42 at the plurality of positions P_2, P_3 in the longitudinal direction of the laminate sheet 1, and the cutter 48 is pressed in along the slits 45. As a result, it is possible to form the laminate sheet 1 including an end of a stair shape.

[0077] FIGs. 9A and 9B illustrate a laminate-sheet cutting apparatus 50 according to one embodiment, including an ultrasonic cutter 60, a lower casing 52 for accommodating at least a part of the laminate sheet 1, and an upper casing 56 attached rotatably to the lower casing 52 about a rotation shaft 59.

[0078] The ultrasonic cutter 60 includes a cutter holder 61, and a cutter 62 attached to the cutter holder 61. The cutter holder 61 may be an ultrasonic generation part, in case of which the ultrasonic cutter 30 from FIG. 7 may be used. Further, the cutter holder 61 includes a flange 63 in order to restrict the traveling amount of the cutter 62 in the thickness direction of the laminate sheet 1. The flange 63 may be formed in a ring shape and slidably mounted to the circumferential surface of the cutter holder 61, so that the position of the flange 63 is changeable in the length direction of the cutter holder 61. In this way, it is possible to set the traveling amount of the cutter 62 optionally in the thickness direction of the laminate sheet 1.

[0079] The lower casing 52 includes a base 53 including a flat reference surface on which the laminate sheet 1 is to be placed, and a pair of side walls 54 stood up on opposite sides of the laminate sheet 1 in the width direction from the base 53. The pair of side walls 54 includes a pair of slits 55 at each of the plurality of positions P_2, P_3 in the longitudinal direction of the laminate sheet 1. The slits 55 both extend down beyond the reference surface.

[0080] The upper casing 56 includes a lid 57 having a contact surface contacting the side walls 54, and insertion apertures 57a disposed on the lid 57. The cutter holder 61 is configured to be inserted through the insertion aperture 57a. Further, the upper casing 56 may include a presser portion 58 for pressing the laminate sheet 1 accommodated in the lower casing 52 from above in order to fix the laminate sheet 1 on the reference surface at a relative position appropriately.

[0081] With the laminate-sheet cutting apparatus 50 with the above configuration, a part of the laminate sheet 1 is accommodated in the lower casing 52 while the upper casing 56 is open, and then the upper casing 56 is rotated and closed. At this time, the laminate sheet 1 is pressed against the reference surface from above by the presser portion 58. Next, the ultrasonic cutter 60 is inserted through the insertion aperture 57a of the upper casing 56 so as to press the cutter 62 into the laminate sheet 1. Then, the ultrasonic cutter 60 is pressed in further until the flange portion 63 disposed on the cutter holder 61 comes into contact with the circumferential edge of the insertion aperture 57a, and then the ultrasonic cutter 60 stops at the point of contact. In this way, the pressing-in amount of the cutter 62 is determined. Similar operation is performed at the plurality of positions P_2, P_3 in the longitudinal direction of the laminate sheet 1. At this time, the pressing-in amounts (traveling amounts) 9 of the cutter 62 at the respective positions are restricted due to the varied positions of the flange 63 in the length direction of the cutter holder 61 at the plurality of positions P_2, P_3. As a result, the end is formed in a stair shape.

[0082] With the above configuration, the lower casing 52 and the upper casing 56 are attached rotatably to each other via the rotation shaft 59. Further, the cutter holder 61 contacts the insertion apertures 57a at the flange 63, so that the cutter 62 and the casing 56 are positioned with respect to each other. In this way, by assembling the lower casing 52 and the upper casing 56, it is possible to determine the positions of the laminate sheet 1 placed on the base 53, and the cutter 62 attached to the cutter holder 61. Thus, it is possible to form stepped portions of a stair shape on the laminate sheet 1 accurately.

[0083] As described above, according to the above embodiments, the laminate sheet 1 is cut by pressing the cutter 12 into the laminate sheet 1 at the plurality of positions in the longitudinal direction of the laminate sheet 1. At this time, the cutter 12 is pressed into the laminate sheet 1 in the thickness direction. Thus, as compared to a case where the laminate sheet 1 is cut to have a tapered shape, the cutting work is facilitated, because the cutter only needs to be pressed in a direction perpendicular to the laminate sheet. Further, the end of the laminate sheet 1 is cut to have a stair shape by differentiating the pressing-in amounts of the cutter at the respective positions, which makes it possible to obtain fiber-reinforced plastic which is less likely to cause delamination, when manufacturing fiber-reinforced plastic by stacking a plurality of laminate sheets 1 having been cut by the above method of cutting a laminate sheet.

[0084] Embodiments of the present invention were described in detail above, but the present invention is not limited thereto, and various amendments and modifications may be implemented within a scope that does not depart from the present invention, as defined by the claims.

[0085]

1, 1A to 1C	Laminate sheet
2	End surface
4, 4', 4A to 4C	Stepped portion
10, 10', 20, 40, 50	Laminate-sheet cutting apparatus
12, 12', 32, 48, 62	Cutter
14	Cutting jig
14a	Cutter receiving surface
15, 22, 43, 53	Base
16	Groove
17	Stopper
20	Cutting apparatus
21,42	Casing
23, 44, 54	Side wall
23a	Upper surface
24, 45, 55	Slit
25	Cutter holder
26	Support plate
17	Contact surface
28	Plate member
30, 60	Ultrasonic cutter
31	Ultrasonic generation part
52	Lower casing
56	Upper casing
57	Casing body
57a	Insertion aperture
58	Presser portion
59	Rotation shaft
63	Flange portion
100	Fiber-reinforced plastic

Claims

1. A method of cutting a laminate sheet (1) in which a plurality of sheet members are assembled to form fiber-reinforced plastic (100), the method comprising:

a cutter-placing step of placing at least one cutter (12, 32, 48, 62) which extends in a thickness direction of the laminate sheet (1), on the laminate sheet (1) at a plurality of positions in a longitudinal direction of the laminate sheet (1); and
a cutting step, after the cutter-placing step, of cutting the laminate sheet (1) by pressing the at least one cutter (12, 32, 48, 62) into the laminate sheet (1) in the thickness direction,
wherein, in the cutting step, at the plurality of positions, respective pressing-in amounts by which the at least one cutter (12, 32, 48, 62) is pressed into the laminate sheet (1) are varied from one another so that an end of the laminate sheet (1) is cut to have a stair shape.

2. The method of cutting a laminate sheet (1) for fiber-reinforced plastic (100) according to claim 1, further comprising, before the cutter-placing step, a jig-positioning step of positioning a cutting jig (14) on the laminate sheet (1) with respect to the thickness direction,
wherein, in the cutting step, a traveling amount traveled by the at least one cutter (12, 32, 48, 62) in the thickness direction is restricted by the cutting jig (14), so as to differentiate the respective pressing-in amounts of the at least one cutter (12, 32, 48, 62) at the plurality of positions.

3. The method of cutting a laminate sheet (1) for fiber-reinforced plastic (100) according to claim 1 or 2,
wherein, in the cutter-placing step, the at least one cutter (12, 32, 48, 62) is placed on the laminate sheet (1) so that a blade surface of the at least one cutter (12, 32, 48, 62) is diagonal with respect to a width direction of the laminate sheet (1), and

wherein, in the cutting step, the laminate sheet (1) is cut in a diagonal direction with respect to the width direction by the at least one cutter (12, 32, 48, 62).

4. The method of cutting a laminate sheet (1) for fiber-reinforced plastic (100) according to claim 3, wherein, in the cutting step, the laminate sheet (1) is cut along a cutting line of a V shape.

5. The method of cutting a laminate sheet (1) for fiber-reinforced plastic (100) according to claim 3 or 4, wherein an angle (θ) between the width direction and the cutting line of the laminate sheet (1) is more than 0 degree and not more than 60 degrees.

6. The method of cutting a laminate sheet (1) for fiber-reinforced plastic (100) according any one of claims 1 or 5, wherein a difference in the pressing-in amounts between adjacent two of the plurality of positions is not less than 0.1mm and not more than 5mm.

7. A laminate-sheet cutting apparatus (10, 20, 40, 50) for cutting a laminate sheet (1) in which a plurality of sheets are assembled to form fiber-reinforced plastic (100), the cutting apparatus (10, 20, 40, 50) comprising:

at least one cutter (12, 32, 48, 62) for cutting the laminate sheet (1);
a positioning part configured to be capable of positioning the at least one cutter (12, 32, 48, 62) at a plurality of positions in a longitudinal direction of the laminate sheet (1); and
a traveling-amount restricting part for restricting traveling amounts traveled by the at least one cutter (12, 32, 48, 62) in a thickness direction of the laminate sheet (1),
a base (15, 22, 43, 53) which includes a reference surface on which the laminate sheet (1) is placed,
wherein the traveling-amount restricting part is configured to differentiate the respective traveling amounts at the plurality of positions from one another so that an end of the laminate sheet (1) is cut to have a stair shape,
wherein the traveling-amount restriction part is configured to restrict the traveling amounts of the at least one cutter (12, 32, 48, 62) with respect to the reference surface, and
wherein the traveling-amount restriction part includes: a pair of side walls (23, 44, 53) stood up on the base (15, 22, 43, 53) at opposite sides of the reference surface in the width direction of the laminate sheet (1), the pair of side walls (23, 44, 53) including an upper surface (23a) of a stair shape; and a cutter holder (25) attached to the at least one cutter (12, 32, 48, 62), the cutter holder (25) including a contact surface (27) of a stair shape which is configured to contact the upper surface (23a) of the stair shape.

8. The laminate-sheet cutting apparatus (10, 20, 40, 50) for fiber-reinforced plastic according to claim 7, wherein the positioning part is an engaging part between a protrusion disposed on one of the pair of side walls (23, 44, 53) or the cutter holder (25) and a recess disposed on other one of the pair of side walls (23, 44, 53) or the cutter holder (25), and
wherein the engaging part is disposed at each of the plurality of positions in the longitudinal direction of the laminate sheet (1).

9. A laminate-sheet cutting apparatus (10, 20, 40, 50) for cutting a laminate sheet (1) in which a plurality of sheets are assembled to form fiber-reinforced plastic (100), the cutting apparatus (10, 20, 40, 50) comprising:

at least one cutter (12, 32, 48, 62) for cutting the laminate sheet (1);
a positioning part configured to be capable of positioning the at least one cutter (12, 32, 48, 62) at a plurality of positions in a longitudinal direction of the laminate sheet (1); and
a traveling-amount restricting part for restricting traveling amounts traveled by the at least one cutter (12, 32,48, 62) in a thickness direction of the laminate sheet (1),
a base (15, 22, 43, 53) which includes a reference surface on which the laminate sheet (1) is placed,
a pair of side walls (23, 44, 53) stood up on the base at opposite sides of the reference surface in the width direction of the laminate sheet (1), the pair of side walls (23, 44, 53) including an upper surface (23a) of a stair shape, and
an upper casing (56) rotatably attached to a lower casing (52) about a rotation shaft (59), the lower casing (52) including the base (53) and the pair of side walls (23, 44, 53), and the upper casing (56) including an insertion aperture (57a) for a cutter holder (25) which is attached to the at least one cutter (12, 32,48, 62),
wherein the traveling-amount restricting part is configured to differentiate the respective traveling amounts at the plurality of positions from one another so that an end of the laminate sheet (1) is cut to have a stair shape,
wherein the traveling-amount restriction part is configured to restrict the traveling amounts of the at least one

cutter (12, 32, 48, 62) with respect to the reference surface, and
wherein the traveling-amount restricting part includes a flange portion (63) which restricts an insertion depth to which the cutter holder (25) is inserted through the insertion aperture.

Patentansprüche

1. Verfahren zum Schneiden eines Laminatbogens (1), bei dem mehrere Lagen zusammengefügt sind, um faserverstärkten Kunststoff (100) zu bilden, wobei das Verfahren umfasst:

   einen Schneidvorrichtung-Anordnungsschritt zum Anordnen mindestens einer Schneidvorrichtung (12, 32, 48, 62), die sich in einer Dickenrichtung des Laminatbogens (1) erstreckt, auf dem Laminatbogen (1) an mehreren Positionen in einer Längsrichtung des Laminatbogens (1), und
   einen Schneidschritt nach dem Schneidvorrichtung-Anordnungsschritt zum Schneiden des Laminatbogens (1) durch Hineindrücken der mindestens einen Schneidvorrichtung (12, 32, 48, 62) in den Laminatbogens (1) in der Dickenrichtung,
   wobei in dem Schneidschritt an den mehreren Positionen jeweilige Eindrückbeträge, um die die mindestens eine Schneidvorrichtung (12, 32, 48, 62) in den Laminatbogen (1) hineingedrückt wird, so voneinander variiert werden, dass ein Ende des Laminatbogens (1) so geschnitten ist, dass es eine Treppenform bildet.

2. Verfahren zum Schneiden eines Laminatbogens (1) für faserverstärkten Kunststoff (100) nach Anspruch 1, das ferner vor dem Schneidvorrichtung-Anordnungsschritt einen Schablonen-Positionierungsschritt zum Positionieren einer Schneidschablone (14) an dem Laminatbogen (1) in Bezug auf die Dickenrichtung umfasst,
   wobei in dem Schneidschritt ein Vorschubbetrag, der von der mindestens einen Schneidvorrichtung (12, 32, 48, 62) in der Dickenrichtung zurückgelegt wird, durch die Schneidschablone (14) begrenzt wird, um die jeweiligen Eindrückbeträge der mindestens einen Schneidvorrichtung (12, 32, 48, 62) an den mehreren Positionen voneinander zu unterscheiden.

3. Verfahren zum Schneiden eines Laminatbogens (1) für faserverstärkten Kunststoff (100) nach Anspruch 1 oder 2, wobei in dem Schneidvorrichtung-Anordnungsschritt die mindestens eine Schneidvorrichtung (12, 32, 48, 62) so auf dem Laminatbogen (1) angeordnet wird, dass eine Messerfläche der mindestens einen Schneidvorrichtung (12, 32, 48, 62) in Bezug auf eine Breitenrichtung des Laminatbogens (1) diagonal verläuft, und
   wobei in dem Schneidschritt der Laminatbogen (1) in einer diagonalen Richtung in Bezug auf die Breitenrichtung von der mindestens einen Schneidvorrichtung (12, 32, 48, 62) geschnitten wird.

4. Verfahren zum Schneiden eines Laminatbogens (1) für faserverstärkten Kunststoff (100) nach Anspruch 3, wobei in dem Schneidschritt der Laminatbogen (1) entlang einer V-förmigen Schneidlinie geschnitten wird.

5. Verfahren zum Schneiden eines Laminatbogens (1) für faserverstärkten Kunststoff (100) nach Anspruch 3 oder 4, wobei ein Winkel (θ) zwischen der Breitenrichtung und der Schneidlinie des Laminatbogens (1) mehr als 0 Grad und nicht mehr als 60 Grad beträgt.

6. Verfahren zum Schneiden eines Laminatbogens (1) für faserverstärkten Kunststoff (100) nach einem der Ansprüche 1 oder 5,
   wobei eine Differenz der Eindrückbeträge zwischen benachbarten zwei der mehreren Positionen nicht geringer als 0,1 mm und nicht mehr als 5 mm beträgt.

7. Laminatbogenschneidvorrichtung (10, 20, 40, 50) zum Schneiden eines Laminatbogens (1), bei dem mehrere Lagen zusammengefügt sind, um faserverstärkten Kunststoff (100) zu bilden, wobei die Schneidvorrichtung (10, 20, 40, 50) umfasst:

   mindestens eine Schneidvorrichtung (12, 32, 48, 62) zum Schneiden des Laminatbogens (1),
   einen Positionierungsteil, der dafür konfiguriert ist, die mindestens eine Schneidvorrichtung (12, 32, 48, 62) an mehreren Positionen in einer Längsrichtung des Laminatbogens (1) positionieren zu können, und
   einen Vorschubbetragbegrenzungsteil zum Begrenzen von Vorschubbeträgen, die von der mindestens einen Schneidvorrichtung (12, 32, 48, 62) in einer Dickenrichtung des Laminatbogens (1) zurückgelegt werden,
   eine Grundplatte (15, 22, 43, 53), die eine Referenzfläche enthält, auf der der Laminatbogen (1) angeordnet wird,
   wobei der Vorschubbetragbegrenzungsteil dafür konfiguriert ist, die jeweiligen Vorschubbeträge an den meh-

reren Positionen so voneinander zu differenzieren, dass ein Ende des Laminatbogens (1) so geschnitten wird, dass es eine Treppenform aufweist,
wobei der Vorschubbetragbegrenzungsteil dafür konfiguriert ist, die Vorschubbeträge der mindestens einen Schneidvorrichtung (12, 32, 48, 62) in Bezug auf die Referenzfläche zu begrenzen, und
wobei der Vorschubbetragbegrenzungsteil enthält: ein Paar Seitenwände (23, 44, 53), die auf der Grundplatte (15, 22, 43, 53) auf gegenüberliegenden Seiten der Referenzfläche in der Breitenrichtung des Laminatbogens (1) aufrecht stehen, wobei das Paar Seitenwände (23, 44, 53) eine treppenförmige Oberseite (23a) enthält, und einen Schneidvorrichtungshalter (25), der an der mindestens einen Schneidvorrichtung (12, 32, 48, 62) angebracht ist, wobei der Schneidvorrichtungshalter (25) eine treppenförmige Kontaktfläche (27) enthält, die dafür konfiguriert ist, die treppenförmige Oberseite (23a) zu berühren.

8. Laminatbogenschneidvorrichtung (10, 20, 40, 50) für faserverstärkten Kunststoff nach Anspruch 7,
wobei der Positionierungsteil ein Belegteil zwischen einem Vorsprung, der an einem des Paares Seitenwände (23, 44, 53) oder des Schneidvorrichtungshalters (25) angeordnet ist, und einer Aussparung, die an dem anderen des Paares Seitenwände (23, 44, 53) oder des Schneidvorrichtungshalters (25) angeordnet ist, ist, und
wobei der Belegteil an jeder der mehreren Positionen in der Längsrichtung des Laminatbogens (1) angeordnet ist.

9. Laminatbogenschneidvorrichtung (10, 20, 40, 50) zum Schneiden eines Laminatbogens (1), bei dem mehrere Lagen zusammengefügt sind, um faserverstärkten Kunststoff (100) zu bilden, wobei die Schneidvorrichtung (10, 20, 40, 50) umfasst:

mindestens eine Schneidvorrichtung (12, 32, 48, 62) zum Schneiden des Laminatbogens (1),
einen Positionierungsteil, der dafür konfiguriert ist, die mindestens eine Schneidvorrichtung (12, 32, 48, 62) an mehreren Positionen in einer Längsrichtung des Laminatbogens (1) positionieren zu können, und
einen Vorschubbetragbegrenzungsteil zum Begrenzen von Vorschubbeträgen, die von der mindestens einen Schneidvorrichtung (12, 32, 48, 62) in einer Dickenrichtung des Laminatbogens (1) zurückgelegt werden,
eine Grundplatte (15, 22, 43, 53), die eine Referenzfläche enthält, an der der Laminatbogens (1) angeordnet wird,
ein Paar Seitenwände (23, 44, 53), die auf der Grundplatte auf gegenüberliegenden Seiten der Referenzfläche in der Breitenrichtung des Laminatbogens (1) aufrecht stehen, wobei das Paar Seitenwände (23, 44, 53) eine treppenförmige Oberseite (23a) enthält, und
ein oberes Gehäuse (56), das um eine Drehwelle (59) herum drehbar an einem unteren Gehäuse (52) angebracht ist, wobei das untere Gehäuse (52) die Grundplatte (53) und das Paar Seitenwände (23, 44, 53) enthält, und das obere Gehäuse (56) eine Einschuböffnung (57a) für einen Schneidvorrichtungshalter (25) enthält, der an der mindestens einen Schneidvorrichtung (12, 32, 48, 62) angebracht ist,
wobei der Vorschubbetragbegrenzungsteil dafür konfiguriert ist, die jeweiligen Vorschubbeträge an den mehreren Positionen so voneinander zu differenzieren, dass ein Ende des Laminatbogens (1) so geschnitten wird, dass es eine Treppenform aufweist,
wobei der Vorschubbetragbegrenzungsteil dafür konfiguriert ist, die Vorschubbeträge der mindestens einen Schneidvorrichtung (12, 32, 48, 62) mit Bezug auf die Referenzfläche zu begrenzen, und
wobei der Vorschubbetragbegrenzungsteil einen Flanschabschnitt (63) enthält, der eine Einschubtiefe begrenzt, um die der Schneidvorrichtungshalter (25) durch die Einschuböffnung geschoben wird.

Revendications

1. Procédé de coupe d'une feuille de stratifié (1) dans laquelle une pluralité d'éléments de feuille est assemblée pour former une matière plastique renforcée de fibres (100), le procédé comportant :

une étape de mise en place de dispositif de coupe destinée à mettre en place au moins un dispositif de coupe (12, 32, 48, 62) qui s'étend dans une direction d'épaisseur de la feuille de stratifié (1), sur la feuille de stratifié (1) dans une pluralité de positions dans une direction longitudinale de la feuille de stratifié (1) ; et
une étape de coupe, après l'étape de mise en place de dispositif de coupe, destinée à couper la feuille de stratifié (1) en appuyant le au moins un dispositif de coupe (12, 32, 48, 62) dans la feuille de stratifié (1) dans la direction d'épaisseur,
selon lequel, dans l'étape de coupe, dans la pluralité de positions, des quantités d'enfoncement respectives grâce auxquelles le au moins un dispositif de coupe (12, 32, 48, 62) est appuyé dans la feuille de stratifié (1) sont modifiées l'une par rapport à l'autre de telle sorte qu'une extrémité de la feuille de stratifié (1) est coupée pour avoir une forme d'escalier.

2. Procédé de coupe d'une feuille de stratifié (1) pour une matière plastique renforcée de fibres (100) selon la revendication 1, comportant en outre, avant l'étape de mise en place de dispositif de coupe, une étape de positionnement de gabarit destinée à positionner un gabarit de coupe (14) sur la feuille de stratifié (1) par rapport à la direction d'épaisseur,
selon lequel, dans l'étape de coupe, une quantité de déplacement parcourue par le au moins un dispositif de coupe (12, 32, 48, 62) dans la direction d'épaisseur est limitée par le gabarit de coupe (14), de façon à différencier les quantités d'enfoncement respectives du au moins un dispositif de coupe (12, 32, 48, 62) dans la pluralité de positions.

3. Procédé de coupe d'une feuille de stratifié (1) pour une matière plastique renforcée de fibres (100) selon la revendication 1 ou 2,
selon lequel, dans l'étape de mise en place de dispositif de coupe, le au moins un dispositif de coupe (12, 32, 48, 62) est placé sur la feuille de stratifié (1) de telle sorte qu'une surface de lame du au moins un dispositif de coupe (12, 32, 48, 62) est en diagonale par rapport à une direction de largeur de la feuille de stratifié (1), et
selon lequel, dans l'étape de coupe, la feuille de stratifié (1) est coupée dans une direction diagonale par rapport à la direction de largeur par le au moins un dispositif de coupe (12, 32, 48, 62).

4. Procédé de coupe d'une feuille de stratifié (1) pour une matière plastique renforcée de fibres (100) selon la revendication 3,
selon lequel, dans l'étape de coupe, la feuille de stratifié (1) est coupée suivant une ligne de coupe en forme de V.

5. Procédé de coupe d'une feuille de stratifié (1) pour une matière plastique renforcée de fibres (100) selon la revendication 3 ou 4,
selon lequel un angle (θ) entre la direction de largeur et la ligne de coupe de la feuille de stratifié (1) est supérieur à 0 degré et pas supérieur à 60 degrés.

6. Procédé de coupe d'une feuille de stratifié (1) pour une matière plastique renforcée de fibres (100) selon l'une quelconque des revendications 1 ou 5,
selon lequel une différence dans les quantités d'enfoncement entre deux positions adjacentes de la pluralité de positions n'est pas inférieure à 0,1 mm et pas supérieure à 5 mm.

7. Appareil de coupe de feuille de stratifié (10, 20, 40, 50) destiné à couper une feuille de stratifié (1) dans laquelle une pluralité de feuilles est assemblée pour former une matière plastique renforcée de fibres (100), l'appareil de coupe (10, 20, 40, 50) comportant :

au moins un dispositif de coupe (12, 32, 48, 62) destiné à couper la feuille de stratifié (1) ;
une partie de positionnement configurée pour être capable de positionner le au moins un dispositif de coupe (12, 32, 48, 62) dans une pluralité de positions dans une direction longitudinale de la feuille de stratifié (1) ; et
une partie de limitation de quantité de déplacement destinée à limiter des quantités de déplacement parcourues par le au moins un dispositif de coupe (12, 32, 48, 62) dans une direction d'épaisseur de la feuille de stratifié (1),
une base (15, 22, 43, 53) qui comprend une surface de référence sur laquelle la feuille de stratifié (1) est placée,
dans lequel la partie de limitation de quantité de déplacement est configurée pour différencier les quantités de déplacement respectives dans la pluralité de positions l'une par rapport à l'autre de telle sorte qu'une extrémité de la feuille de stratifié (1) est coupée pour avoir une forme d'escalier,
dans lequel la partie de limitation de quantité de déplacement est configurée pour limiter les quantités de déplacement du au moins un dispositif de coupe (12, 32, 48, 62) par rapport à la surface de référence, et
dans lequel la partie de limitation de quantité de déplacement comprend : une paire de parois latérales (23, 44, 53) qui se dressent sur la base (15, 22, 43, 53) sur des côtés opposés de la surface de référence dans la direction de largeur de la feuille de stratifié (1), la paire de parois latérales (23, 44, 53) comprenant une surface supérieure (23a) en forme d'escalier ; et un support de dispositif de coupe (25) fixé sur le au moins un dispositif de coupe (12, 32, 48, 62), le support de dispositif de coupe (25) comprenant une surface de contact (27) en forme d'escalier qui est configurée pour venir en contact avec la surface supérieure (23a) de la forme d'escalier.

8. Appareil de coupe de feuille de stratifié (10, 20, 40, 50) pour une matière plastique renforcée de fibres selon la revendication 7,
dans lequel la partie de positionnement est une partie d'engagement entre une saillie disposée sur un de la paire de parois latérales (23, 44, 53) ou du support de dispositif de coupe (25) et un renfoncement disposé sur l'autre de la paire de parois latérales (23, 44, 53) ou du support de dispositif de coupe (25), et
dans lequel la partie d'engagement est disposée dans chacune de la pluralité de positions dans la direction longi-

tudinale de la feuille de stratifié (1).

9. Appareil de coupe de feuille de stratifié (10, 20, 40, 50) pour couper une feuille de stratifié (1) dans laquelle une pluralité de feuilles est assemblée pour former une matière plastique renforcée de fibres (100), l'appareil de coupe comportant (10, 20, 40, 50) :

au moins un dispositif de coupe (12, 32, 48, 62) destiné à couper la feuille de stratifié (1) ;
une partie de positionnement configurée pour être capable de positionner le au moins un dispositif de coupe (12, 32, 48, 62) dans une pluralité de positions dans une direction longitudinale de la feuille de stratifié (1) ; et
une partie de limitation de quantité de déplacement destinée à limiter des quantités de déplacement parcourues par le au moins un dispositif de coupe (12, 32, 48, 62) dans une direction d'épaisseur de la feuille de stratifié (1),
une base (15, 22, 43, 53) qui comprend une surface de référence sur laquelle la feuille de stratifié (1) est placée,
une paire de parois latérales (23, 44, 53) qui se dressent sur la base sur des côtés opposés de la surface de référence dans la direction de largeur de la feuille de stratifié (1), la paire de parois latérales (23, 44, 53) comprenant une surface supérieure (23a) en forme d'escalier ; et
un boîtier supérieur (56) fixé de façon rotative sur un boîtier inférieur (52) autour d'un arbre de rotation (59), le boîtier inférieur (52) comprenant la base (53) et la paire de parois latérales (23, 44, 53), et le boîtier supérieur (56) comprenant une ouverture d'insertion (57a) pour un support de dispositif de coupe (25) qui est fixé sur le au moins un dispositif de coupe (12, 32, 48, 62),
dans lequel la partie de limitation de quantité de déplacement est configurée pour différencier les quantités de déplacement respectives dans la pluralité de positions l'une par rapport à l'autre de telle sorte qu'une extrémité de la feuille de stratifié (1) est coupée pour avoir une forme d'escalier,
dans lequel la partie de limitation de quantité de déplacement est configurée pour limiter les quantités de déplacement du au moins un dispositif de coupe (12, 32, 48, 62) par rapport à la surface de référence, et
dans lequel la partie de limitation de quantité de déplacement comprend une partie de rebord (63) qui limite une profondeur d'insertion à laquelle le support de dispositif de coupe (25) est inséré à travers l'ouverture d'insertion.

FIG. 1A

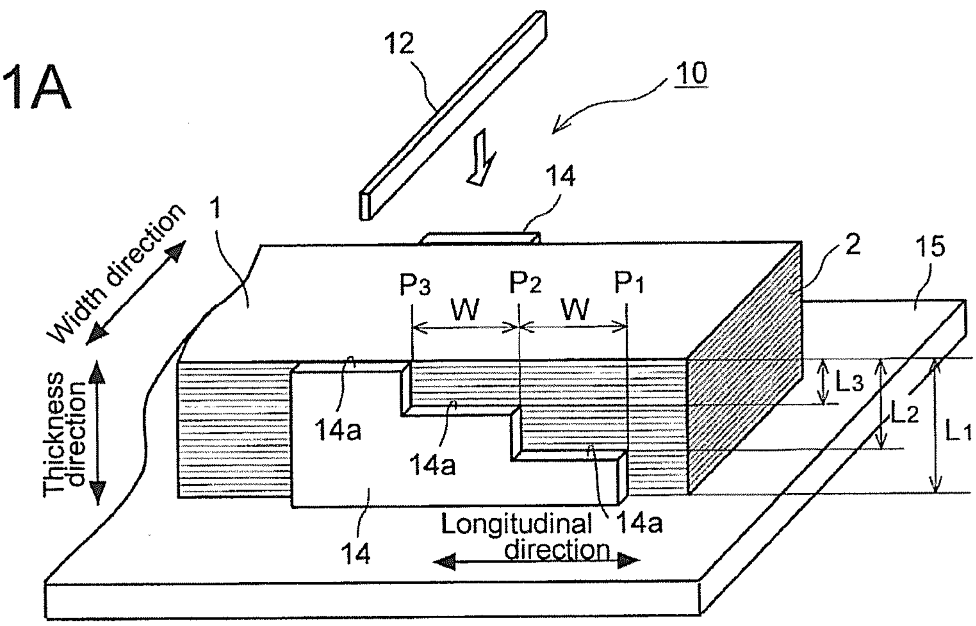


FIG. 1B

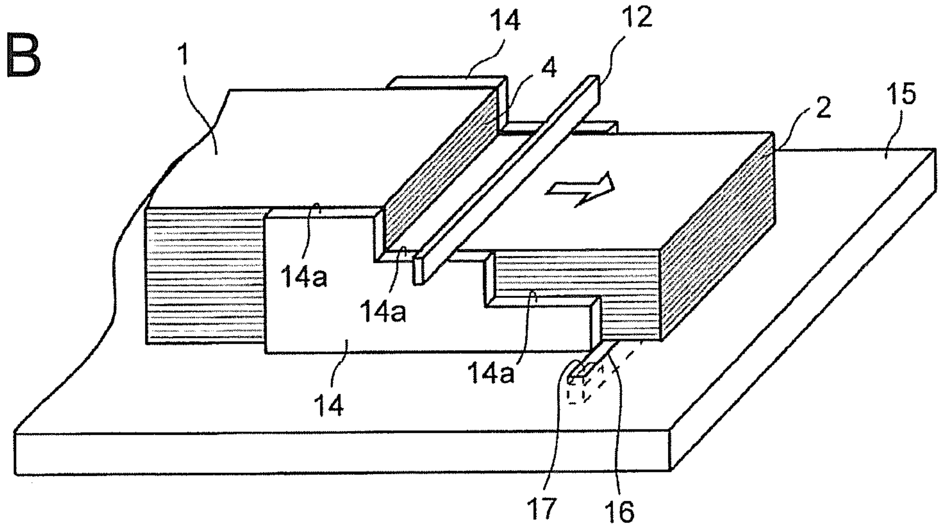


FIG. 1C

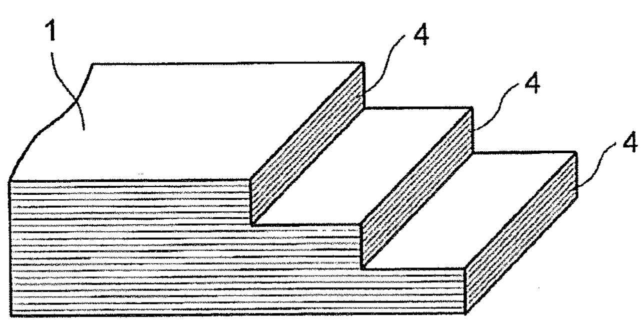


FIG. 2A

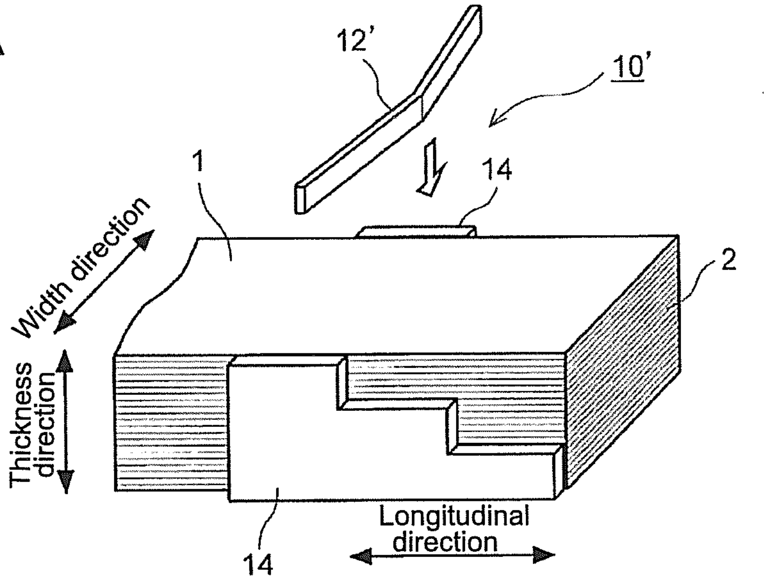


FIG. 2B

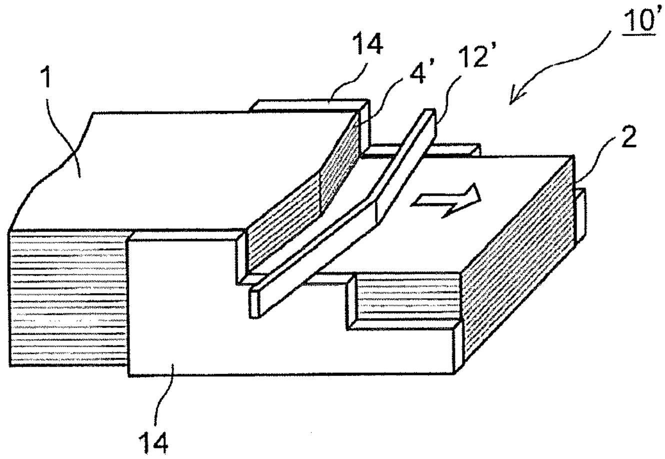


FIG. 2C

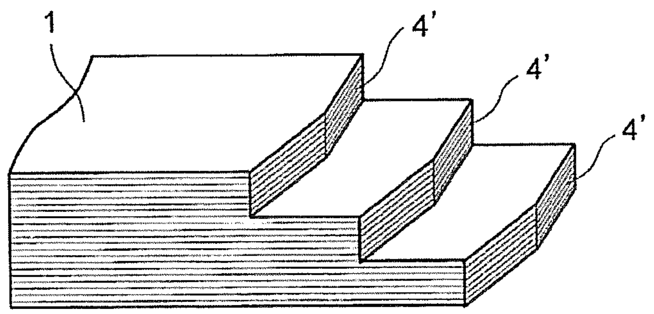


FIG. 3

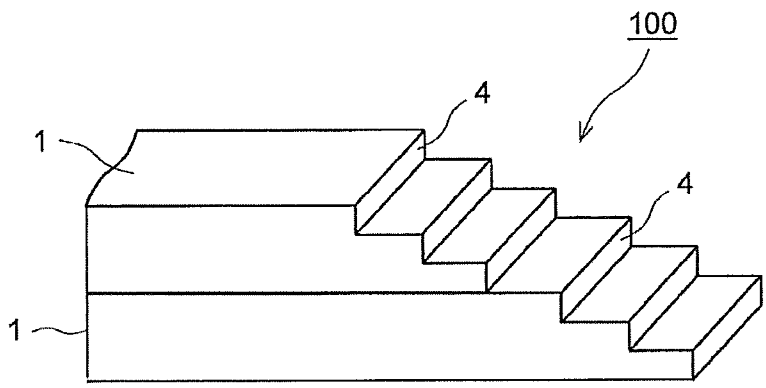


FIG. 4A

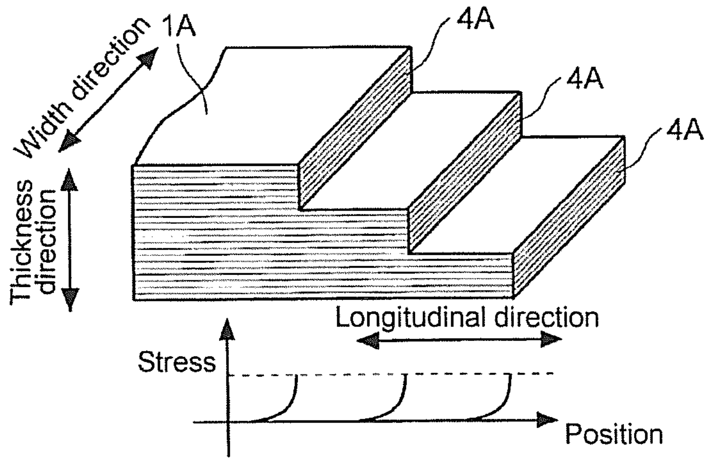


FIG. 4B

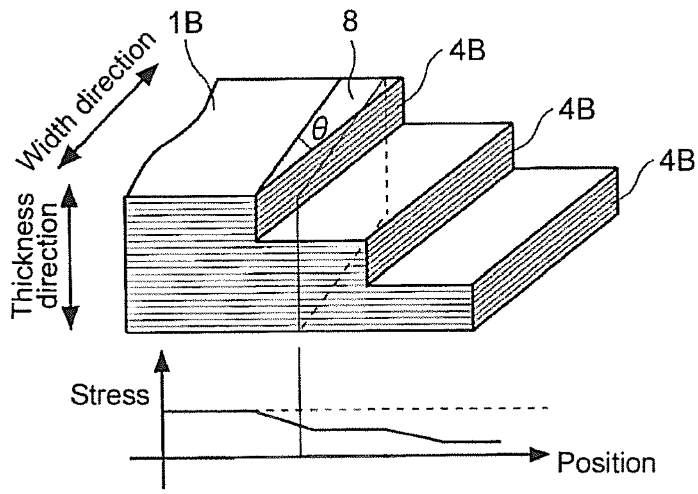


FIG. 4C

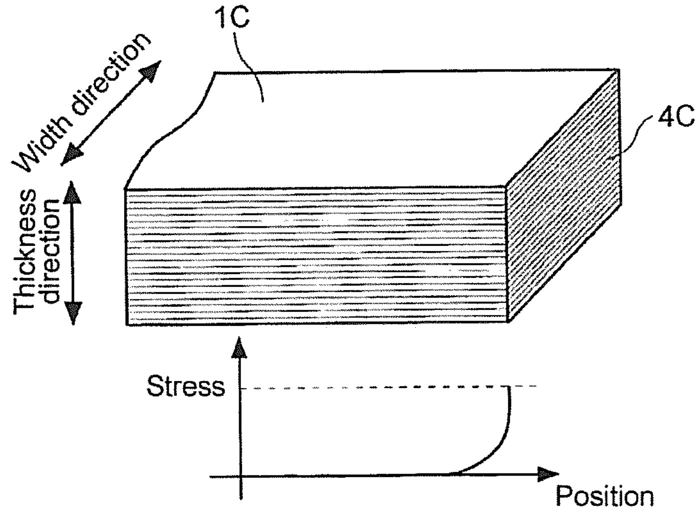


FIG. 5

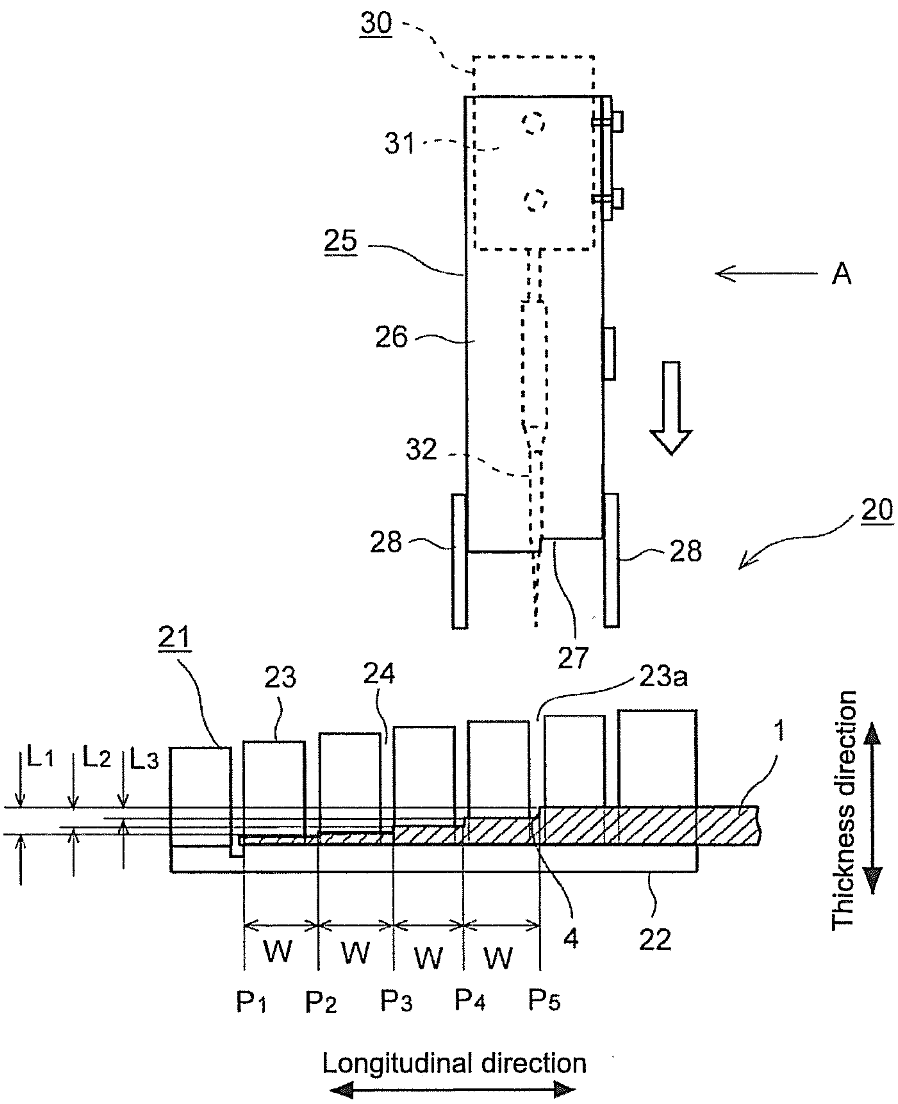

30
31
25
26
32
28
28
A
20
27
21
23
24
23a
1
L1
L2
L3
4
22
W
W
W
W
P1
P2
P3
P4
P5
Thickness direction
Longitudinal direction

FIG. 6

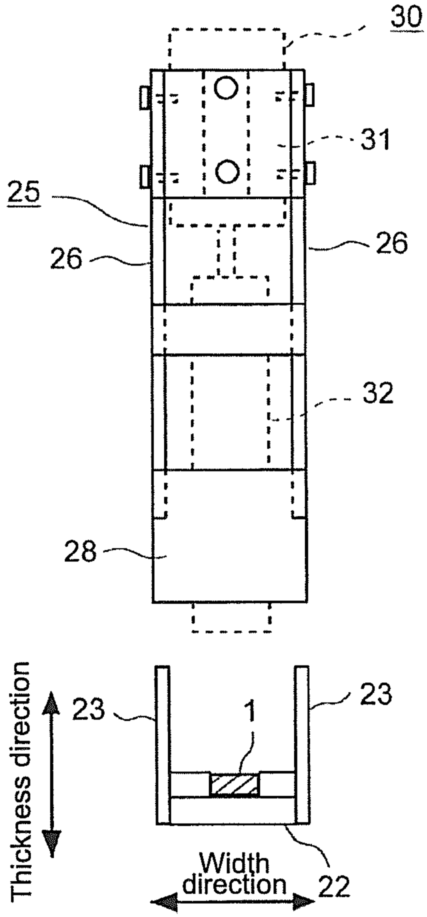

30
31
25
26
26
32
28
23
23
1
Thickness direction
Width direction
22

FIG. 7

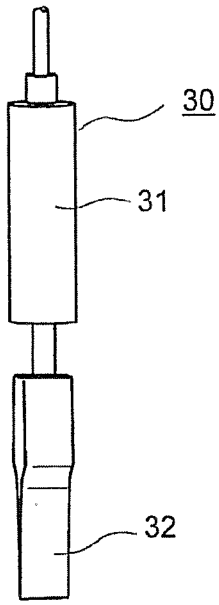

30
31
32

FIG. 8

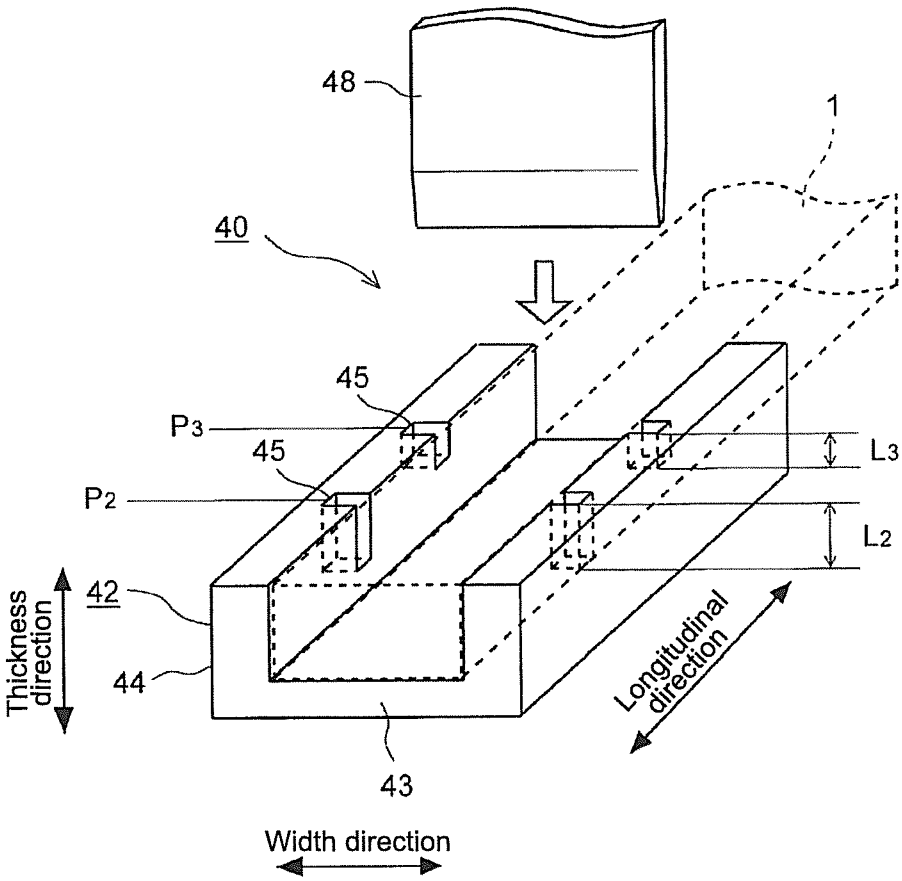

48
1
40
45
P3
45
L3
P2
L2
42
Thickness direction
44
Longitudinal direction
43
Width direction

FIG. 9A

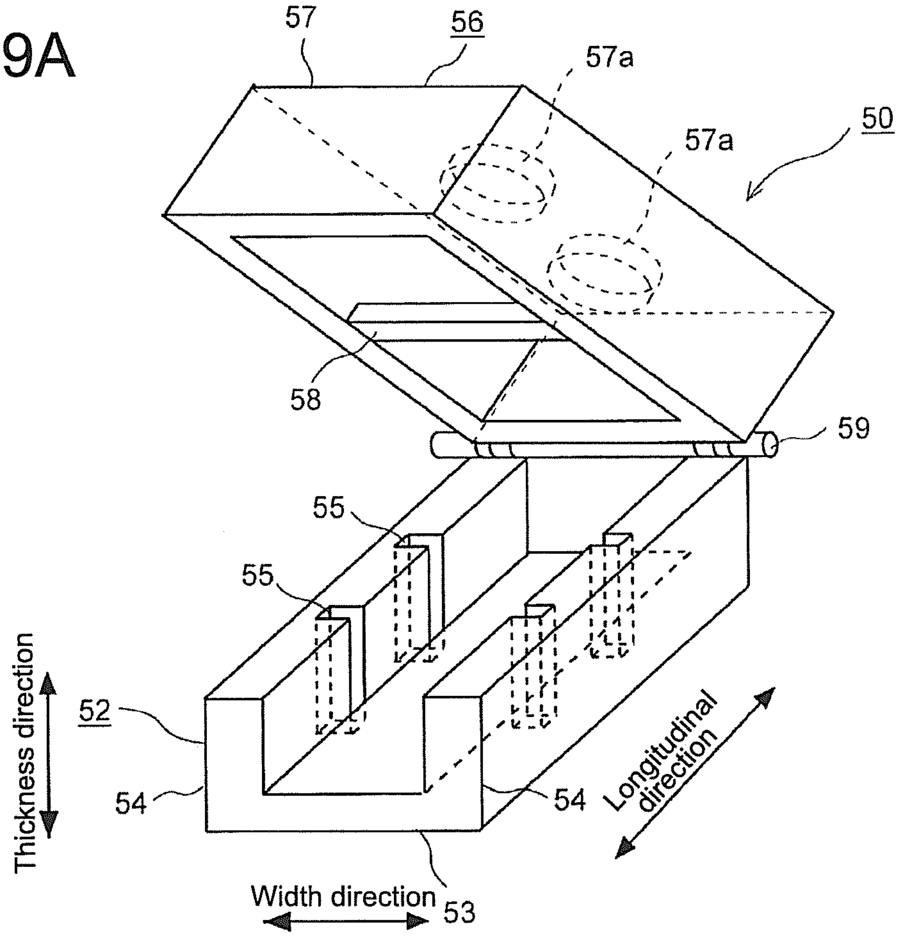
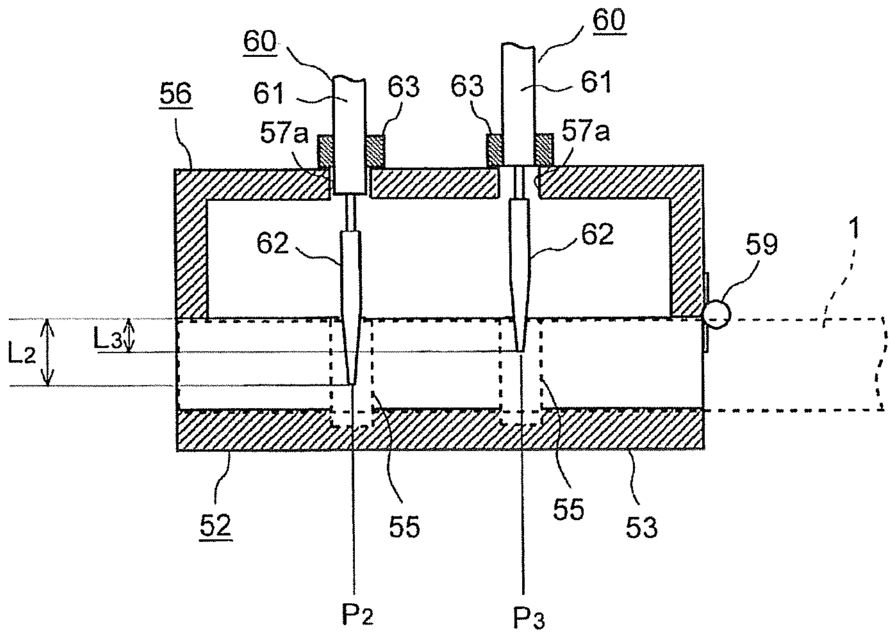

57
56
57a
57a
50
58
59
55
55
52
54
54
53
Thickness direction
Longitudinal direction
Width direction

FIG. 9B


60
60
56
61
63
63
61
57a
57a
62
62
59
1
L2
L3
52
55
55
53
P2
P3

REFERENCES CITED IN THE DESCRIPTION

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