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(54) **CUT SURFACE SMOOTHING DEVICE AND
MANUFACTURING SYSTEM**

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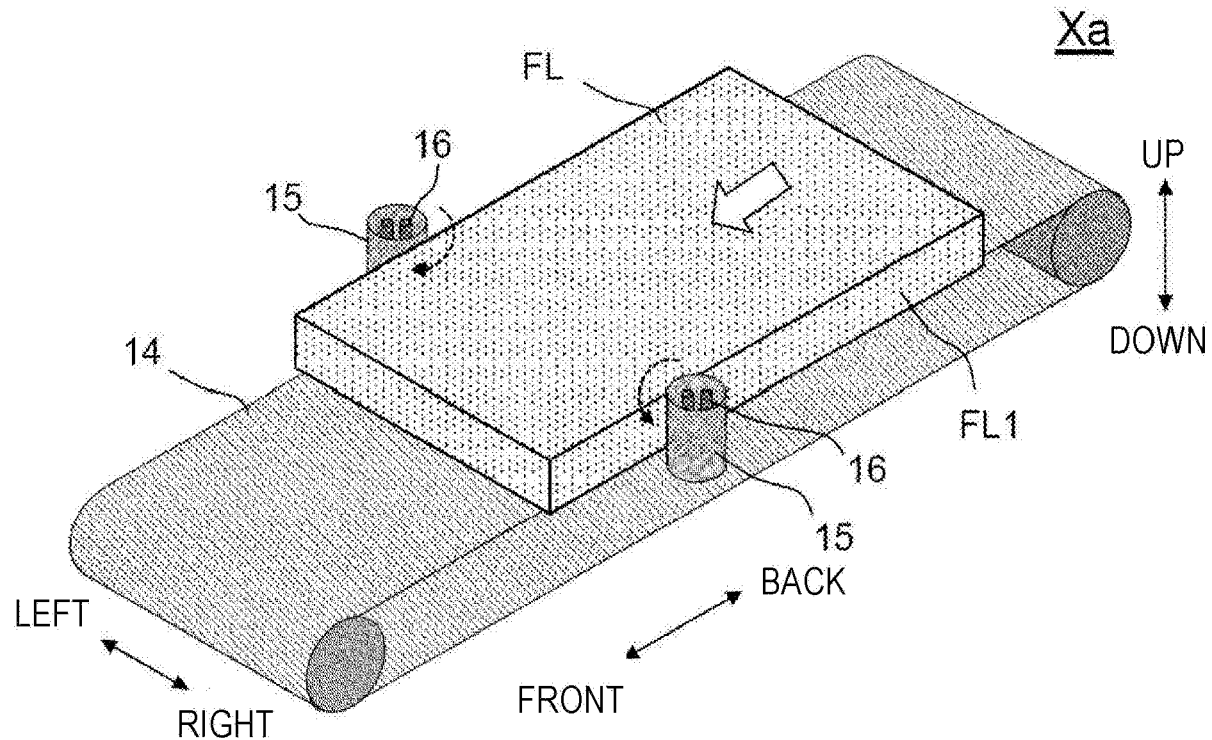
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ABSTRACT

A cut surface smoothing device which can smooth the cut surface of a filament three-dimensional bonded member is provided. The cut surface smoothing device includes a high temperature portion which is heated to a temperature equal to or higher than the melting point of the filament three-dimensional bonded member, and the high temperature portion is applied to the cut surface of the filament three-dimensional bonded member to smooth the cut surface.



S1

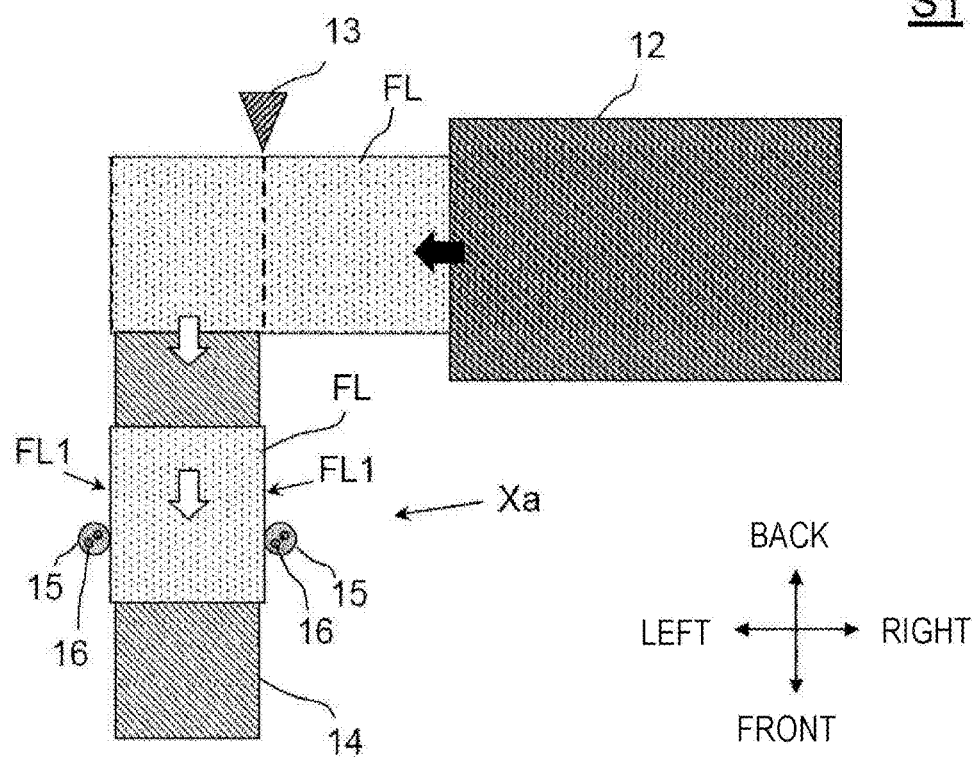


FIG. 1

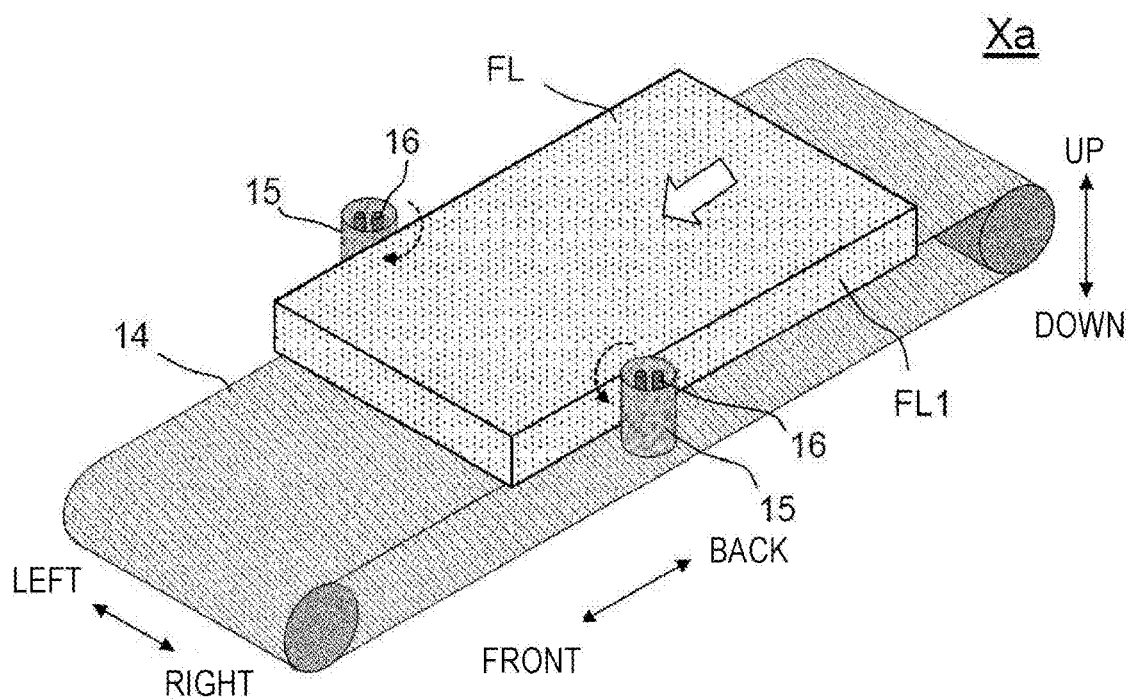


FIG. 2

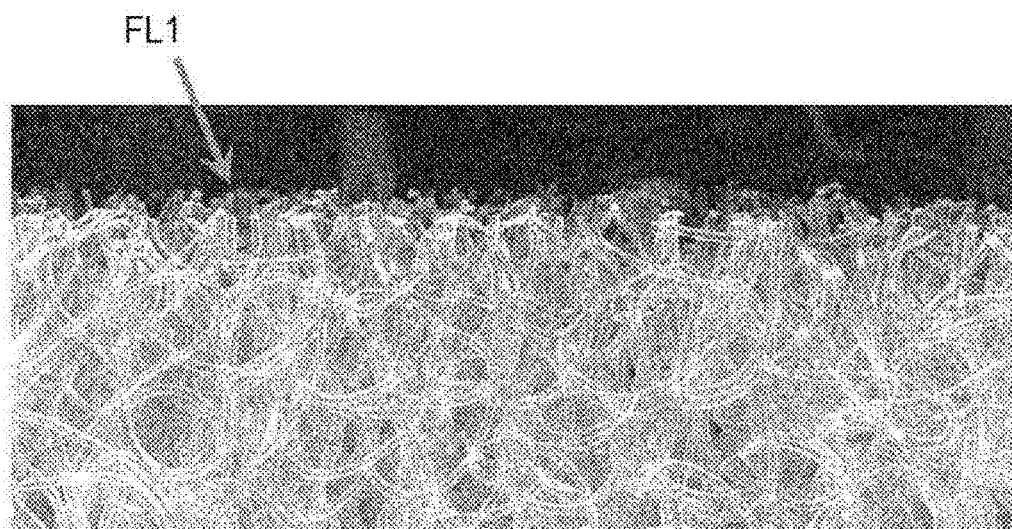


FIG. 3

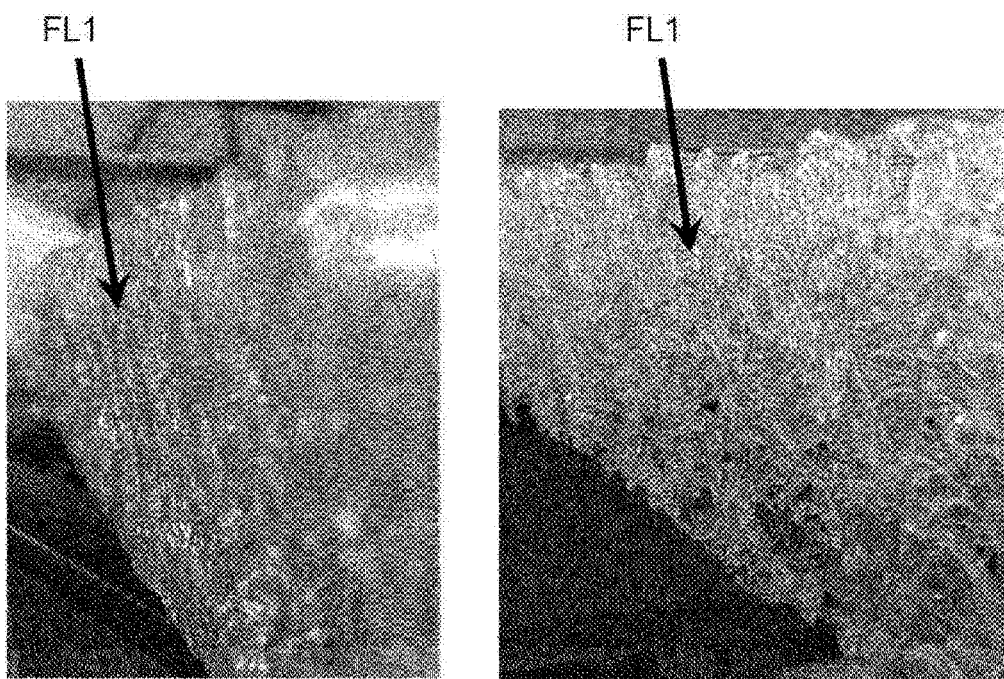


FIG. 4

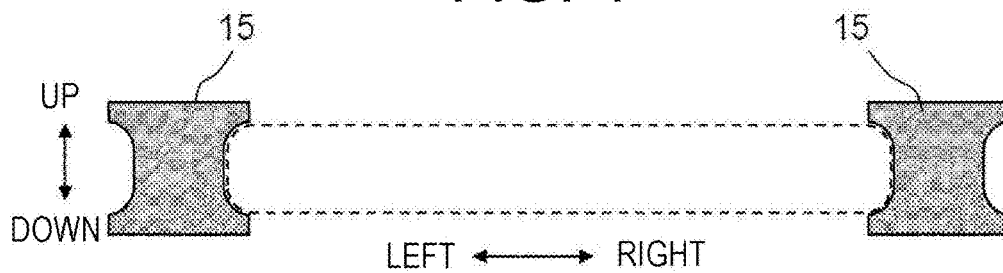


FIG. 5

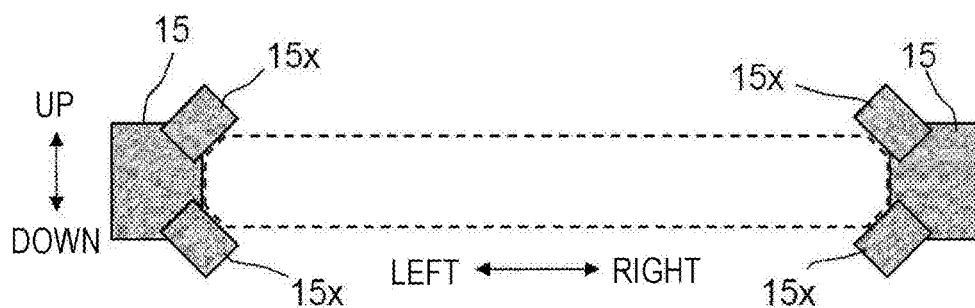


FIG. 6

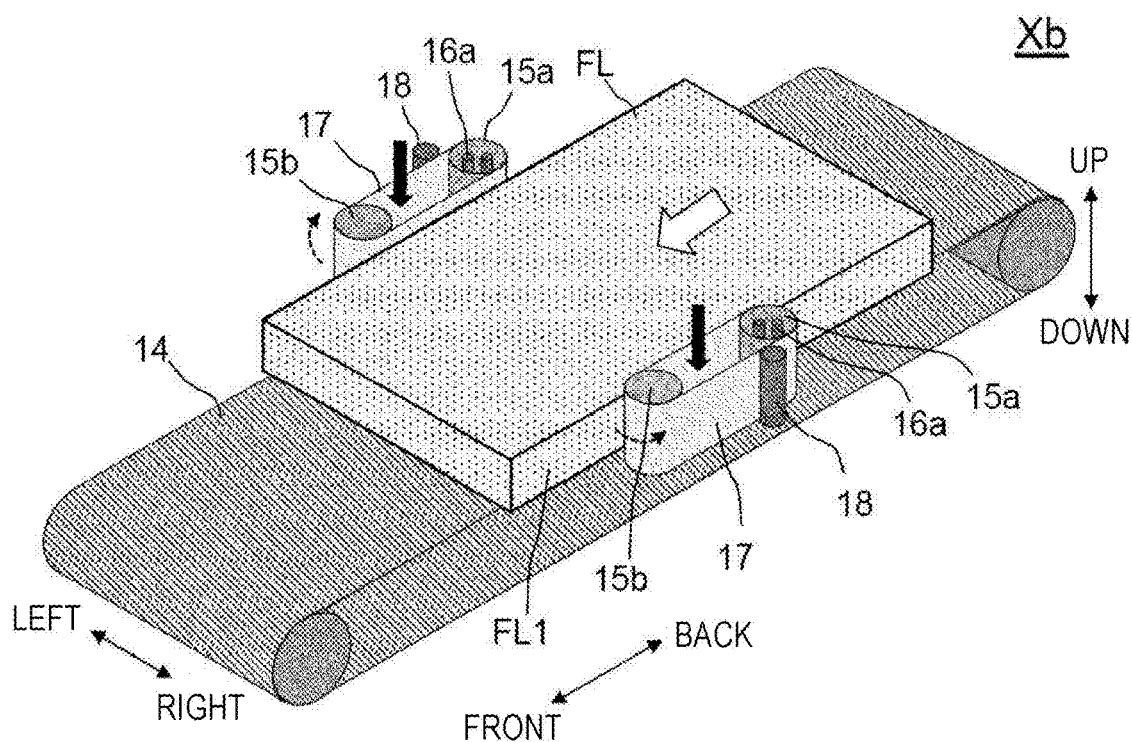


FIG. 7

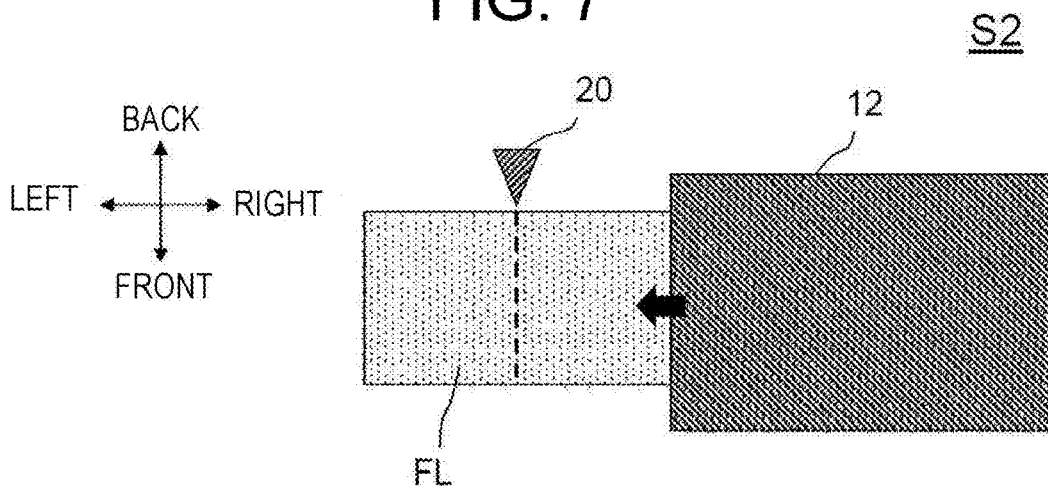


FIG. 8

21

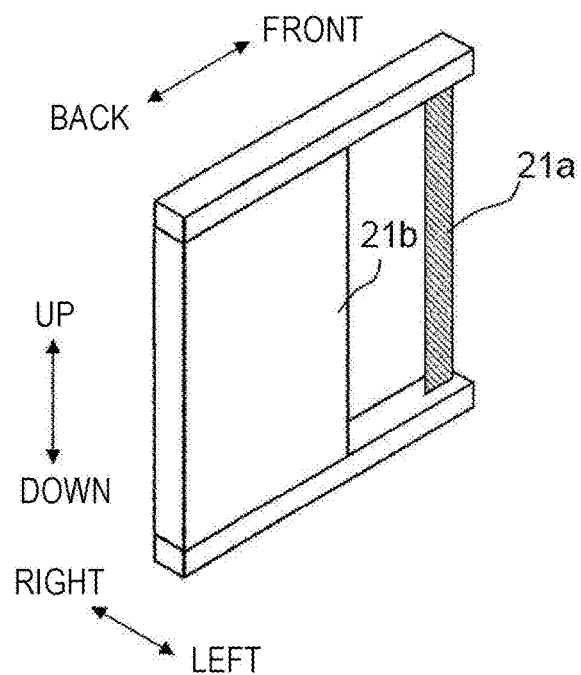


FIG. 9

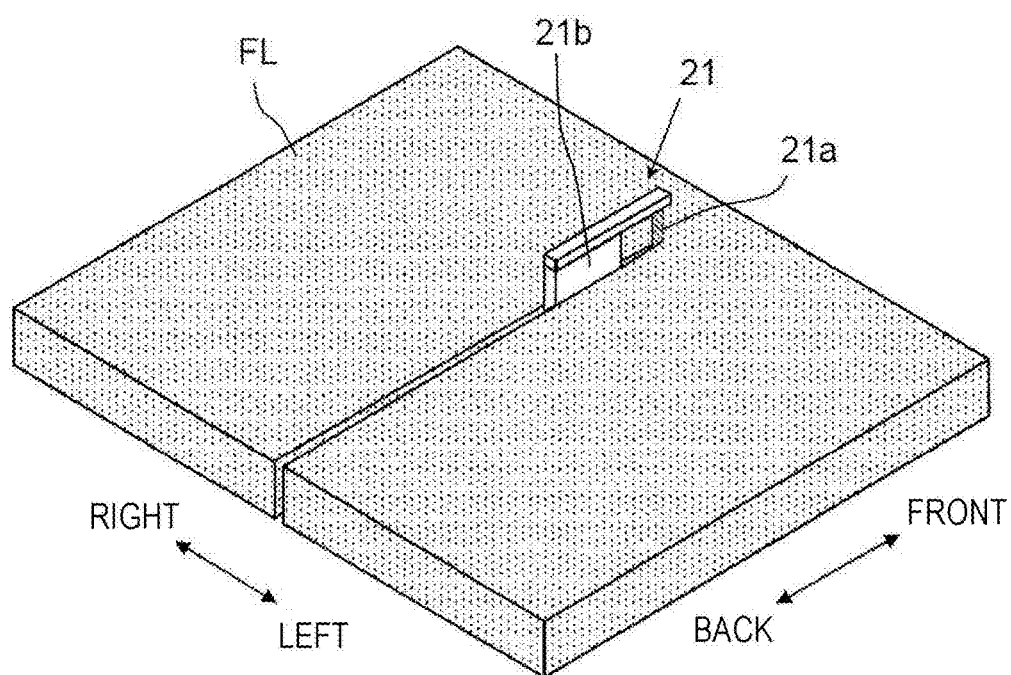


FIG. 10

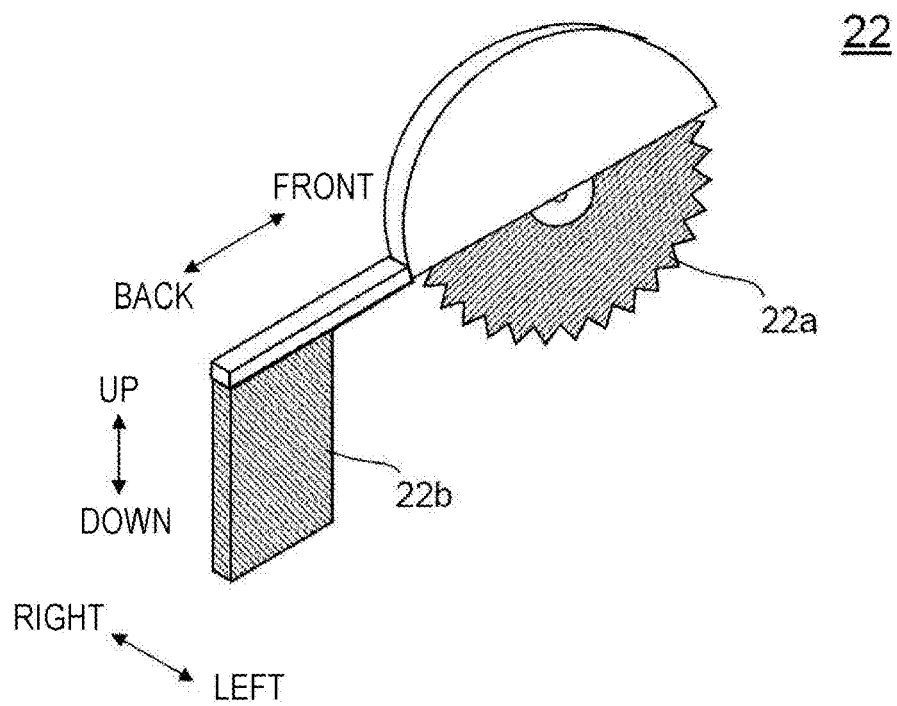


FIG. 11

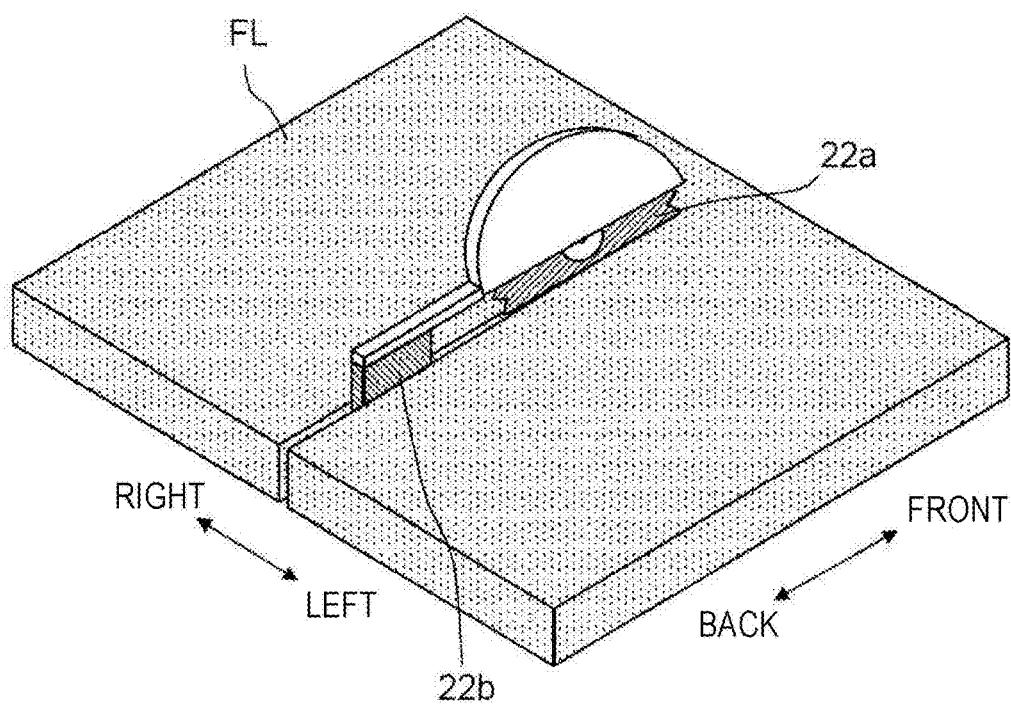


FIG. 12

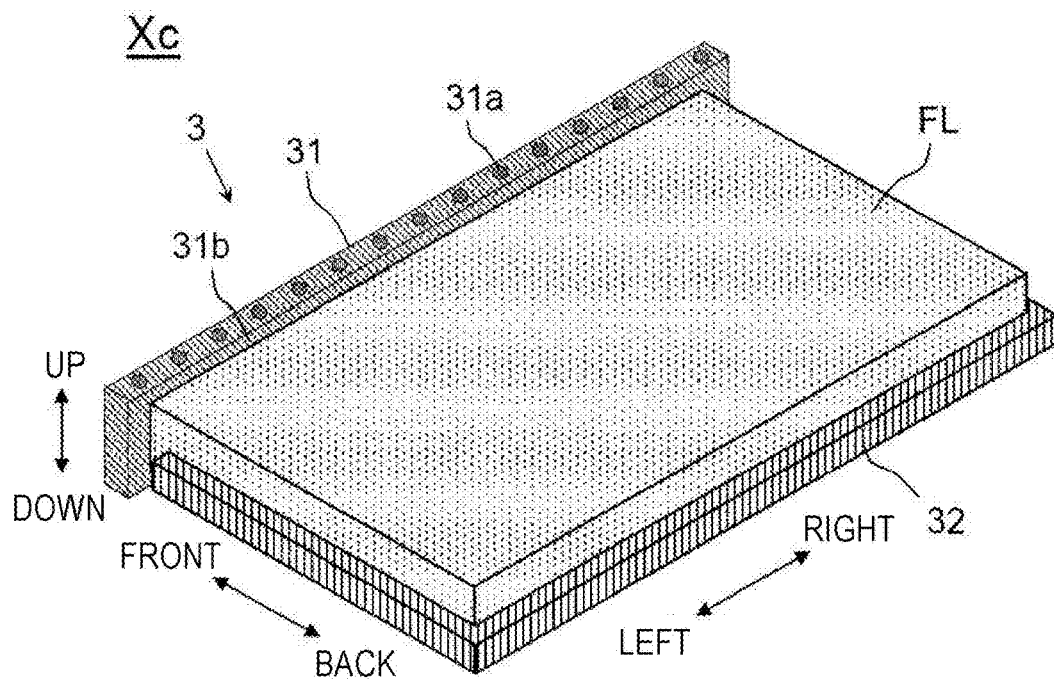


FIG. 13

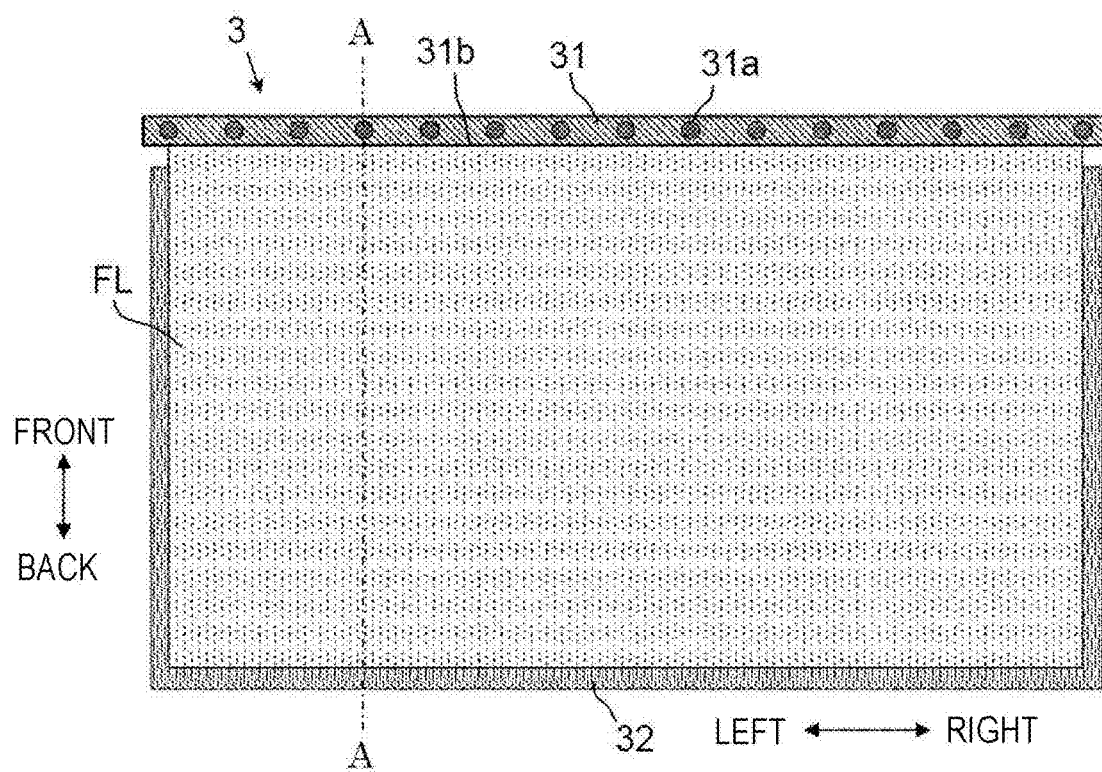


FIG. 14

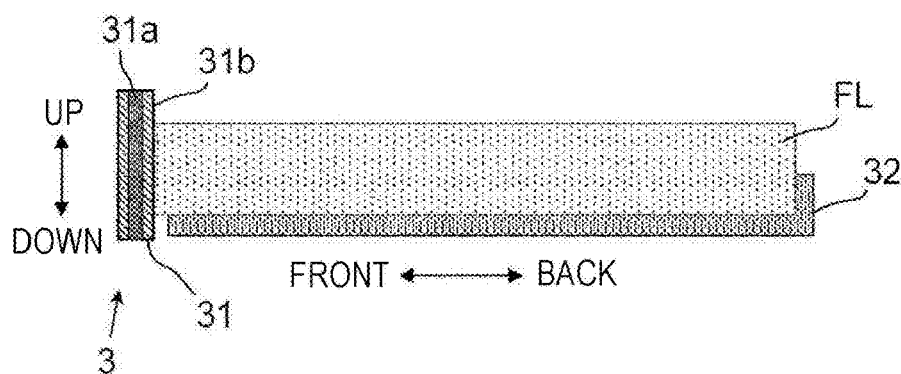


FIG. 15

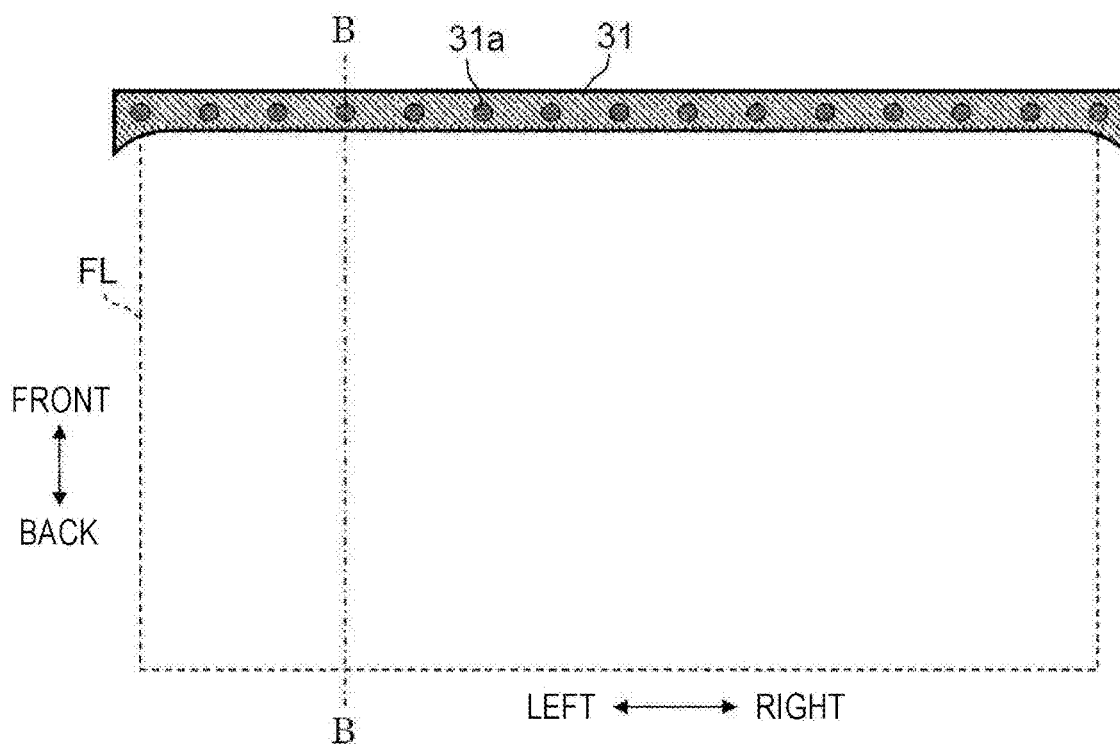


FIG. 16

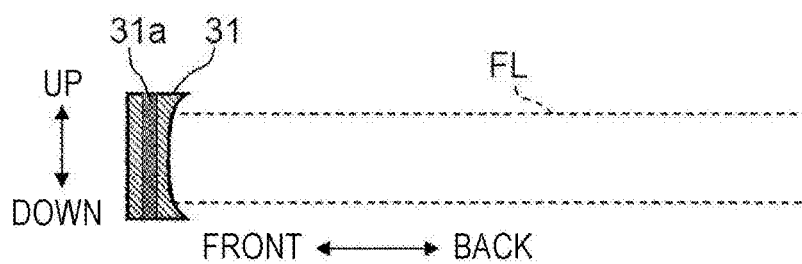


FIG. 17

CUT SURFACE SMOOTHING DEVICE AND MANUFACTURING SYSTEM

TECHNICAL FIELD

[0001] The present invention relates to a cut surface smoothing device which smooths a cut surface of a filament three-dimensional bonded member, a manufacturing system which uses the cut surface smoothing device, a cutting device and a method for processing the filament three-dimensional bonded member.

BACKGROUND ART

[0002] In recent years, attention has focused on a highly resilient mattress that is highly breathable, is easy to turn over on and uses, as a cushion material, a filament three-dimensional bonded member (reticular structure) which is obtained by three-dimensionally fusing and bonding filaments made of a thermoplastic resin. The filament three-dimensional bonded member can be applied not only to mattresses but also to various products which are required to have a cushioning property.

[0003] Since the filament three-dimensional bonded member is satisfactorily breathable and is, for example, easy to wash with water, the filament three-dimensional bonded member is excellent in that it can be cleanly used. For example, Patent Documents 1 and 2 disclose devices and methods for manufacturing a filament three-dimensional bonded member. In these patent documents, the devices and methods for continuously forming and discharging the filament three-dimensional bonded member are disclosed, and the continuously discharged filament three-dimensional bonded member is sheared at predetermined intervals and applied to mattresses and the like.

RELATED ART DOCUMENT

Patent Document

[0004] Patent Document 1: Japanese Patent No. 4966438

[0005] Patent Document 2: Japanese Unexamined Patent Application Publication No. 2019-131950

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

[0006] However, the filaments of the filament three-dimensional bonded member have random loop shapes. Hence, the cut surface of the filament three-dimensional bonded member is nonuniform, and thus when the filament three-dimensional bonded member is touched, for example, in the operation of storing the filament three-dimensional bonded member in a cover member, the ends of the filaments which protrude from the nonuniform cut surface are disadvantageously touched to cause an injury or to cause pain without causing an injury.

[0007] Even after the filament three-dimensional bonded member is stored in the cover member, in particular, when a mesh cover member is used, the ends of the filaments may protrude from gaps of the mesh to collide with a user or may be caught in a carpet, a futon or the like which makes contact during use so as to damage other items.

[0008] In view of the problem described above, an object of the present invention is to provide a cut surface smoothing

device, a manufacturing system, a cutting device and a method for processing a filament three-dimensional bonded member which can easily smooth the cut surface of the filament three-dimensional bonded member.

Means for Solving the Problem

[0009] A cut surface smoothing device according to the present invention includes: a high temperature portion that is heated to a temperature equal to or higher than the melting point of a filament three-dimensional bonded member, and the high temperature portion is applied to a cut surface of the filament three-dimensional bonded member to smooth the cut surface. In the present configuration, it is possible to easily smooth the cut surface of the filament three-dimensional bonded member.

[0010] More specifically, the cut surface of the filament three-dimensional bonded member that is conveyed parallel to the cut surface is smoothed, and in the cut surface smoothing device configured described above, the high temperature portion may be arranged to rotate in the same direction as the conveyance while being applied to the cut surface.

[0011] Specifically, in the configuration described above, the high temperature portion may be an outer surface of a belt that is tensioned and supported by rollers arranged on an upstream side and a downstream side of the conveyance. More specifically, in the configuration described above, the belt may be heated by a heat source provided in the roller on the upstream side, and cooling air may be supplied between the rollers inside the belt. More specifically, in the configuration described above, coating treatment that easily separates the cut surface from the outer surface may be further performed on the outer surface of the belt.

[0012] More specifically, in the configuration described above, the cut surface smoothing device may include: the high temperature portion that is a wall surface; and a fixing vibration table that exposes the cut surface and fixes and supports the filament three-dimensional bonded member, and the fixing vibration table may vibrate parallel to the cut surface while applying the cut surface to the wall surface to smooth the cut surface. More specifically, in the configuration described above, coating that suppresses adhesion of a resin to the wall surface may be performed on the wall surface.

[0013] More specifically, in the configuration described above, the cut surface smoothing device may include: a cutter that is moved along a planned cut surface of the filament three-dimensional bonded member to cut the filament three-dimensional bonded member; and the high temperature portion that is provided on a side opposite to the direction of the movement of the cutter and sequentially smooths the cut surface successively generated by cutting the filament three-dimensional bonded member with the cutter.

[0014] A manufacturing system according to the present invention includes: a filament three-dimensional bonded member manufacturing device that continuously forms and discharges the filament three-dimensional bonded member; a cutting device that cuts the discharged filament three-dimensional bonded member at predetermined intervals; and the cut surface smoothing device configured as described above that smooths the cut surface generated by the cutting.

[0015] A cutting device according to the present invention includes: a high temperature portion that is heated to a

temperature equal to or higher than the melting point of a filament three-dimensional bonded member, and the high temperature portion is moved along a planned cut surface of the filament three-dimensional bonded member to fuse and cut the filament three-dimensional bonded member.

[0016] A method for processing a filament three-dimensional bonded member according to the present invention includes: a cutting step of cutting a filament three-dimensional bonded member; and a smoothing step of applying an object having a temperature equal to or higher than the melting point of the filament three-dimensional bonded member to a cut surface of the filament three-dimensional bonded member generated by the cutting so as to smooth the cut surface.

[0017] More specifically, the method for processing a filament three-dimensional bonded member may further include: a cooling step of cooling the object applied to the cut surface to a temperature lower than the melting point; and a separation step of separating the object from the cut surface after the cooling step is performed.

Advantages of the Invention

[0018] In the cut surface smoothing device, the manufacturing system, the cutting device and the method for processing a filament three-dimensional bonded member according to the present invention, it is possible to smooth the cut surface of the filament three-dimensional bonded member.

BRIEF DESCRIPTION OF DRAWINGS

[0019] FIG. 1 is a configuration diagram of a manufacturing system for a filament three-dimensional bonded member according to a first embodiment;

[0020] FIG. 2 is a configuration diagram of a cut surface smoothing device Xa;

[0021] FIG. 3 is an illustrative diagram of a cut surface FL1 before being smoothed;

[0022] FIG. 4 is an illustrative diagram of the cut surface FL1 which has been smoothed;

[0023] FIG. 5 is a schematic configuration diagram of rollers 15 in a variation and a part in the vicinity thereof;

[0024] FIG. 6 is a schematic configuration diagram of rollers 15 in another variation and a part in the vicinity thereof;

[0025] FIG. 7 is a configuration diagram of a cut surface smoothing device Xb;

[0026] FIG. 8 is a configuration diagram of a manufacturing system for a filament three-dimensional bonded member according to a second embodiment;

[0027] FIG. 9 is a configuration diagram of a movable member 21;

[0028] FIG. 10 is an illustrative diagram showing how the filament three-dimensional bonded member is cut by the movable member 21;

[0029] FIG. 11 is a configuration diagram of a movable member 22;

[0030] FIG. 12 is an illustrative diagram showing how the filament three-dimensional bonded member is cut by the movable member 22;

[0031] FIG. 13 is a perspective diagram of a cut surface smoothing device Xc;

[0032] FIG. 14 is a configuration diagram of the cut surface smoothing device Xc in plan view;

[0033] FIG. 15 is a cross-sectional view of the cut surface smoothing device Xc;

[0034] FIG. 16 is a configuration diagram of a heating plate 31 in a variation in plan view; and

[0035] FIG. 17 is a cross-sectional view of the heating plate 31 in the variation.

DESCRIPTION OF EMBODIMENTS

[0036] Embodiments of the present invention will be described below with reference to drawings. For convenience, in the following description, an up/down direction, a left/right direction and a forward/backward direction (which are orthogonal to each other) are as shown in the figures, and the up/down direction corresponds to a vertical direction.

1. First Embodiment

[0037] A first embodiment will first be described. FIG. 1 shows a schematic configuration diagram of a manufacturing system S1 for a filament three-dimensional bonded member according to the first embodiment. As shown in the figure, the manufacturing system 1 includes a filament three-dimensional bonded member manufacturing device 12 (which may be hereinafter referred to as a “manufacturing device 12” in short), a cutting device 13, a conveyer 14, rollers 15 and heaters 16. The conveyer 14, the rollers 15 and the heaters 16 mainly constitute a cut surface smoothing device Xa which smooths the cut surfaces FL1 of the filament three-dimensional bonded member FL.

[0038] The manufacturing device 12 is a device which three-dimensionally fuses and bonds filaments made of a thermoplastic resin to continuously form and discharge the filament three-dimensional bonded member FL. In the manufacturing device 12 in the example of FIG. 1, the filament three-dimensional bonded member FL is discharged from the right side to the left side. Since the basic configuration, the basic operation and the like of the filament three-dimensional bonded member manufacturing device are known as disclosed in, for example, Patent Documents 1 and 2, the details thereof are omitted here.

[0039] The cutting device 13 is arranged in the vicinity of a position at which the continuous filament three-dimensional bonded member FL discharged from the manufacturing device 12 arrives, and uses, for example, a cutter to cut the filament three-dimensional bonded member FL at predetermined intervals. In the example shown in FIG. 1, the cutter of the cutting device 13 is moved along the planned cut surface (surface indicated by a broken line with an arrow in FIG. 1) in the forward/backward direction, and the continuous filament three-dimensional bonded member FL is cut by the cutting device 13 such that the cut surface FL1 perpendicular to the direction (direction indicated by a colored arrow in FIG. 1) in which the filament three-dimensional bonded member FL is discharged is generated.

[0040] The conveyer 14 is arranged to convey the filament three-dimensional bonded member FL cut by the cutting device 13 toward the rollers 15. In the example shown in FIG. 1, the filament three-dimensional bonded member FL with two parallel left and right cut surfaces FL1 which has been cut is conveyed by the conveyer 14 in a forward direction (direction indicated by white arrows in FIG. 1) parallel to the cut surfaces.

[0041] The rollers 15 are formed in a cylindrical shape with the up/down direction being an axial direction, and function to smooth the cut surfaces of the filament three-dimensional bonded member FL generated by the cutting of the cutting device 13. The configuration and the function of the rollers 15 will be described below with reference to FIG. 2.

[0042] FIG. 2 is a schematic configuration diagram of the cut surface smoothing device Xa. As shown in the figure, the rollers 15 are provided on both left and right sides of the conveyer 14 so as to be opposite each other in the left/right direction, and are rotatably installed with its center axis extending in the up/down direction used as a rotation axis. The rollers 15 are arranged such that the outer surface of one of the left and right rollers 15 is in contact with the cut surface FL1 of the filament three-dimensional bonded member FL conveyed by the conveyer 14 and the outer surface of the other roller 15 is in contact with the other cut surface FL1. The distance between the outer surfaces of the rollers 15 is set slightly smaller than the distance between the cut surfaces FL1 of the filament three-dimensional bonded member FL.

[0043] In each of the rollers 15, the heater 16 for heating the roller 15 is arranged. As the heater 16, for example, a halogen heater is adopted, and the roller 15 is heated such that at least the temperature of the outer surface of the roller 15 is equal to or higher than the melting point of the filament three-dimensional bonded member FL. The specific form of the heater 16 is not particularly limited as long as the specific form does not depart from the spirit of the present invention, and for example, a heater which outputs hot air or a heater which uses IH (Induction Heating) may be used. As the heater 16, a heater which heats the roller 15 from the outside of the roller 15 may be used.

[0044] When the filament three-dimensional bonded member FL conveyed by the conveyer 14 passes through a position sandwiched between the rollers 15, the rollers 15 receive forces from the cut surfaces FL1 to rotate in directions indicated by broken lines with arrows in FIG. 2. In other words, the rollers 15 are rotated in the same direction as the direction of the conveyance of the conveyer 14 while being applied to the cut surfaces FL1 (that is, the rollers 15 are rotated such that the direction of travel at a contact point is the same). A drive device such as a motor which drives the rollers 15 to rotate may be provided, and thus the drive device may rotate the rollers 15 according to the speed of the conveyance of the filament three-dimensional bonded member FL.

[0045] Since the distance between the outer surfaces of the rollers 15 is slightly smaller than the distance between the cut surfaces FL1 of the filament three-dimensional bonded member FL, the cut surfaces FL1 travel in the direction of the conveyance while being slightly pressed by the rollers 15. Here, the temperature of each of the outer surfaces of the rollers 15 is equal to or higher than the melting point of the filament three-dimensional bonded member FL, and thus the cut surfaces FL1 are smoothed. When the entire filament three-dimensional bonded member FL has passed through the position sandwiched between the rollers 15, the entire cut surfaces FL1 have been smoothed. In this way, it is possible to obtain the filament three-dimensional bonded member FL in which the cut surfaces FL1 on both left and right sides are smoothed.

[0046] Here, FIG. 3 shows an example of the external view (photograph) of the cut surface FL1 before being smoothed, and FIG. 4 shows an example of the external view (photograph) of the cut surface FL1 which has been smoothed. FIG. 3 shows a diagram which is viewed in a direction substantially perpendicular to the cut surface FL1. FIG. 4 shows diagrams which are viewed in slightly different directions.

[0047] As shown in FIG. 3, the cut surface FL1 before being smoothed is remarkably nonuniform, and in particular, the loop shapes of the filaments of the filament three-dimensional bonded member FL are cut by the cutter, with the result that the ends of the filaments are often exposed. On the other hand, in the cut surface FL1 shown in FIG. 4, the ends of the filaments and the like are melted and are then pressed by the rollers 15, and thus they are fused to filaments in the vicinity thereof or are deformed in the direction of the pressing, with the result that the cut surface FL1 is smoothed as compared with the cut surface FL1 shown in FIG. 3. For example, as compared with a case where the ends of the filaments are pressed straight by a plat plate in a direction perpendicular to the cut surface FL1, the cut surfaces FL1 are pressed by the rotating rollers 15 such that the ends of the filaments are pressed so as to be cut down, with the result that the cut surfaces FL1 are efficiently smoothed.

[0048] Although the filament three-dimensional bonded member FL cut by the cutting device 13 is substantially in the shape of a rectangular parallelepiped, the manufacturing system S1 may form the corners of the shape of the rectangular parallelepiped into rounded or inclined corners. In the manufacturing system S1 configured as described above, configuration diagrams viewed from the front in schematic configurations of the rollers 15 and a part in the vicinity thereof are shown as examples in FIGS. 5 and 6. In these figures, approximate positions of the outer edges of the filament three-dimensional bonded member FL are indicated by broken lines.

[0049] Although in each of the rollers 15 in the manufacturing system S1 shown in FIG. 5, the outer diameter dimension thereof in the vicinity of the center in the up/down direction is equivalent to the outer diameter dimension of each of the rollers 15 shown in FIG. 2, the outer diameter dimension is gradually increased toward both ends in the up/down direction. In this way, in the left and right cut surfaces FL1 of the filament three-dimensional bonded member FL, parts in the vicinity of both ends in the up/down direction (that is, the corners of the filament three-dimensional bonded member FL) are significantly pressed by the rollers 15 having a high temperature so as to be deformed, with the result that the rounded corners of the filament three-dimensional bonded member FL can be provided.

[0050] In the manufacturing system S1 shown in FIG. 6, immediately on the front sides of the left and right rollers 15, interference members 15x are arranged to interfere with the four corners of the filament three-dimensional bonded member FL which are viewed from the front. In this way, parts in the vicinity of the corners of the left and right cut surfaces FL1 of the filament three-dimensional bonded member FL are pressed by the interference members 15x immediately after being heated by the rollers 15 so as to be deformed, with the result that the inclined corners of the filament three-dimensional bonded member FL can be provided.

[0051] In the manufacturing system S1, instead of the cut surface smoothing device Xa, a cut surface smoothing

device in another form may be adopted. As an example of the cut surface smoothing device in the other form described above, the cut surface smoothing device Xb of a configuration shown in FIG. 7 will be described below.

[0052] The cut surface smoothing device Xb includes a conveyer 14, upstream rollers 15a, downstream rollers 15b, heaters 16a, belts 17 and coating rollers 18. The configuration and the like of the conveyer 14 are equivalent to the configuration and the like of the conveyer 14 in the cut surface smoothing device Xa.

[0053] The upstream rollers 15a are formed in a cylindrical shape with the up/down direction being an axial direction, and the downstream rollers 15b are formed in a cylindrical shape with the up/down direction being an axial direction. These rollers 15a and 15b are provided on each of the left and right sides. The upstream rollers 15a are provided on both left and right sides of the conveyer 14 so as to be opposite each other in the left/right direction, and are rotatably installed with its center axis extending in the up/down direction used as a rotation axis. The downstream rollers 15b are provided on both left and right sides of the conveyer 14 so as to be opposite each other in the left/right direction on the front side of the upstream rollers 15a (that is, the downstream side in the direction of the conveyance of the conveyer 14), and are rotatably installed with its center axis extending in the up/down direction used as a rotation axis.

[0054] The belts 17 are provided on both left and right sides, the belt 17 on the left side is tensioned and supported by the upstream roller 15a and the downstream roller 15b on the left side and the belt 17 on the right side is tensioned and supported by the upstream roller 15a and the downstream roller 15b on the right side. The belts 17 are arranged such that the outer surface of the belt 17 on one of the left and right sides is in contact with the cut surface FL1 of the filament three-dimensional bonded member FL conveyed by the conveyer 14 and the outer surface of the other belt 17 is in contact with the other cut surface FL1. The distance between the outer surfaces of the belts 17 is set slightly smaller than the distance between the cut surfaces FL1 of the filament three-dimensional bonded member FL.

[0055] In each of the upstream rollers 15a, the heater 16a for heating the belt 17 via the upstream roller 15a is arranged. As the heater 16a, for example, a halogen heater is adopted, and the belt 17 is heated such that at least the temperature of the outer surface of the belt 17 is equal to or higher than the melting point of the filament three-dimensional bonded member FL. The specific form of the heater 16a is not particularly limited as long as the specific form does not depart from the spirit of the present invention, and for example, a heater which outputs hot air or a heater which uses IH (Induction Heating) may be used. As the heater 16a, a heater which heats the belt 17 from the outside of the belt 17 may be used.

[0056] The coating roller 18 is a roller for performing coating treatment (treatment which easily separates the cut surface FL1 from the outer surface of the belt 17) which coats the outer surface of the belt 17 with a mold release agent (for example, silicone oil). The cut surface smoothing device Xb uses the coating rollers 18 to perform the coating treatment.

[0057] The coating rollers 18 are formed in a cylindrical shape with the up/down direction being an axial direction, and are rotatably installed on the outer sides of the belts 17

in the left/right direction with its center axis extending in the up/down direction used as a rotation axis. In the coating rollers 18, the mold release agent is continuously supplied from an unillustrated mold release agent supply device, and the coating rollers 18 are formed to be impregnated with the supplied mold release agent.

[0058] The outer surface of the coating roller 18 on the left side is in contact with the left side outer surface of the belt 17 on the left side, and as the belt 17 is rotated, the coating roller 18 is also rotated. In this way, the coating roller 18 on the left side can coat the outer surface of the belt 17 with the mold release agent continuously and uniformly with almost no friction caused between the coating roller 18 and the belt 17 on the left side.

[0059] The outer surface of the coating roller 18 on the right side is in contact with the right side outer surface of the belt 17 on the right side, and as the belt 17 is rotated, the coating roller 18 is also rotated. In this way, the coating roller 18 on the right side can coat the outer surface of the belt 17 with the mold release agent continuously and uniformly with almost no friction caused between the coating roller 18 and the belt 17 on the right side. The type of agent with which the outer surface of the belt 17 is coated in the coating treatment is not particularly limited as long as the agent causes the cut surface FL1 to easily separate from the outer surface.

[0060] Between the upstream roller 15a and the downstream roller 15b inside the belt 17 on each of the left and right sides, as indicated by colored arrows in FIG. 7, cooling air (for example, air at room temperature or air cooled to room temperature or below) is supplied by an unillustrated blower from above. In this way, the parts of the outer surface of the rotating belt 17 are heated by the heater 16a to a temperature equal to or higher than the melting point of the filament three-dimensional bonded member FL and are thereafter cooled to a temperature lower than the melting point by the cooling air. As described above, in the cut surface smoothing device Xb, the belt 17 is heated by the heater 16a (heat source) provided in the upstream roller 15a and is further cooled by supplying the cooling air between the rollers 15a and 15b inside the belt 17.

[0061] When the filament three-dimensional bonded member FL conveyed by the conveyer 14 passes through a position sandwiched between the belts 17, the belts 17 receive forces from the cut surfaces FL1 to rotate in directions indicated by broken lines with arrows in FIG. 7 together with the rollers 15a and 15b. In other words, the belts 17 are rotated in the same direction as the direction of the conveyance of the conveyer 14 while being applied to the cut surfaces FL1 (that is, the belts 17 are rotated such that the direction of travel at a contact point is the same). A drive device such as a motor which drives the rollers 15a and 15b to rotate may be provided, and thus the drive device may rotate the rollers 15a and 15b according to the speed of the conveyance of the filament three-dimensional bonded member FL.

[0062] Since the distance between the outer surfaces of the belts 17 is slightly smaller than the distance between the cut surfaces FL1 of the filament three-dimensional bonded member FL, the cut surfaces FL1 travel in the direction of the conveyance while being slightly pressed by the belts 17. Here, when attention is focused on an arbitrary part Z of each of the cut surfaces FL1, the part Z is first applied to a part near the back end of the belt 17 (part heated by the

heater 16a to a temperature equal to or higher than the melting point of the filament three-dimensional bonded member FL), and thus the cut surface FL1 is smoothed by the same principle as in the case of the cut surface smoothing device Xa.

[0063] Thereafter, when the filament three-dimensional bonded member FL is further conveyed, the part Z is applied to a part in the vicinity of the center of the belt 17 in the forward/backward direction (part cooled by the cooling air to a temperature lower than the melting point of the filament three-dimensional bonded member FL), and thus the temperature of the part Z is lowered to solidify the part Z while the part Z is being in contact with the outer surface of the planar belt 17, with the result that the part Z is stabilized in a shape as close to a flat surface as possible. Thereafter, when the filament three-dimensional bonded member FL is further conveyed, the part Z is separated from the belt 17. Here, the belt 17 is coated with the mold release agent, and thus it is possible to smoothly separate the part Z from the belt 17.

[0064] The manufacturing system S1 described above includes: the manufacturing device 12 which continuously forms and discharges the filament three-dimensional bonded member FL; the cutting device 13 which cuts the discharged filament three-dimensional bonded member FL at predetermined intervals; and the cut surface smoothing device Xa (or Xb) which smooths the cut surface FL1 generated by the cutting. The cut surface smoothing device Xa (or Xb) includes a high temperature portion which is heated to a temperature equal to or higher than the melting point of the filament three-dimensional bonded member FL, and the high temperature portion is applied to the cut surface FL1 of the filament three-dimensional bonded member FL to smooth the cut surface FL1. The high temperature portion of the cut surface smoothing device Xa corresponds to the outer surface of the roller 15, and the high temperature portion of the cut surface smoothing device Xb corresponds to the outer surface of the belt 17.

[0065] A method for processing the filament three-dimensional bonded member FL which is performed by the manufacturing system S1 includes: a cutting step of cutting the filament three-dimensional bonded member FL with the cutting device 13; and a smoothing step of applying an object (the roller 15 or the belt 17) having a temperature equal to or higher than the melting point of the filament three-dimensional bonded member FL to the cut surface FL1 of the filament three-dimensional bonded member FL generated by the cutting so as to smooth the cut surface FL1. The method for processing the filament three-dimensional bonded member FL when the cut surface smoothing device Xb is used further includes: a cooling step of cooling the object (the belt 17) applied to the cut surface FL1 to a temperature lower than the melting point of the filament three-dimensional bonded member FL by utilization of the cooling air; and a separation step of separating the belt 17 from the cut surface FL1 after the cooling step is performed.

2. Second Embodiment

[0066] A second embodiment will then be described. FIG. 8 shows a schematic configuration diagram of a manufacturing system S2 for a filament three-dimensional bonded member according to the second embodiment. As shown in the figure, the manufacturing system S2 includes a manufacturing device 12 for manufacturing the filament three-

dimensional bonded member FL and a cutting device 20. The manufacturing device 12 in the second embodiment is the same as in the first embodiment.

[0067] The cutting device 20 is arranged in the vicinity of a position at which the continuous filament three-dimensional bonded member FL discharged from the manufacturing device 12 arrives, and cuts the filament three-dimensional bonded member FL at predetermined intervals. More specifically, the cutting device 20 includes a movable member which can be moved along a planned cut surface (surface indicated by a broken line with an arrow in FIG. 8) of the filament three-dimensional bonded member FL in the forward/backward direction, the movable member is moved and thus the continuous filament three-dimensional bonded member FL is cut such that a cut surface perpendicular to a direction (direction indicated by a colored arrow in FIG. 8) in which the filament three-dimensional bonded member FL is discharged is generated. As specific examples of the movable member, a movable member 21 shown in FIG. 9 and a movable member 22 shown in FIG. 11 will be described below.

[0068] In the movable member 21 shown in FIG. 9, on the back side of a blade portion 21a which extends in the up/down direction and has a sharp front edge, a flat plate portion 21b in the shape of a flat plate the front and back of which are directed in the left/right direction is provided. The movable member 21 is coupled to an unillustrated drive device to be movable in the forward/backward direction. The blade portion 21a is heated by, for example, electric power to a temperature equal to or higher than the melting point of the filament three-dimensional bonded member FL.

[0069] FIG. 10 shows how the movable member 21 is moved forward to cut the filament three-dimensional bonded member FL. As shown in the figure, when the movable member 21 is moved along the planned cut surface of the filament three-dimensional bonded member FL, the blade portion 21a which is heated to a high temperature gradually cuts the filament three-dimensional bonded member FL while melting the filament three-dimensional bonded member FL. Here, the flat plate portion 21b arranged on the back side of the blade portion 21a is interposed between the cut parts of the filament three-dimensional bonded member FL and thus a problem in which these parts are brought into contact with each other to be fused is suppressed.

[0070] When the blade portion 21a gradually cuts the filament three-dimensional bonded member FL while melting the filament three-dimensional bonded member FL, filaments appearing on the cut surfaces are pressed by the blade portion 21a in a state where the filaments are melted. In this way, the filament three-dimensional bonded member FL is cut by the blade portion 21a, and simultaneously, the cut surfaces generated by the cutting are smoothed.

[0071] As described above, the cutting device 20 including the movable member 21 includes the blade portion 21a (high temperature portion) which is heated to a temperature equal to or higher than the melting point of the filament three-dimensional bonded member FL, and the blade portion 21a is moved along the planned cut surface of the filament three-dimensional bonded member FL to fuse and cut the filament three-dimensional bonded member FL. The specific form of the blade portion 21a is not particularly limited as long as the specific form does not depart from the spirit of the present invention, and the blade portion 21a may be in the form of, for example, a wire.

[0072] In the movable member 22 shown in FIG. 11, on the back side of a disk-shaped rotary blade portion 22a which is rotated with the left/right direction being an axial direction, a flat plate portion 22b in the shape of a flat plate the front and back of which are directed in the left/right direction is provided. The movable member 22 is coupled to an unillustrated drive device to be movable in the forward/backward direction. The flat plate portion 22b is heated by, for example, electric power to a temperature equal to or higher than the melting point of the filament three-dimensional bonded member FL.

[0073] FIG. 12 shows how the movable member 22 is moved forward to cut the filament three-dimensional bonded member FL. As shown in the figure, when the movable member 22 is moved along the planned cut surface of the filament three-dimensional bonded member FL, the rotary blade portion 22a which is rotated at high speed gradually cuts the filament three-dimensional bonded member FL. Then, the flat plate portion 22b arranged on the back side of the rotary blade portion 22a abuts on cut surfaces on both left and right sides which are successively generated by the cutting. In this way, the cut surfaces of the filament three-dimensional bonded member FL successively generated by the cutting of the rotary blade portion 22a are pressed by the flat plate portion 22b in a state where the cut surfaces are melted by the heat of the flat plate portion 22b so as to be smoothed.

[0074] The movable member 22 shown in FIG. 11 can be regarded as a cut surface smoothing device which includes the flat plate portion 22b (high temperature portion) that is heated to a temperature equal to or higher than the melting point of the filament three-dimensional bonded member FL, and in which the flat plate portion 22b is applied to the cut surfaces FL1 of the filament three-dimensional bonded member FL to smooth the cut surfaces FL1. The cut surface smoothing device serving as the movable member 22 includes: the rotary blade portion 22a (cutter) which is moved along the planned cut surface of the filament three-dimensional bonded member FL to cut the filament three-dimensional bonded member FL; and the flat plate portion 22b which is provided on a side opposite to the direction of the movement (on a back side) of the rotary blade portion 22b so as to sequentially smooth the cut surfaces FL1 successively generated by cutting of the rotary blade portion 22a.

3. Third Embodiment

[0075] A cut surface smoothing device Xc according to a third embodiment will then be described. The cut surface smoothing device Xc is a device which smooths the cut surface of the filament three-dimensional bonded member FL in the shape of a rectangular parallelepiped, and FIG. 13 is a schematic perspective view of the cut surface smoothing device Xc in a state where the filament three-dimensional bonded member FL is set. FIG. 14 is a configuration diagram of the cut surface smoothing device Xc in plan view. FIG. 15 is a cross-sectional view of the cut surface smoothing device Xc taken along A-A plane shown in FIG. 14.

[0076] As shown in these figures, the cut surface smoothing device Xc includes a heating plate 31 and a fixing vibration table 32. The heating plate 31 is formed in the shape of a plate having a wall surface 31b which is exposed downward, and a plurality of heaters 31a (for example, halogen heaters) are provided inside the heating plate 31. In

the example of the present embodiment, as the heating plate 31, an aluminum plate is adopted, and fluororesin coating is applied to the wall surface 31b. The heaters 31a heat the heating plate 31 such that the temperature of the wall surface 31b is equal to or higher than the melting point of the filament three-dimensional bonded member FL.

[0077] The fixing vibration table 32 is formed such that the cut surface is exposed to the front side and the filament three-dimensional bonded member FL can be fixed and supported. More specifically, the fixing vibration table 32 is formed such that the filament three-dimensional bonded member FL in the shape of a rectangular parallelepiped having upper and lower surfaces, left and right surfaces and front and back surfaces can be placed and set, the fixing vibration table 32 includes walls in contact with the lower surface, the left surface, the back surface and the right surface of the set filament three-dimensional bonded member FL and thus the filament three-dimensional bonded member FL is fixed and supported. In the fixing vibration table 32, no wall in contact with the front surface of the set filament three-dimensional bonded member FL is provided, and thus as shown in FIGS. 13 to 15, a part in the vicinity of the front end of the filament three-dimensional bonded member FL can be caused to protrude to the front side beyond the front end of the fixing vibration table 32.

[0078] When the cut surface smoothing device Xc is used, the heating plate 31 is heated by the heaters 31a, and as shown in FIGS. 13 to 15, the filament three-dimensional bonded member FL is previously set in the fixing vibration table 32. In the filament three-dimensional bonded member FL shown in these figures, the cut surface is directed forward, and the part in the vicinity of the front end protrudes to the front side beyond the front end of the fixing vibration table 32. The cut surface is lightly pressed to the wall surface 31b of the heating plate 31. A configuration may be adopted in which in order to easily realize a state where the cut surface is lightly pressed to the wall surface 31b, the position of the heating plate 31 or the fixing vibration table 32 can be adjusted in the forward/backward direction.

[0079] In a state where the filament three-dimensional bonded member FL is set in the fixing vibration table 32, for example, an unillustrated switch is operated, and thus the fixing vibration table 32 vibrates in the left/right direction. As described above, while the cut surface of the filament three-dimensional bonded member FL is being applied to the wall surface 31b, the fixing vibration table 32 vibrates parallel to the cut surface, and thus filaments appearing on the cut surface are pressed to the wall surface 31b in a state where the filaments are melted, with the result that the cut surface is smoothed.

[0080] Here, the fluororesin coating is applied to the wall surface 31b, and thus adherence of the resin of the melted filaments to the wall surface 31b is suppressed. As the coating which is applied to the wall surface 31b in order to suppress the adherence of the resin, coating other than the fluororesin coating may be adopted.

[0081] The shape of the heating plate 31 may be set such that the edge of the cut surface of the filament three-dimensional bonded member FL is rounded. For an example of the heating plate 31 configured as described above, a configuration diagram in plan view is shown in FIG. 16, and a cross-sectional view taken along B-B plane shown in FIG. 16 is shown in FIG. 17. Broken lines in these figures

schematically show the positions of the outer edges of the filament three-dimensional bonded member FL set in the fixing vibration table 32.

[0082] In the heating plate 31 shown in these figures, a part in the vicinity of the left end of the wall surface 31b is formed in a curved shape such that as the part extends leftward, the part is gradually curved backward whereas a part in the vicinity of the right end of the wall surface 31b is formed in a curved shape such that as the part extends rightward, the part is gradually curved backward. A part in the vicinity of the upper end of the wall surface 31b is formed in a curved shape such that as the part extends upward, the part is gradually curved backward whereas a part in the vicinity of the lower end of the wall surface 31b is formed in a curved shape such that as the part extends downward, the part is gradually curved backward. In this way, the edge of the cut surface of the filament three-dimensional bonded member FL can be rounded.

[0083] The cut surface smoothing device Xc described above includes a high temperature portion which is heated to a temperature equal to or higher than the melting point of the filament three-dimensional bonded member FL, and the high temperature portion is applied the cut surface FL1 of the filament three-dimensional bonded member FL to smooth the cut surface FL1. More specifically, the cut surface smoothing device Xc includes the high temperature portion which is the wall surface 31b of the heating plate 31 and the fixing vibration table 32 which exposes the cut surface FL1 and fixes and supports the filament three-dimensional bonded member FL, and the fixing vibration table 32 vibrates parallel to the cut surface FL1 while applying the cut surface FL1 to the wall surface 31b to smooth the cut surface FL1.

4. Others

[0084] The smoothing of the cut surface performed by the cut surface smoothing device according to the present invention can be performed with appropriate timing with consideration given to various conditions and the like, and the smoothing may be performed during final finishing. For example, although in the first embodiment, the cut surface is smoothed immediately after the filament three-dimensional bonded member FL is cut by the cutting device 13, instead of the configuration described above, other processing may be previously performed after the cutting, and then the smoothing of the cut surface may be performed as final finishing.

[0085] Although the embodiments of the present invention have been described above, the configuration of the present invention is not limited to the embodiments described above, and various modifications can be added without departing from the spirit of the invention. In other words, it should be considered that the embodiments described above are illustrative in all respects and not restrictive. The technical scope of the present invention is indicated not by the description of the above embodiments but by the scope of claims, and it should be understood that meanings equivalent to the scope of claims and all modifications in the scope are included therein.

INDUSTRIAL APPLICABILITY

[0086] The present invention can be utilized in a manufacturing system for a filament three-dimensional bonded member and the like.

REFERENCE SIGNS LIST

- [0087] 12 filament three-dimensional bonded member manufacturing device
- [0088] 13 cutting device
- [0089] 14 conveyer
- [0090] 15 roller
- [0091] 15a upstream roller
- [0092] 15b downstream roller
- [0093] 15x interference member
- [0094] 16, 16a heater
- [0095] 17 belt
- [0096] 18 coating roller
- [0097] 20 cutting device
- [0098] 21, 22 movable member
- [0099] 21a blade portion
- [0100] 21b flat plate portion
- [0101] 22a rotary blade portion
- [0102] 22b flat plate portion
- [0103] 31 heating plate
- [0104] 31a heater
- [0105] 31b wall surface
- [0106] 32 fixing vibration table
- [0107] FL filament three-dimensional bonded member
- [0108] FL1 cut surface of filament three-dimensional bonded member
- [0109] S1, S2 manufacturing system
- [0110] Xa, Xb, Xc cut surface smoothing device

1. A cut surface smoothing device comprising:
 - a high temperature portion that is heated to a temperature equal to or higher than a melting point of a filament three-dimensional bonded member,
 - wherein the high temperature portion is applied to a cut surface of the filament three-dimensional bonded member to smooth the cut surface,
 - the cut surface of the filament three-dimensional bonded member that is conveyed parallel to the cut surface is smoothed, and
 - the high temperature portion is arranged to rotate in a same direction as the conveyance while being applied to the cut surface.
2. (canceled)
3. The cut surface smoothing device according to claim 1, wherein the high temperature portion is an outer surface of a belt that is tensioned and supported by rollers arranged on an upstream side and a downstream side of the conveyance.
4. The cut surface smoothing device according to claim 3, wherein the belt is heated by a heat source provided in the roller on the upstream side, and cooling air is supplied between the rollers inside the belt.
5. The cut surface smoothing device according to claim 3, wherein coating treatment that easily separates the cut surface from the outer surface is performed on the outer surface of the belt.
6. A cut surface smoothing device comprising:
 - a high temperature portion that is heated to a temperature equal to or higher than a melting point of a filament three-dimensional bonded member,
 - wherein the high temperature portion is applied to a cut surface of the filament three-dimensional bonded member to smooth the cut surface,

the cut surface smoothing device includes:
the high temperature portion that is a wall surface; and
a fixing vibration table that exposes the cut surface and
fixes and supports the filament three-dimensional
bonded member,

wherein the fixing vibration table vibrates parallel to the
cut surface while applying the cut surface to the wall
surface to smooth the cut surface.

7. The cut surface smoothing device according to claim 6,
wherein coating that suppresses adhesion of a resin to the
wall surface is performed on the wall surface.

8. (canceled)

9. A manufacturing system comprising:

a filament three-dimensional bonded member manufac-
turing device that continuously forms and discharges
the filament three-dimensional bonded member;

a cutting device that cuts the discharged filament three-
dimensional bonded member at predetermined inter-
vals; and

the cut surface smoothing device according to claim 1 that
smooths the cut surface generated by the cutting.

10. (canceled)

11. (canceled)

12. (canceled)

13. The cut surface smoothing device according to claim

4,
wherein coating treatment that easily separates the cut
surface from the outer surface is performed on the outer
surface of the belt.

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