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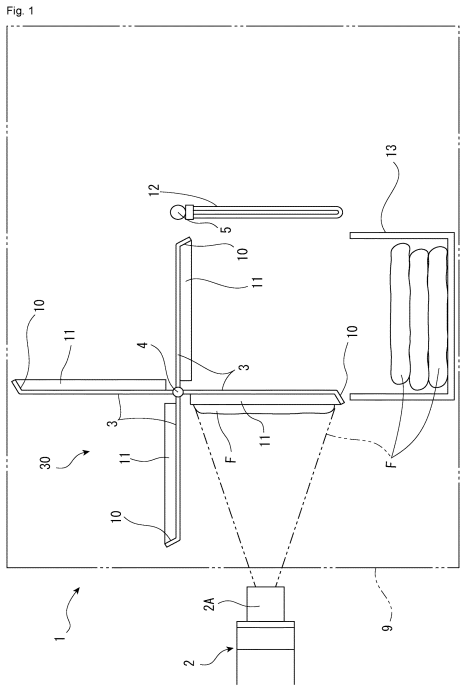
(54) **NANOFIBER COLLECTION DEVICE, NANOFIBER COLLECTION METHOD, AND NANOFIBER ACCUMULATION/MOLDING APPARATUS AND ACCUMULATION/MOLDING METHOD THEREFOR**

(57) A device and method for collecting nanofibers are provided that allow mass production of nanofibers. A device (1) for collecting nanofibers includes: a collecting mechanism rotation axis (4) horizontally arranged to rotatably support parallel collecting bars (31) for collecting nanofibers (F) in a collecting position; a collecting mechanism drive motor (6) to rotatively drive the collecting mechanism rotation axis (4); a control mechanism (8) to stop, for each 90°, the collecting mechanism rotation axis (4) rotatively driven by the collecting mechanism drive motor (6); and peel off bars (12) to peel off the nanofibers (F) collected by the parallel collecting bars (31) below in a non-collecting position.

Fig. 1



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Description

Technical Field

[0001] The present invention relates to a device and method for collecting nanofibers drawn in the form of fibers with a fine diameter. In particular, the present invention relates to a device and method for collecting nanofibers that collect nanofibers drawn in the form of fibers with a fine diameter while forming in a predetermined shape. The present invention relates to a device and method for collecting nanofibers with greatly improved nanofiber production efficiency.

[0002] The present invention also relates to a device and method for depositing and forming nanofibers that deposit nanofibers while forming in a predetermined shape, the nanofibers produced by discharging a molten resin or a dissolved resin to a gas flow and drawing in the form of fibers with a fine diameter. In particular, the present invention relates to a device and method for depositing and forming nanofibers that allow formation of a formation in a predetermined shape including a sheet shape, a mat shape, and a block shape by depositing a discharged nanofiber flow flowing on a gas flow while deflecting the flow by deflecting air from an air nozzle arranged in the vicinity.

Background Art

[0003] Taking advantage of properties as fibers with a fine diameter, nanofibers are conventionally used in various fields. In recent years, nonwoven fabrics made of fibers with an ultrafine diameter and formed in a mat shape in a predetermined size are used as oil adsorbing materials and filters. For example, PTL 1 describes a nanofiber production apparatus for producing and collecting fibers with a fine diameter. The nanofiber production apparatus has a nanofiber generating device, a collecting device, a suction device, and a guide material. The nanofiber generating device is provided with an air nozzle to generate high speed hot air and a blowing nozzle to discharge a polymer solution to the high speed hot air generated from the air nozzle or the vicinity of the high speed hot air. The collecting device is provided on a downstream side of the nanofiber generating device and collects the nanofibers generated by the nanofiber generating device. The suction device is provided on a downstream side of the collecting device and sucks gas. The guide material is formed in a tubular shape and provided on a downstream side of the nanofiber generating device and an upstream side of the collecting device to pass the high speed hot air inside.

Citation List

Patent Literature

[0004] PTL 1: JP 2015/145880 A

Summary of Invention

Technical Problem

[0005] PTL 1 describes that "a filter substrate with nanofibers deposited thereon is heat treated, laminated, and integrated by a thermocompression roller and wound on a winding roll as a nanofiber filter material". That is, PTL 1 describes that a nanofiber material deposited on a filter substrate of the collecting device is wound and collected on a winding roll of the collecting device. PTL 1, however, does not specifically describe the technique to produce a nanofiber material formed in a mat shape. The collecting device in PTL 1 is specialized in collecting nanofibers in a long thin sheet shape to be wound on a roll and is not suitable for forming and efficiently collecting nanofibers in a relatively thick mat shape.

[0006] For collecting nanofibers in a sheet shape by discharging nanofibers from a single discharge nozzle on the collecting device side, the nanofibers are deposited in a circular shape centered around the extension of the discharge nozzle. For effective deposition of nanofibers, a process of sucking with air from behind a sprayed surface (PTL 1) and the like are thus employed. Such a process, however, causes reduction in the suction force to the outer periphery of the sprayed surface as well as the amount of deposited nanofiber. Since nanofibers tend to be deposited near the center, it is difficult to form a formation in a predetermined shape with a uniform thickness.

[0007] There is also a case of spraying nanofibers in a wide area as a roller-type sheet processing device. In this case, a method of installing a plurality of nanofiber discharge nozzles in a wide area or a method of employing a process of moving a discharge nozzle including a melting section and a drive section is considered while causing problems of increasing in size and price of the device. In addition, a general discharge nozzle has a mechanism of moving only in a uniaxial direction, whereas a mechanism of moving in a plurality of directions causes a very complex structure.

[0008] The present invention has been made in view of the above problems and it is thus an object thereof to provide a device and method for collecting nanofibers with greatly improved production efficiency by allowing efficient automatic collection of nanofibers in a mat shape of a relatively thick layer while forming in a predetermined shape.

[0009] It is also an object of the present invention to provide a device and method for depositing and forming nanofibers allowing deposition of nanofibers while collecting and forming in a predetermined shape, such as a square shape.

Solution to Problem

[0010] A device for collecting nanofibers of the present invention is a device for collecting nanofiber produced

by drawing a molten resin or a dissolved resin discharged to a gas flow in a fiber form with a fine diameter, the device including:

a collecting mechanism rotation axis arranged horizontally;
a nanofiber collecting mechanism provided at the collecting mechanism rotation axis;
a collecting mechanism drive motor configured to rotatively drive the collecting mechanism rotation axis;
a control mechanism configured to control the collecting mechanism drive motor to cause the nanofiber collecting mechanism to move between a collecting position to collect the nanofiber and a non-collecting position out of the collecting position by intermittently rotating the collecting mechanism rotation axis; and
a peel off mechanism configured to peel off the nanofiber collected by the nanofiber collecting mechanism when the nanofiber collecting mechanism is in the non-collecting position.

[0011] In the present description, "the nanofiber collecting mechanism to move between a collecting position to collect the nanofiber and a non-collecting position out of the collecting position" includes not only movement by rotation but also movement by sliding.

[0012] Further, in the device for collecting nanofiber of the present invention, the nanofiber collecting mechanism has at least one collecting element provided at the collecting mechanism rotation axis.

[0013] Further, in the device for collecting nanofiber of the present invention, the nanofiber collecting mechanism has a plurality of collecting elements provided at the collecting mechanism rotation axis at regular angular intervals.

[0014] Further, in the device for collecting nanofiber of the present invention, the collecting element of the nanofiber collecting mechanism is configured with a collecting bar group having a plurality of bars aligned in parallel with each other along the collecting mechanism rotation axis. The collecting bar group, herein, having the plurality of bars aligned in parallel with each other along the collecting mechanism rotation axis may be referred to as a nanofiber collecting element or a collecting element as an element of the nanofiber collecting mechanism.

[0015] Further, in the device for collecting nanofiber of the present invention, the plurality of bars configuring the collecting bar group include bars located at both ends in an aligned direction to which respective shape retaining materials are fixed, the shape retaining materials retaining the collected nanofiber in a predetermined shape.

[0016] Further, in the device for collecting nanofiber of the present invention, the nanofiber collecting mechanism has a fall prevention portion prepared by bending a distal end of each bar of the collecting bar group in a direction of rotation.

[0017] Further, in the device for collecting nanofiber of the present invention,
the peel off mechanism is configured with a peel off bar group having a plurality of bars aligned in parallel with each other, and
the plurality of bars of the peel off bar group are moved, when the collecting bar group configuring the collecting element of the nanofiber collecting mechanism is in the non-collecting position, to pass between the respective bars of the collecting bar group.

[0018] Further, in the device for collecting nanofiber of the present invention,
a nanofiber collecting mechanism has a collecting element configured with a collecting bar group having a plurality of bars aligned in parallel with each other,
a peel off mechanism configured to peel off nanofiber collected by the collecting bar group is configured with a peel off bar group having a plurality of bars aligned in parallel with each other,
a control mechanism is provided to control rotation of the nanofiber collecting mechanism and the peel off mechanism,
when the collecting bar group is in the nanofiber non-collecting position, the plurality of bars of the peel off bar group are arranged to pass between the respective bars of the collecting bar group during rotation of the peel off mechanism, and
the control mechanism is configured to control the collecting element to move to the non-collecting position by intermittently rotating the nanofiber collecting mechanism and then to control the bars of the peel off bar group to pass between the respective bars of the collecting bar group by rotating the a peel off mechanism.

[0019] A method for collecting nanofibers of the present invention that collects nanofibers while forming in a predetermined shape is a method for collecting nanofiber while forming in a predetermined shape using a device for collecting nanofiber produced by drawing a molten resin or a dissolved resin discharged to a gas flow in a fiber form with a fine diameter, the method including:

collecting the nanofiber by a collecting element of a nanofiber collecting mechanism in a collecting position;
rotating the nanofiber collecting mechanism by a control mechanism to move the collecting element in the collecting position to a non-collecting position; and
peeling off the collected nanofiber by causing a peel off mechanism to contact, by the control mechanism, the nanofiber collected and formed in the predetermined shape by the collecting element on the collecting element moved to the non-collecting position.

[0020] In the method for collecting nanofiber of the present invention, the nanofiber collected by the collecting element is attached on a rear surface side in a direction of rotation of the nanofiber collecting mechanism and

is recovered in a recovery container provided below when peeled off by the peel off mechanism.

[0021] A method for collecting nanofibers of the present invention is a method for collecting nanofiber used in a device for collecting nanofiber produced by drawing a molten resin or a dissolved resin discharged to a gas flow in a fiber form with a fine diameter, the device having a collecting mechanism rotation axis arranged horizontally, a collecting element of a nanofiber collecting mechanism provided on an outer peripheral surface of the collecting mechanism rotation axis, and a peel off mechanism configured to peel off the nanofiber collected by the collecting element below, wherein
the collecting element is moved between a collecting position on a gas flow and a non-collecting position out of the gas flow by intermittently rotating the collecting mechanism rotation axis, and
the nanofiber collected by the collecting element is peeled off below by the peel off mechanism when the collecting element is in the non-collecting position.

[0022] A method for collecting nanofiber of the present invention includes a procedure of following (a) through (e):

(a) nanofiber is discharged from an outlet of a nanofiber discharge device, the device configured to produce nanofiber by discharging a molten or dissolved resin to a hot air flow and drawing in a fiber form with a fine diameter, to a nanofiber collecting mechanism, the collecting mechanism configured by aligning a plurality of bars in parallel and configured to be intermittently rotatively driven in a predetermined direction, on a rear surface side in a direction of rotation of the nanofiber collecting mechanism;
(b) the discharged nanofiber is collected while formed in a predetermined shape on the rear surface side in the direction of rotation of the nanofiber collecting mechanism;
(c) the nanofiber collecting mechanism with the nanofiber collected and formed in the predetermined shape attached to the rear surface side in the direction of rotation is rotated;
(d) a peel off mechanism is rotated to the nanofiber collected and formed in the predetermined shape by the nanofiber collecting mechanism to peel off the nanofiber attached to the nanofiber collecting mechanism; and
(e) a nanofiber formation peeled off by the peel off mechanism is received in a recovery container.

[0023] Further, in the procedure (b), the nanofiber discharged from the nanofiber discharge device is collected while formed in the predetermined shape by the nanofiber collecting mechanism while the nanofiber collecting mechanism is stopped.

[0024] A nanofiber deposition and formation device of the present invention is a nanofiber deposition and formation device for collecting and depositing nanofiber by a nanofiber collecting mechanism, the nanofiber being discharged from a discharge nozzle of a nanofiber discharge device configured to produce nanofiber by discharging a molten resin or a dissolved resin to a gas flow and drawing in a fiber form with a fine diameter, the nanofiber deposition and formation device including
a discharge flow direction deflection mechanism configured to deflect a direction of a discharged nanofiber flow from the discharge nozzle to the nanofiber collecting mechanism.

[0025] Further, in the nanofiber deposition and formation device of the present invention, the discharge flow direction deflection mechanism includes an air nozzle configured to deflect the direction of the discharged nanofiber flow by directing deflecting air from a direction of a side of the discharged nanofiber flow in a path from the discharge nozzle to the nanofiber collecting mechanism.

[0026] Further, the nanofiber deposition and formation device of the present invention includes an air nozzle blasting angle changing mechanism configured to adjust an air blasting angle from the air nozzle.

[0027] Further, the nanofiber deposition and formation device of the present invention includes an air blast amount changing mechanism configured to adjust an air blast amount of the air nozzle.

[0028] Further, in the nanofiber deposition and formation device of the present invention, the air nozzle is provided in plurality and the plurality of air nozzles are concentrically disposed at regular angular intervals to the discharge nozzle.

[0029] Further, the nanofiber deposition and formation device of the present invention includes an air blast control mechanism configured to continuously control air blasting operation of the air nozzles, concentrically disposed at regular angular intervals, clockwise or counterclockwise in order.

[0030] A nanofiber deposition and formation method of the present invention is a nanofiber deposition and formation method, using a nanofiber deposition and formation device for collecting and depositing nanofiber by a nanofiber collecting mechanism, the nanofiber being discharged from a discharge nozzle of a nanofiber discharge device configured to produce nanofiber by discharging a molten resin or a dissolved resin to a gas flow and drawing in a fiber form with a fine diameter, wherein a direction of a discharged nanofiber flow is deflected by a discharge flow direction deflection mechanism configured to deflect the direction of the discharge flow from the discharge nozzle to the nanofiber collecting mechanism.

[0031] Further, in the nanofiber deposition and formation method of the present invention, the direction of the discharged nanofiber flow is deflected by directing deflecting air from a direction of a side of the discharged nanofiber flow in a path from the discharge nozzle to the nanofiber collecting mechanism.

[0032] Further, in the nanofiber deposition and formation method of the present invention, air blasting opera-

tion of air nozzles, concentrically disposed at regular angular intervals, is continuously controlled clockwise or counterclockwise in order.

Advantageous Effects of Invention

[0033] The present invention allows mass production of nanofibers by configuring the nanofiber collecting device to continuously achieve collection and peel off of nanofibers. The present invention also allows construction of a system to efficiently achieve a series of processes until packaging of nanofibers in a predetermined shape by collecting the discharged and supplied nanofibers while forming in the predetermined shape.

[0034] The nanofiber collecting mechanism of the nanofiber collecting device of the present invention is configured with the groups of collecting bars arranged in parallel, the groups being provided at a predetermined angle at regular intervals to the collecting mechanism rotation axis, to allow mass production of nanofibers by rotating and stopping the collecting mechanism by intermittently driving for each predetermined angle.

[0035] Specifically, the nanofiber collecting mechanism is provided with the groups of the collecting bars for collecting nanofibers arranged in parallel, the groups being provided in four directions at a regular angle of 90° to the collecting mechanism rotation axis, to be intermittently rotated and stopped for each 90°. This allows the groups of the collecting bars arranged in the four directions to be consecutively located in the collecting position facing the discharge nozzle of the nanofiber discharge device and the collecting bar group after collection of the nanofibers to be moved to a position out of the collecting position (non-collecting position). Accordingly, such a collecting mechanism allows marked improvement of nanofiber production.

[0036] Moreover, when the nanofibers collected from the collecting bar group moved to the non-collecting position are peeled off by the peel off mechanism, the nanofibers are attached on a lower surface side of the collecting bar group arranged to be horizontal and thus the nanofiber collecting mechanism allows the nanofibers peeled off from the collecting mechanism by the peel off mechanism to be automatically dropped and accommodated in the recovery container provided below. Accordingly, even nanofibers in a mat shape of a relatively thick layer allow efficient and automatic collection and thus improvement in production efficiency.

[0037] The present invention allows the direction of the flow of the discharged nanofiber collected and deposited by the nanofiber collecting mechanism to be adjusted and deflected by the discharge flow direction deflection mechanism, and it is thus possible to freely form the nanofibers deposited and formed during collection in a desired predetermined shape, such as a square. Furthermore, regardless of the amount of deposition, it is possible to uniformly deposit the nanofibers on the sprayed surface of the nanofiber collecting mechanism.

[0038] In addition, it is possible to freely control the position to deposit the nanofibers to be deposited on the nanofiber collecting mechanism by adjusting the air blast from the air nozzle to be turned on/off, the air blasting angle, and the air blast amount, thereby allowing preparation of a sheet of nanofibers in a shape with a high degree of freedom without limited by the type of collecting device.

[0039] Still in addition, the air blasting operation of the air nozzle concentrically disposed at regular angular intervals to the discharge nozzle is performed by controlling the air blast (controlling turning on/off or the amount of air) from the respective air nozzles, for example, continuously clockwise or counterclockwise in order or randomly, thereby avoiding many air nozzles to be provided and allowing simplification of the device structure.

Brief Description of the Drawings

[0040]

Fig. 1 is a schematic side view illustrating arrangement relationship between a device for collecting nanofibers as a first embodiment of the present invention and a nanofiber discharge device to discharge and supply nanofibers to the device for collecting nanofibers and illustrates a state of collecting nanofibers while forming in a predetermined shape by a nanofiber collecting mechanism.

Fig. 2 is a schematic side view illustrating arrangement relationship of the device for collecting nanofibers as the first embodiment of the present invention and illustrates a state immediately before peeling off a nanofiber formation collected and formed in the predetermined shape by the nanofiber collecting mechanism.

Fig. 3 is a schematic side view illustrating arrangement relationship of the device for collecting nanofibers as the first embodiment of the present invention and illustrates a state of peeling off the nanofiber formation collected and formed in the predetermined shape by the nanofiber collecting mechanism.

Fig. 4 is a schematic top view illustrating a state of the device for collecting nanofibers as the first embodiment of the present invention taken from above.

Fig. 5 is a perspective view illustrating details of the device for collecting nanofibers as the first embodiment of the present invention.

Fig. 6 is a schematic side view illustrating a nanofiber deposition and formation device as a second embodiment of the present invention.

Fig. 7 is a perspective view illustrating a nanofiber collecting mechanism of the nanofiber deposition and formation device as the second embodiment of the present invention.

Fig. 8 is a perspective view illustrating a discharge nozzle configured in a nanofiber discharge device as the second embodiment of the present invention

and a discharge flow direction deflection mechanism configured to deflect a discharge flow from the discharge nozzle to the nanofiber collecting mechanism.

Fig. 9 is a side view illustrating arrangement relationship between the discharge nozzle configured in the nanofiber discharge device as the second embodiment of the present invention and the discharge flow direction deflection mechanism configured to deflect the discharge flow from the discharge nozzle to the nanofiber collecting mechanism.

Fig. 10 is a front view illustrating arrangement relationship between the discharge nozzle configured in the nanofiber discharge device as the second embodiment of the present invention and the discharge flow direction deflection mechanism configured to deflect the discharge flow from the discharge nozzle to the nanofiber collecting mechanism.

Description of Embodiments

First Embodiment

[0041] With reference to Figs. 1 through 5, a device and method for collecting nanofibers according to the first embodiment of the present invention are described below.

[0042] A nanofiber collecting device 1 in the present embodiment collects nanofibers while forming in a predetermined shape. To the nanofiber collecting device 1, nanofibers to be a jet (may be referred to as a discharge flow) carried on a gas flow from a nanofiber discharge device 2 is supplied, the nanofiber discharge device 2 being configured to produce nanofibers by discharging a molten resin or a dissolved resin to a gas flow to draw in the form of fibers with a fine diameter. As illustrated in Fig. 1, the nanofibers flow to be a jet from a discharge nozzle 2A as an outlet of the nanofiber discharge device 2 and collected by a plurality of parallel collecting bars 31 of a collecting bar group 3 as a collecting element configuring a nanofiber collecting mechanism 30 of the nanofiber collecting device 1.

[0043] The nanofiber collecting device 1 is provided with a collecting mechanism rotation axis 4 and a peel off mechanism rotation axis 5 provided in parallel at the same height in a frame 9 (details not shown), a collecting mechanism drive motor 6 to rotatively drive the collecting mechanism rotation axis 4, a peel off mechanism drive motor 7 to rotatively drive the peel off mechanism rotation axis 5, a control mechanism 8 to stop the collecting mechanism rotation axis 4 for each rotation of 90° and rotate the peel off mechanism rotation axis 5 360° immediately after stopping the collecting mechanism rotation axis 4. It should be noted that the degree does not have to be 90° and may be a predetermined angle as appropriate.

[0044] The collecting mechanism rotation axis 4 is arranged horizontally. The collecting mechanism rotation axis 4 is provided with a plurality of collecting bar groups 3. Each collecting bar group 3 has the parallel collecting bars 31 of a plurality (11) of bars aligned in parallel with each other in an axial direction (in Fig. 4, aligned in the vertical direction) of the collecting mechanism rotation axis 4. The number of the parallel collecting bars 31 arranged in parallel is not limited to 11. At a distal end of each parallel collecting bar 31 of the collecting bar groups 3, a fall prevention portion 10 is formed by bending rearward in the direction of rotation. It should be noted that the collecting bar groups 3 are collecting elements attached to the collecting mechanism rotation axis 4 of the nanofiber collecting mechanism 30. The collecting bar groups 3 as the collecting elements are configured with the parallel collecting bars 31 arranged in parallel.

[0045] As illustrated in Fig. 1, the collecting bar groups 3 of the nanofiber collecting mechanism 30 in the present embodiment are provided in four directions at regular angular intervals (90° intervals) on an outer peripheral surface of the collecting mechanism rotation axis 4. As the embodiment shown, the nanofiber collecting mechanism 30 does not have to be provided at four spots for each 90° at the collecting mechanism rotation axis 4 and the collecting element may be provided in at least one spot. Regarding the positions of the collecting bar groups 3 in the present embodiment, a stopped position below the collecting mechanism rotation axis 4 is defined as the collecting position and a stopped position behind the collecting mechanism rotation axis 4 (right side in Figs. 1 through 3) is defined as the non-collecting position. The collecting bar group 3 in the collecting position is located on the gas flow, and the collecting bar group 3 in the non-collecting position is located out of the gas flow. The gas flow in the present embodiment flows from the discharge nozzle 2A illustrated in Figs. 1 through 3 to the right direction.

[0046] As illustrated in Fig. 5, the 11 parallel collecting bars 31 configuring each collecting bar group 3 include one parallel collecting bar 31 that is located at each end (left and right ends in Fig. 5) in the aligned direction and has a shape retaining material 11 fixed thereto, the shape retaining material 11 being formed in a widened U shape overall to retain the shape of the collected nanofiber. The shape retaining materials 11 and the fall prevention portions 10 described earlier prevent nanofibers F collected by the collecting bar groups 3 from falling and sticking out of the collecting bar groups 3 due to the centrifugal force by rotation and the like.

[0047] As illustrated in Fig. 1, the peel off mechanism rotation axis 5 is provided with peel off bars 12, which are a plurality of bars, as a peel off bar group configuring a peel off mechanism. The peel off bars 12 are bent in a U shape and have both end portions fixed to the peel off mechanism rotation axis 5. It should be noted that the peel off bars 12 may be configured to allow passing between the parallel collecting bars 31 of the collecting bar groups 3 and does not have to be limited to the U shape. Although six peel off bars 12 provided at the peel off mechanism rotation axis 5 illustrated in Fig. 4 are aligned

in an axial direction (vertical direction in Fig. 4) of the peel off mechanism rotation axis 5, the number may be an appropriate number.

[0048] When the peel off mechanism rotation axis 5 is rotated 360° by the control mechanism 8, the peel off bars 12 pass gaps between the parallel collecting bars 31 aligned in parallel of the collecting bar group 3 in the non-collecting position and peel off the nanofibers F collected and deposited by the collecting bar group 3 (collecting element). It should be noted that, as illustrated in Fig. 3, a recovery container 13 is placed below the nanofibers F to be peeled off from the parallel collecting bars 31 of the collecting bar group 3 in the non-collecting position and the nanofibers F peeled off from the parallel collecting bars 31 of the collecting bar group 3 in the non-collecting position are thus automatically recovered in the recovery container 13 due to its own weight.

[0049] In the present embodiment, when the collecting bar groups 3 (parallel collecting bars 31) are arranged in front, rear, top, and bottom directions of the outer peripheral surface of the collecting mechanism rotation axis 4, the control mechanism 8 stops the rotation drive of the collecting mechanism rotation axis 4. The "front, rear, top, and bottom" in this context correspond to the "left, right, top, and bottom" in Figs. 1 through 3. In this situation, the collecting bar group 3 in the bottom position (collecting position) is located vertical (state in Fig. 1) to the jet of the nanofibers F discharged from the nanofiber discharge device 2 (flow region schematically illustrated by dash double-dotted lines in Figs. 1 through 3). The nanofibers F are discharged and supplied from the discharge nozzle 2A of the nanofiber discharge device 2 only to the parallel collecting bars 31 in the bottom position of the collecting mechanism rotation axis 4 (collecting bar group 3 in the collecting position). Then, when the parallel collecting bars 31 are in the state of being rotated 90° from there and arranged horizontally (collecting bar group 3 arranged in parallel on the right illustrated in Fig. 2 (collecting element in the non-collecting position)), the peel off mechanism rotation axis 5 is rotated 360°, followed by contact of the peel off bars 12 with the nanofibers F collected by the parallel collecting bars 31 to peel off, as illustrated in Fig. 3, the nanofibers F collected by the parallel collecting bars 31. The peeled nanofibers F are then automatically recovered in the recovery container 13.

[0050] A series of operations for collecting the nanofibers F by the nanofiber collecting device 1 is described below. As illustrated in Fig. 1, when the nanofibers F are discharged and supplied from the discharge nozzle 2A of the nanofiber discharge device 2 to the vertical parallel collecting bars 31 of the collecting bar group 3 in the bottom position (collecting position) of the collecting mechanism rotation axis 4 facing the discharge nozzle 2A, the nanofibers F are attached on the parallel collecting bars 31 of the collecting bar group 3 in the collecting position to be collected. The nanofibers F are thus deposited in a mat shape in a predetermined relatively thick shape.

[0051] Then, the control mechanism 8 rotates the collecting mechanism rotation axis 4 90° (as illustrated in Fig. 2, rotates 90° counterclockwise) and the collecting bar group 3 after collection of the nanofibers F in the collecting position is arranged horizontally in the rear position (non-collecting position). That is, the control mechanism 8 intermittently rotates the collecting mechanism rotation axis 4 to control the collecting mechanism drive motor 6 to move the collecting bar group 3 between the collecting position to collect the nanofibers F and the non-collecting position out of the collecting position. In this state (non-collecting position), as illustrated in Fig. 2, the collected nanofibers F are arranged on a bottom side (lower surface side) of each parallel collecting bar 31.

[0052] After the rotation stop of the collecting mechanism rotation axis 4, the control mechanism 8 rotates the peel off mechanism rotation axis 5 360° (as illustrated in Fig. 2, counterclockwise), followed by passing of the six peel off bars 12 between the 11 parallel collecting bars 31, arranged in parallel and having the collected nanofibers F, of the collecting bar group 3 in the non-collecting position (peel off bars 12 illustrated by solid lines in Fig. 3). The nanofibers F in the predetermined shape collected by the parallel collecting bars 31 arranged in parallel are thus peeled off by the contact of the peel off bars 12, and the peeled nanofibers F are automatically accommodated in the recovery container 13 due to its own weight. Such a series of operations is then performed automatically and repeatedly, thereby allowing mass production of the nanofibers F in a mat shape and the like.

[0053] The method for collecting nanofibers of the present invention includes the following procedure of (a) through (e):

(a) nanofibers are discharged from an outlet of a nanofiber discharge device, the device configured to produce nanofibers by discharging a molten resin or a dissolved resin to a hot air flow (hot gas flow) and drawing in the form of fibers with a fine diameter, to a nanofiber collecting mechanism, the collecting mechanism configured by aligning a plurality of bars in parallel and configured to be intermittently rotatively driven in a predetermined direction, on a rear surface side in a direction of rotation of the nanofiber collecting mechanism;

(b) the discharged nanofibers are collected while formed in a predetermined shape on the rear surface side in the direction of rotation of the nanofiber collecting mechanism;

(c) the nanofiber collecting mechanism with the nanofibers collected and formed in the predetermined shape attached to the rear surface side in the direction of rotation is rotated;

(d) a peel off mechanism is rotated to the nanofibers collected and formed in the predetermined shape by the nanofiber collecting mechanism to peel off the nanofibers attached to the nanofiber collecting

mechanism; and

(e) a nanofiber formation peeled off by the peel off mechanism is received in a recovery container.

[0054] In the procedure (b), the nanofibers discharged from the nanofiber discharge device is collected while formed in the predetermined shape by the nanofiber collecting mechanism while the nanofiber collecting mechanism is stopped.

[0055] As described above, according to the nanofiber collecting device 1 in the present embodiment, the collecting mechanism rotation axis 4 configured to be rotatively driven and intermittently rotated and stopped for each 90° is provided with the collecting bar groups 3 in four directions at regular angular intervals of 90° (front, rear, top, and bottom of the collecting mechanism rotation axis 4), the collecting bar groups 3 having the parallel collecting bars 31 configured to collect the nanofibers F and aligned in parallel. Such configuration allows the collecting bar groups 3 to be rotated and stopped for each 90° and each of the parallel collecting bars 31 in the four directions to be continually arranged in the position facing the discharge nozzle 2A of the nanofiber discharge device 2 (collecting position). It is thus possible to improve the efficiency of collecting the nanofibers F by the collecting bar groups 3, leading to improvement in production efficiency. It should be noted that the intermittent rotation and stop of the collecting mechanism rotation axis 4 is not limited to the control by rotating and stopping for each 90° and is to be intermittently controlled in accordance with the angle of arranging the collecting bar groups 3 as appropriate.

[0056] Moreover, when the nanofibers F are peeled off from the parallel collecting bars 31 aligned in parallel by the peel off bars 12, the collecting mechanism rotation axis 4 is rotated in a predetermined direction (in Fig. 2, counterclockwise) to cause the nanofibers F to be attached on the lower surface side of each parallel collecting bar 31 in the non-collecting position. Such configuration allows the nanofibers F peeled off from the parallel collecting bars 31 arranged in parallel in the non-collecting position by the peel off bars 12 to be automatically dropped and accommodated in the recovery container 13 provided below. It is thus possible to effectively automatically recover nanofibers even in a mat shape of a relatively thick layer and improve the production efficiency.

Second Embodiment

[0057] With reference to Figs. 6 through 10, a device and method for depositing and forming nanofibers according to the second embodiment of the present invention are described below.

[0058] Fig. 6 illustrates a nanofiber deposition and formation device 1 including the nanofiber discharge device 2 and a nanofiber collecting device 15. Specifically, Fig. 6 illustrates a state where a nanofiber collecting mechanism collects and deposits nanofibers as a discharge flow carried on a gas flow from the discharge nozzle 2A of the nanofiber discharge device 2.

[0059] The device and method for depositing and forming nanofibers of the present invention exhibit strong effects by being applied to the collecting device in the first embodiment, and the present embodiment is described using the discharge nozzle and the collecting device in the first embodiment. It should be noted that the discharge nozzle and the collecting device are not limited to those described in the first embodiment and application to a general technique is readily made by those skilled in the art.

[0060] The nanofiber deposition and formation device 1 in the present embodiment is roughly provided with the nanofiber discharge device 2 and the nanofiber collecting device 15. The nanofiber discharge device 2 discharges a molten resin or a dissolved resin to a gas flow and draws the resin in the form of fibers with a fine diameter to produce nanofibers F. The nanofiber discharge device 2 discharges and supplies the nanofibers F as a jet (may be referred to as a discharge flow) carried on a gas flow from the discharge nozzle 2A to the nanofiber collecting device 15. As illustrated in Fig. 1, the nanofibers F flow to be a jet from the discharge nozzle 2A as an outlet of the nanofiber discharge device 2 and are collected by the plurality of parallel collecting bars 31 of the collecting bar groups 3 as collecting elements configuring the nanofiber collecting mechanism 30 of the nanofiber collecting device 15. The nanofiber collecting device 15 is the nanofiber collecting device 1 described above in the first embodiment.

[0061] The nanofiber deposition and formation device 1 is provided with the collecting mechanism rotation axis 4 and the peel off mechanism rotation axis 5 provided in parallel at the same height in the frame (housing) 9, details not shown, a collecting mechanism drive motor configured to rotatively drive the collecting mechanism rotation axis 4, and a peel off mechanism drive motor configured to rotatively drive the peel off mechanism rotation axis 5. The collecting mechanism rotation axis 4 is provided with a control mechanism to stop the collecting mechanism rotation axis 4 for each rotation of 90° and to rotate the peel off mechanism rotation axis 5 360° immediately after stopping the collecting mechanism rotation axis 4. The discharged nanofibers are collected and deposited by the collecting bar group 3 stopped at a bottom position illustrated in Fig. 1. By rotation of the collecting bar groups 3 90° in an M direction and rotation of the peel off mechanism rotation axis 5 360° in an N direction, the nanofibers F deposited and collected by the collecting bar group 3 are peeled off by peel off bars 12 in a U shape attached to the peel off mechanism rotation axis 5. It should be noted that the collecting mechanism drive motor, the peel off mechanism drive motor, and the control mechanism are omitted from the illustration because they are not the spirit of the present invention.

[0062] Fig. 7 illustrates details of the nanofiber collect-

ing mechanism 30. The collecting mechanism rotation axis 4 is provided with the four collecting bar groups 3 arranged at 90° intervals. Each collecting bar groups 3 has the parallel collecting bars 31 of the plurality (11) of bars aligned in the axial direction of the collecting mechanism rotation axis 4. At the distal end of each parallel collecting bar 31 of the collecting bar groups 3, the fall prevention portion 10 is formed by bending.

[0063] As illustrated in Fig. 7, the 11 parallel collecting bars 31 configuring each collecting bar group 3 include one parallel collecting bar 31 that is located at each end (left and right ends in Fig. 7) in the aligned direction and has a shape retaining material 11 fixed thereto in a widened U shape. The shape retaining materials 11 and the fall prevention portions 10 described earlier prevent the nanofibers F collected by the collecting bar groups 3 from falling and sticking out of the collecting bar groups 3 due to the centrifugal force by rotation and the like.

[0064] As illustrated in Fig. 6, the peel off mechanism rotation axis 5 is provided with the peel off bars 12, which are a plurality of bars, as the peel off bar group configuring the peel off mechanism. The peel off bars 12 are bent in a U shape and have both end portions fixed to the peel off mechanism rotation axis 5. Six peel off bars 12 provided at the peel off mechanism rotation axis 5 are aligned in the axial direction of the peel off mechanism rotation axis 5.

[0065] When the peel off mechanism rotation axis 5 is rotated 360° by the control mechanism 8, the peel off bars 12 pass gaps between the parallel collecting bars 31 and peel off the nanofibers F collected and deposited by the parallel collecting bars 31. It should be noted that the recovery container 13 is placed below the nanofibers F to be peeled off from the parallel collecting bars 31 and the nanofibers F peeled off from the parallel collecting bars 31 are thus automatically recovered in the recovery container 13 due to its own weight.

[0066] In the present embodiment, when the collecting bar groups 3 are arranged in the front, rear, top, and bottom of the outer periphery of the collecting mechanism rotation axis 4, the control mechanism stops the rotation drive of the collecting mechanism rotation axis 4 (state in Fig. 6). The "front, rear, top, and bottom" in this context correspond to the "left, right, top, and bottom" in Fig. 6. The nanofibers F are discharged and supplied from the discharge nozzle 2A of the nanofiber discharge device 2 only to the parallel collecting bars 31 of the collecting bar group 3 in the bottom position of the collecting mechanism rotation axis 4 (collecting position). Then, when the parallel collecting bars 31 are in the state of being rotated 90° from there and arranged horizontally, the peel off mechanism rotation axis 5 is rotated 360°, followed by contact of the peel off bars 12 with the nanofibers F collected by the parallel collecting bars 31 to peel off the nanofibers F collected by the parallel collecting bars 31. The peeled nanofibers F are then automatically recovered in the recovery container 13.

[0067] The discharge flow direction deflection mechanism as an embodiment of the present invention is then described. With reference to Figs. 8 through 10, a discharge flow direction deflection mechanism 16 is described below that is configured to deflect a flow of the discharged nanofibers F (discharge flow) from the discharge nozzle 2A of the nanofiber discharge device 2 to the nanofiber collecting mechanism 30 carried on a gas flow. It should be noted that, although the discharge flow direction deflection mechanism 16 in the present embodiment belongs to the nanofiber discharge device 2, it may belong to the nanofiber collecting device 15 side.

[0068] The discharge flow direction deflection mechanism 16 deflects a flow of the discharged nanofibers F by directing deflecting air from a direction of a side of the flow of the discharged nanofibers F from the discharge nozzle 2A to form a discharge flow to a desired direction, in other words, to shift the flow of the discharged nanofibers F. The discharge flow direction deflection mechanism 16 is provided with a plurality of air nozzles 17 to direct the deflecting air from the side to the flow of the discharged nanofibers F from the discharge nozzle 2A. The plurality of air nozzles 17 are arranged circumferentially. The deflecting air blasted from the air nozzles 17 is blown at respective angles (air blasting angles to the discharge flow) adjustable by deflection angle adjustment plates 18. The deflection angle adjustment plates 18 are radially (direction to move closer to or farther from the flow of the discharged nanofibers F) slidably mounted on a retention frame 19 in a hollow disk shape. To the air nozzles 17, pipes are connected to supply high pressure air to be the deflecting air while the pipes are now shown for simplification of the drawing. The pipes may guide the deflecting air to the air nozzles 17. In addition to the pipes, the air nozzles 17 are provided with a pump, a solenoid valve for operation of turning on/off air supply, and the like while they may be configured as appropriate and details are not described herein. This embodiment of the present invention is provided with an air blast control mechanism 21 configured to control various types of air blasting operation including air blast timing by each air nozzle 17 and an air blast amount changing mechanism 20 configured to electrically adjust an air blast amount by each air nozzle 17.

[0069] The retention frame 19 in a hollow disk shape on which the plurality of air nozzles 17 are circumferentially mounted is concentrically arranged to surround the discharge nozzle 2A on a downstream side of the discharge nozzle 2A and is configured integrally with the nanofiber discharge device 2 via a coupling frame, not shown. As illustrated in Figs. 8 through 10, eight of the air nozzles 17 are disposed at regular angular intervals (45° intervals) concentrically centered around the arrangement of the discharge nozzle 2A. Of course, the plurality of air nozzles 17 are not limited to the arrangement of eight nozzles at 45° intervals.

[0070] On the retention frame 19, each air nozzle 17 is mounted via the deflection angle adjustment plate 18. The deflection angle adjustment plates 18 are slidably

mounted on the retention frame 19 in a hollow disk shape to allow oscillation in a direction to move closer to or farther from the flow of the discharged nanofibers F. The deflection angle adjustment plates 18 are air nozzle blasting angle changing mechanisms configured to adjust the air blasting angles from the air nozzles 17.

[0071] A nanofiber deposition and formation method of the present invention uses a nanofiber deposition and formation device for collecting and depositing nanofibers by a nanofiber collecting mechanism, the nanofibers being discharged from a discharge nozzle of a nanofiber discharge device configured to produce nanofibers by discharging a molten resin or a dissolved resin to a gas flow and drawing in a fiber form with a fine diameter, wherein

a discharged nanofiber flow from the discharge nozzle to the nanofiber collecting mechanism is deflected by the discharge flow direction deflection mechanism 16 to change a position to deposit the nanofibers and obtain a nanofiber deposition in a desired predetermined shape.

[0072] The discharge flow direction deflection mechanism 16 directs deflecting air from a direction of a side of the discharged nanofiber flow in a path from the discharge nozzle to the nanofiber collecting mechanism to deflect the direction of the discharged nanofiber flow.

[0073] The discharge flow direction deflection mechanism 16 controls air blasting operation of the air nozzles concentrically disposed at regular angular intervals to blast the air, for example, continuously controlled clockwise or counterclockwise in order or randomly. The air blast control in this case may be control of turning on/off the air blast by each air nozzle or control of an air blast amount. This allows the deflecting air to be generated as if the deflecting air moves around the discharged nanofiber flow and the direction of the discharge flow to be randomly changed. It is thus possible to form a nanofiber formation in a predetermined shape.

[0074] According to the nanofiber deposition and formation device 1 described in the present embodiment, the direction of the flow of discharged nanofibers collected and deposited by the nanofiber collecting mechanism is appropriately adjusted by the discharge flow direction deflection mechanism 16 in accordance with a shape to be formed. Such configuration allows the nanofibers F collected and deposited by the nanofiber collecting mechanism to be freely deposited and formed in a predetermined shape, such as a square shape. It is thus possible to form a formation in a predetermined shape including a sheet shape, a mat shape, and a block shape. It is also possible to uniformly deposit the nanofibers F on the sprayed surface of the parallel collecting bars 31 of the collecting bar groups 3 regardless of the amount of deposition.

[0075] In addition, the position to deposit the nanofibers F to be deposited by the collecting mechanism is allowed to be freely controlled by adjusting the air blasting angle and the air blast amount of each air nozzle 17, and it is thus possible to prepare a sheet of the nanofibers F in a shape with a high degree of freedom without limited by the type of collecting mechanism.

[0076] Still in addition, the air blast control mechanism 21 is capable of controlling the operation of turning on/off the air blast from air nozzles 17 concentrically disposed at regular angular intervals so as to, for example, continuously rotate clockwise or counterclockwise in order or randomly, thereby avoiding many air nozzles to be provided and achieving simplification of the device structure.

[0077] Although the embodiments of the present invention have been described above, the present invention is not limited to these examples. The embodiments described earlier subjected to addition, deletion, and/or design change of components appropriately by those skilled in the art and those having the characteristics of the embodiments appropriately combined are included in the scope of the present invention as long as including the spirit of the present invention.

Reference Signs List

First Embodiment, Figs. 1 through 5

[0078]

1	Device for Collecting Nanofibers
2	Nanofiber Discharge Device
2A	Discharge Nozzle (Outlet)
3	Collecting Bar Group (Nanofiber Collecting Element)
30	Nanofiber Collecting Mechanism
31	Parallel Collecting Bar
4	Collecting Mechanism Rotation Axis
5	Peel Off Mechanism Rotation Axis
6	Collecting Mechanism Drive Motor
7	Peel Off Mechanism Drive Motor
8	Control Mechanism
9	Frame
10	Fall Prevention Portion
11	Shape Retaining Material
12	Peel Off Bar
13	Recovery Container
F	Nanofiber

Second Embodiment, Figs. 6 through 10

[0079]

1	Nanofiber Deposition and Formation Device
2	Nanofiber Discharge Device
2A	Discharge Nozzle (Outlet)
30	Nanofiber Collecting Mechanism
3	Collecting Bar Group
31	Parallel Collecting Bar
4	Collecting Mechanism Rotation Axis
5	Peel Off Mechanism Rotation Axis
9	Frame (Housing)
10	Fall Prevention Portion

11 Shape Retaining Material
12 Peel Off Bar
13 Recovery Container
15 Nanofiber Collecting Device
16 Discharge Flow Direction Deflection Mechanism
17 Air Nozzle
18 Deflection Angle Adjustment Plate (Air Nozzle Blasting Angle Changing Mechanism)
19 Retention Frame
20 Air Blast Amount Changing Mechanism
21 Air Blast Control Mechanism (Control Mechanism)
F Nanofiber

Claims

1. A device for collecting nanofiber produced by drawing a molten resin or a dissolved resin discharged to a gas flow in a fiber form with a fine diameter, the device comprising:

a collecting mechanism rotation axis arranged horizontally;
a nanofiber collecting mechanism provided at the collecting mechanism rotation axis;
a collecting mechanism drive motor configured to rotatively drive the collecting mechanism rotation axis;
a control mechanism configured to control the collecting mechanism drive motor to cause the nanofiber collecting mechanism to move between a collecting position to collect the nanofiber and a non-collecting position out of the collecting position by intermittently rotating the collecting mechanism rotation axis; and
a peel off mechanism configured to peel off the nanofiber collected by the nanofiber collecting mechanism when the nanofiber collecting mechanism is in the non-collecting position.

2. The device for collecting nanofiber according to Claim 1, wherein the nanofiber collecting mechanism has at least one collecting element provided at the collecting mechanism rotation axis.

3. The device for collecting nanofiber according to Claim 1, wherein the nanofiber collecting mechanism has a plurality of collecting elements provided at the collecting mechanism rotation axis at regular angular intervals.

4. The device for collecting nanofiber according to Claim 2 or 3, wherein the collecting element of the nanofiber collecting mechanism is configured with a collecting bar group having a plurality of bars aligned in parallel with each other along the collecting mechanism rotation axis.

5. The device for collecting nanofiber according to Claim 4, wherein the plurality of bars configuring the collecting bar group include bars located at both ends in an aligned direction to which respective shape retaining materials are fixed, the shape retaining materials retaining the collected nanofiber in a predetermined shape.

6. The device for collecting nanofiber according to Claim 5, wherein the nanofiber collecting mechanism has a fall prevention portion prepared by bending a distal end of each bar of the collecting bar group in a direction of rotation.

7. The device for collecting nanofiber according to Claim 4, wherein
the peel off mechanism is configured with a peel off bar group having a plurality of bars aligned in parallel with each other, and
the plurality of bars of the peel off bar group are moved, when the collecting bar group configuring the collecting element of the nanofiber collecting mechanism is in the non-collecting position, to pass between the respective bars of the collecting bar group.

8. A device for collecting nanofiber, wherein
a nanofiber collecting mechanism has a collecting element configured with a collecting bar group having a plurality of bars aligned in parallel with each other,
a peel off mechanism configured to peel off nanofiber collected by the collecting bar group is configured with a peel off bar group having a plurality of bars aligned in parallel with each other,
a control mechanism is provided to control rotation of the nanofiber collecting mechanism and the peel off mechanism,
when the collecting bar group is in the nanofiber non-collecting position, the plurality of bars of the peel off bar group are arranged to pass between the respective bars of the collecting bar group during rotation of the peel off mechanism, and
the control mechanism is configured to control the collecting element to move to the non-collecting position by intermittently rotating the nanofiber collecting mechanism and then to control the bars of the peel off bar group to pass between the respective bars of the collecting bar group by rotating the a peel off mechanism.

9. A method for collecting nanofiber while forming in a predetermined shape using a device for collecting nanofiber produced by drawing a molten resin or a dissolved resin discharged to a gas flow in a fiber form with a fine diameter, the method comprising:

collecting the nanofiber by a collecting element

of a nanofiber collecting mechanism in a collecting position;
rotating the nanofiber collecting mechanism by a control mechanism to move the collecting element in the collecting position to a non-collecting position; and
peeling off the collected nanofiber by causing a peel off mechanism to contact, by the control mechanism, the nanofiber collected and formed in the predetermined shape by the collecting element on the collecting element moved to the non-collecting position.

10. The method for collecting nanofiber according to Claim 9, wherein the nanofiber collected by the collecting element is attached on a rear surface side in a direction of rotation of the nanofiber collecting mechanism and is recovered in a recovery container provided below when peeled off by the peel off mechanism.

11. A method for collecting nanofiber used in a device for collecting nanofiber produced by drawing a molten resin or a dissolved resin discharged to a gas flow in a fiber form with a fine diameter, the device having a collecting mechanism rotation axis arranged horizontally, a collecting element of a nanofiber collecting mechanism provided on an outer peripheral surface of the collecting mechanism rotation axis, and a peel off mechanism configured to peel off the nanofiber collected by the collecting element below, wherein
the collecting element is moved between a collecting position on a gas flow and a non-collecting position out of the gas flow by intermittently rotating the collecting mechanism rotation axis, and
the nanofiber collected by the collecting element is peeled off below by the peel off mechanism when the collecting element is in the non-collecting position.

12. A method for collecting nanofiber, comprising a procedure of following (a) through (e):

(a) nanofiber is discharged from an outlet of a nanofiber discharge device, the device configured to produce nanofiber by discharging a molten or dissolved resin to a hot air flow and drawing in a fiber form with a fine diameter, to a nanofiber collecting mechanism, the collecting mechanism configured by aligning a plurality of bars in parallel and configured to be intermittently rotatively driven in a predetermined direction, on a rear surface side in a direction of rotation of the nanofiber collecting mechanism;
(b) the discharged nanofiber is collected while formed in a predetermined shape on the rear surface side in the direction of rotation of the nanofiber collecting mechanism;
(c) the nanofiber collecting mechanism with the nanofiber collected and formed in the predetermined shape attached to the rear surface side in the direction of rotation is rotated;
(d) a peel off mechanism is rotated to the nanofiber collected and formed in the predetermined shape by the nanofiber collecting mechanism to peel off the nanofiber attached to the nanofiber collecting mechanism; and
(e) a nanofiber formation peeled off by the peel off mechanism is received in a recovery container.

13. The method for collecting nanofiber according to Claim 12, wherein, in the procedure (b), the nanofiber discharged from the nanofiber discharge device is collected while formed in the predetermined shape by the nanofiber collecting mechanism while the nanofiber collecting mechanism is stopped.

14. A nanofiber deposition and formation device for collecting and depositing nanofiber by a nanofiber collecting mechanism, the nanofiber being discharged from a discharge nozzle of a nanofiber discharge device configured to produce nanofiber by discharging a molten resin or a dissolved resin to a gas flow and drawing in a fiber form with a fine diameter, the nanofiber deposition and formation device comprising
a discharge flow direction deflection mechanism configured to deflect a direction of a discharged nanofiber flow from the discharge nozzle to the nanofiber collecting mechanism.

15. The nanofiber deposition and formation device according to Claim 15, wherein the discharge flow direction deflection mechanism includes an air nozzle configured to deflect the direction of the discharged nanofiber flow by directing deflecting air from a direction of a side of the discharged nanofiber flow in a path from the discharge nozzle to the nanofiber collecting mechanism.

16. The nanofiber deposition and formation device according to Claim 15, further comprising an air nozzle blasting angle changing mechanism configured to adjust an air blasting angle from the air nozzle.

17. The nanofiber deposition and formation device according to Claim 15 or 16, further comprising an air blast amount changing mechanism configured to adjust an air blast amount of the air nozzle.

18. The nanofiber deposition and formation device according to any one of Claims 15 through 17, wherein the air nozzle is provided in plurality and the plurality of air nozzles are concentrically disposed at regular

angular intervals to the discharge nozzle.

19. The nanofiber deposition and formation device according to Claim 18, further comprising an air blast control mechanism configured to continuously control air blasting operation of the air nozzles, concentrically disposed at regular angular intervals, clockwise or counterclockwise in order.

20. A nanofiber deposition and formation method, using a nanofiber deposition and formation device for collecting and depositing nanofiber by a nanofiber collecting mechanism, the nanofiber being discharged from a discharge nozzle of a nanofiber discharge device configured to produce nanofiber by discharging a molten resin or a dissolved resin to a gas flow and drawing in a fiber form with a fine diameter, wherein
a direction of a discharged nanofiber flow is deflected by a discharge flow direction deflection mechanism configured to deflect the direction of the discharge flow from the discharge nozzle to the nanofiber collecting mechanism.

21. The nanofiber deposition and formation method according to Claim 20, wherein the direction of the discharged nanofiber flow is deflected by directing deflecting air from a direction of a side of the discharged nanofiber flow in a path from the discharge nozzle to the nanofiber collecting mechanism.

22. The nanofiber deposition and formation method according to Claim 21, wherein air blasting operation of air nozzles, concentrically disposed at regular angular intervals, is continuously controlled clockwise or counterclockwise in order.

Fig. 1

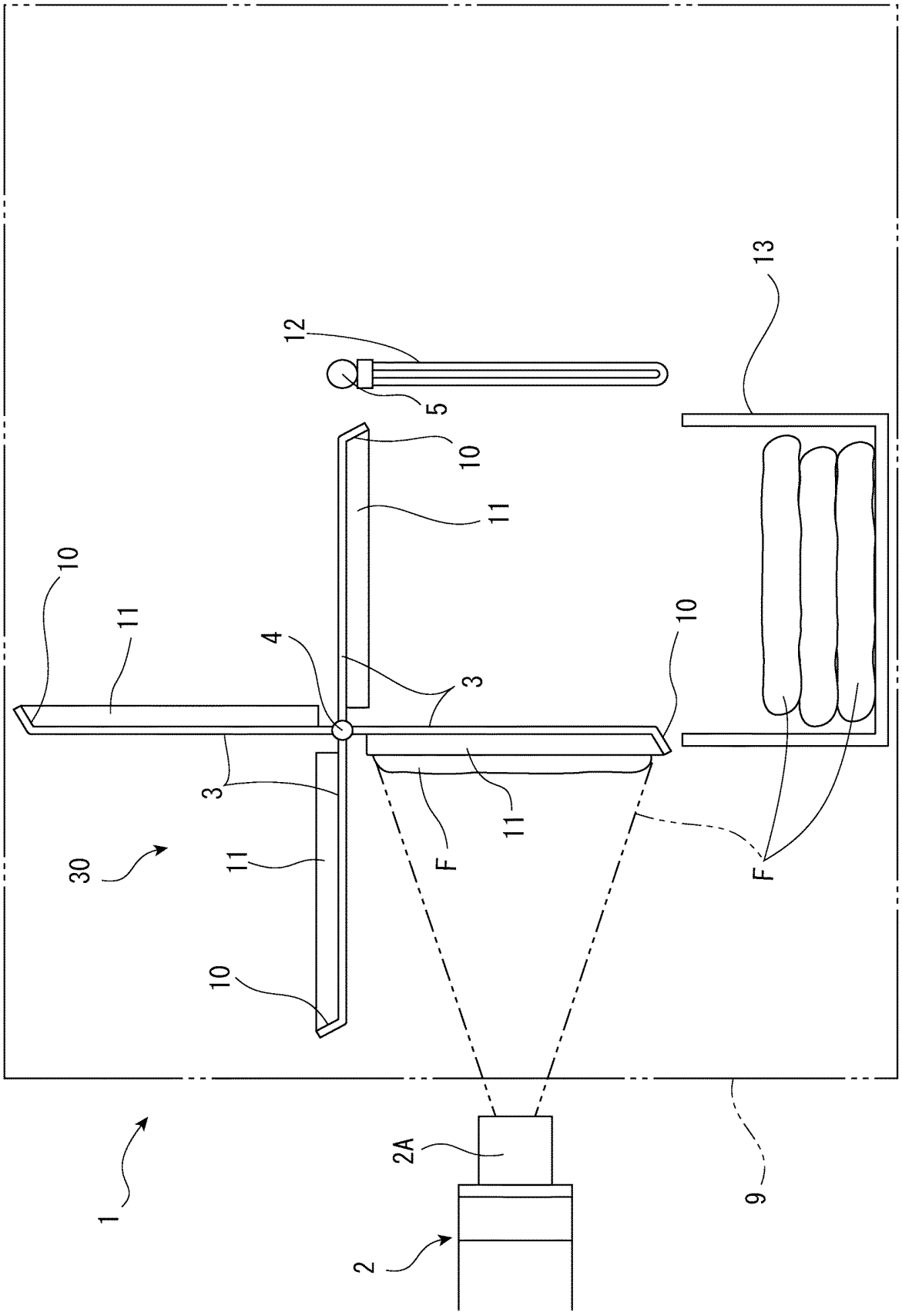


Fig. 2

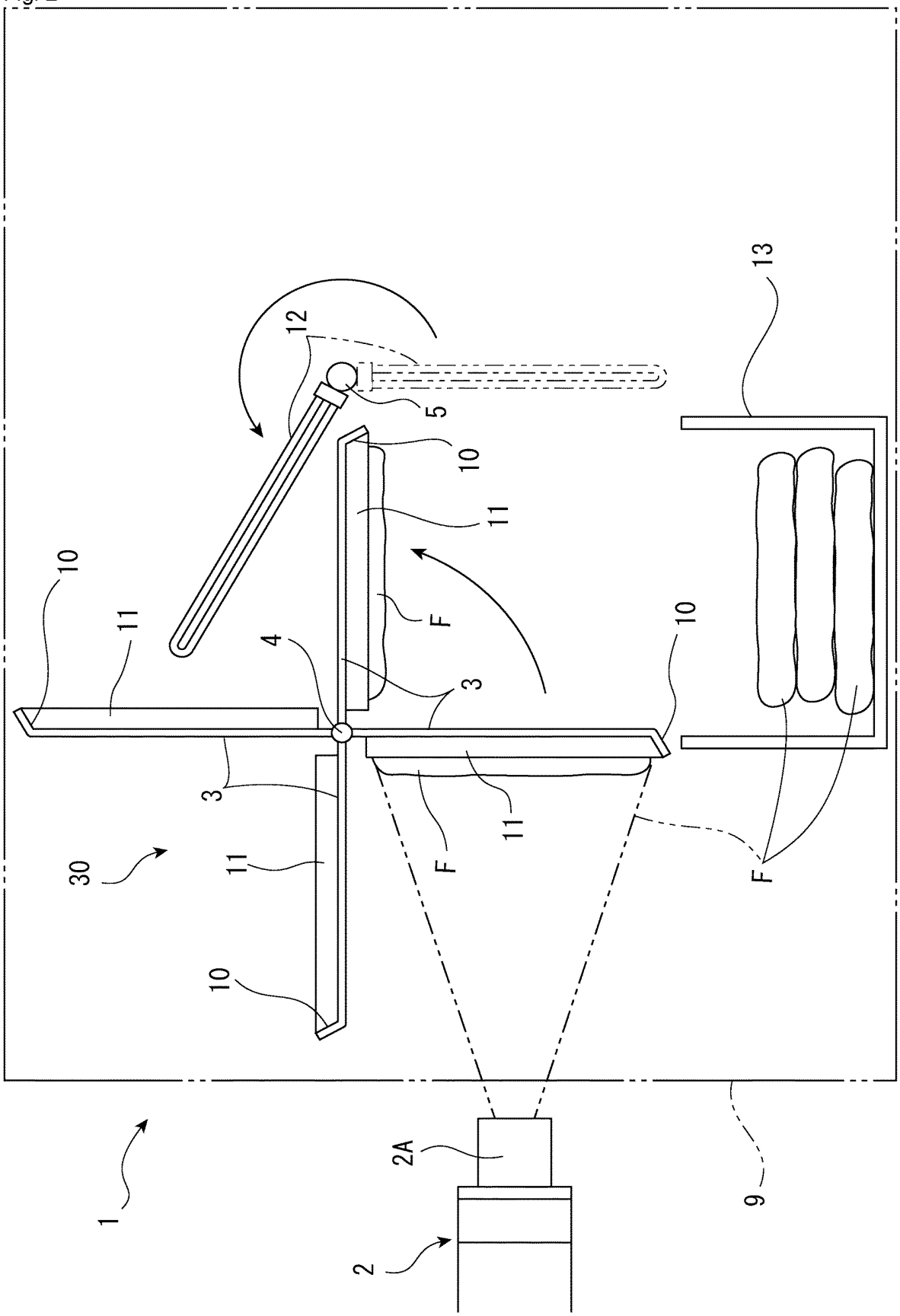


Fig. 3

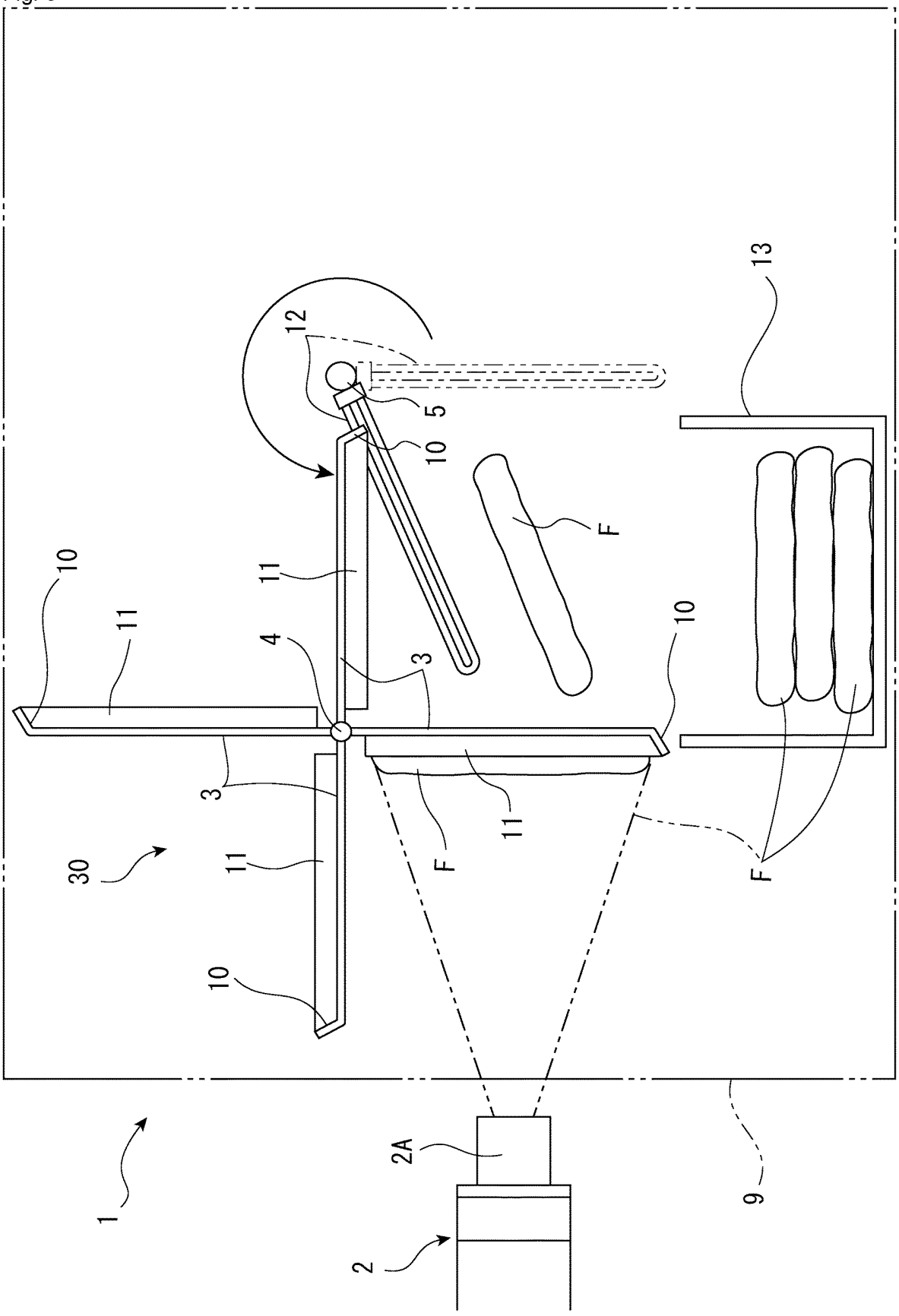


Fig. 4

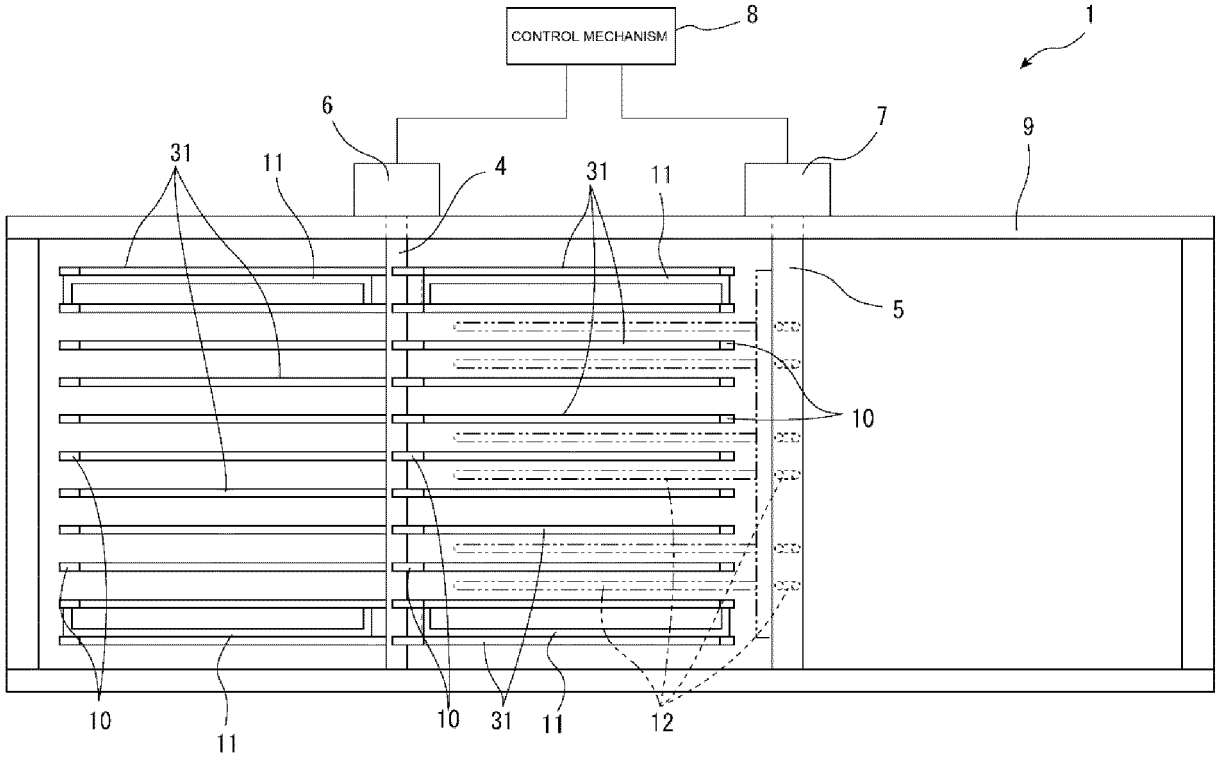


Fig. 5

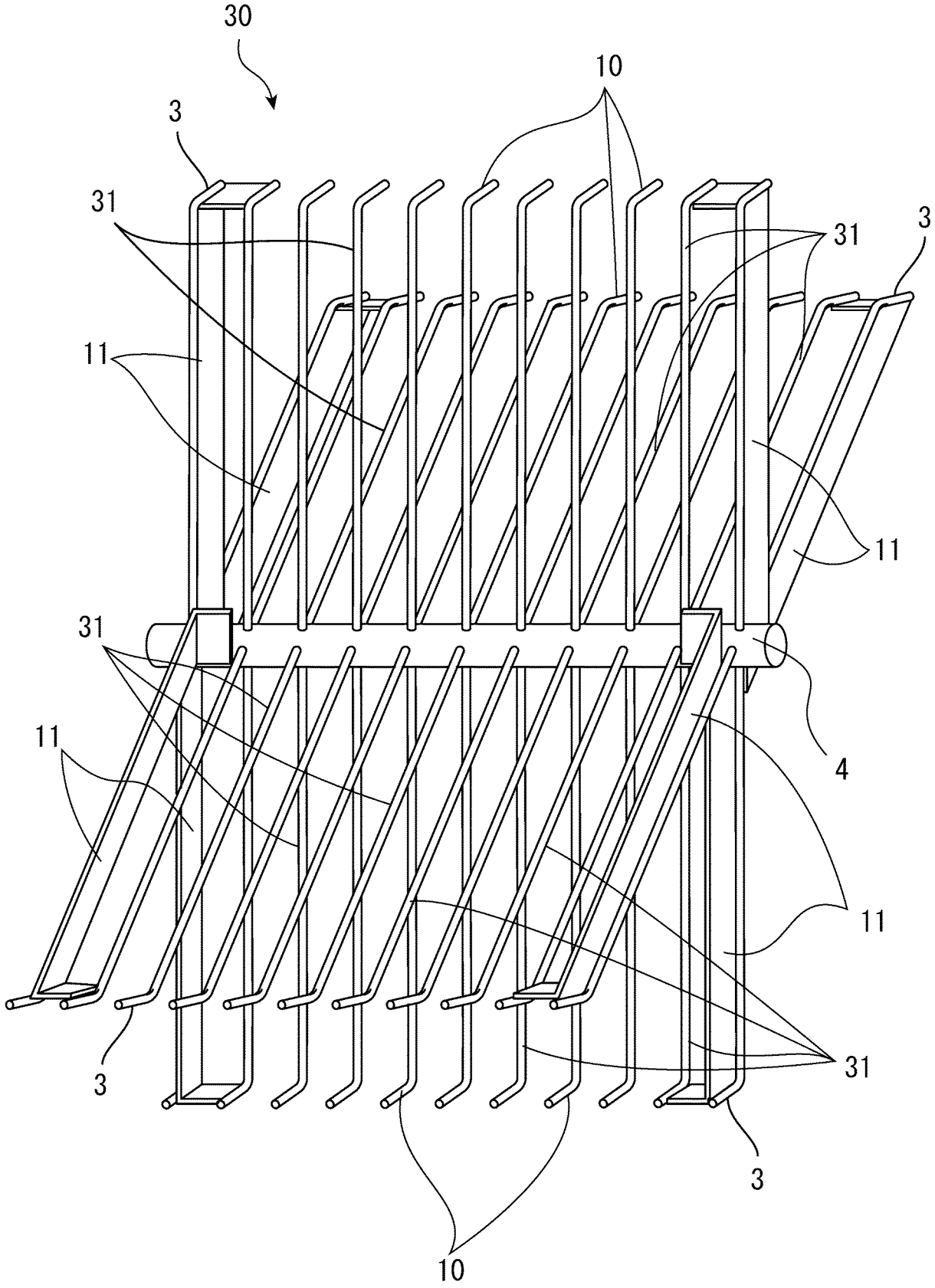
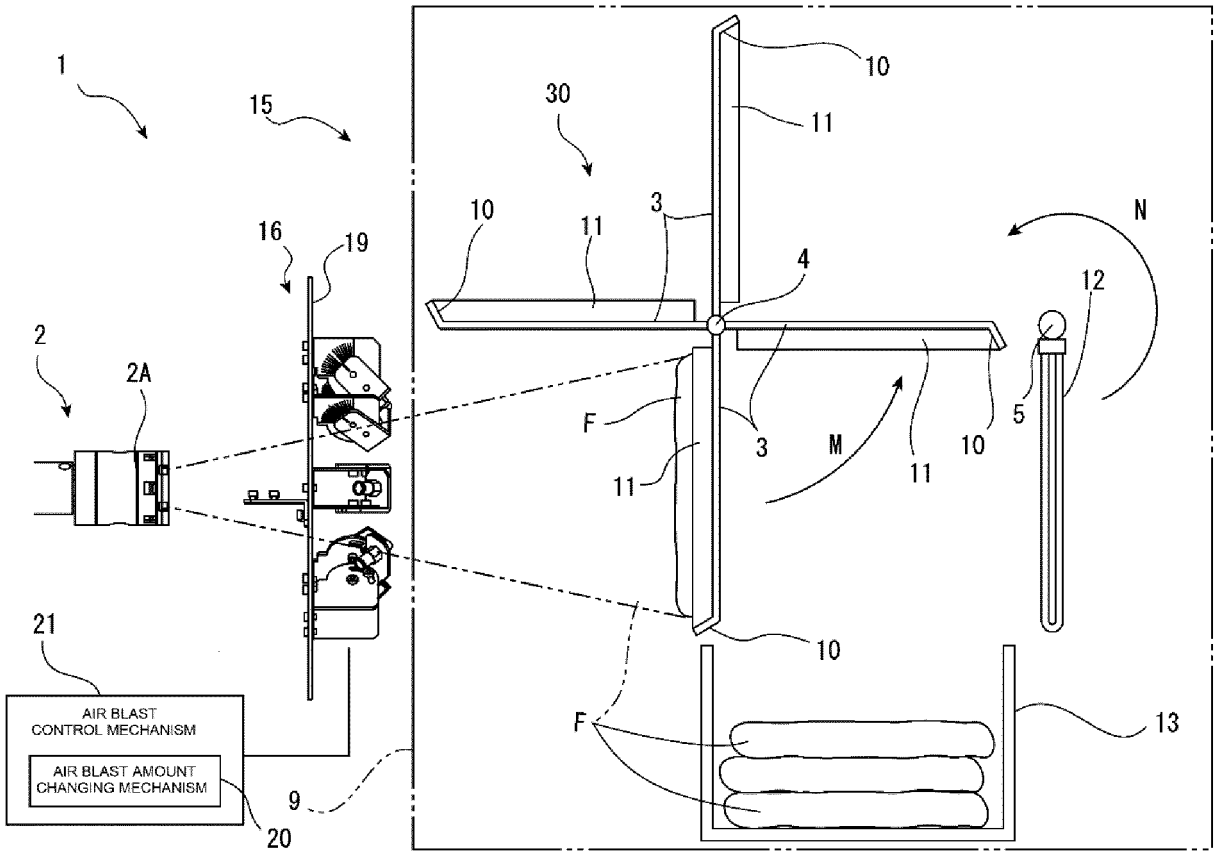


Fig. 6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AIR BLAST CONTROL MECHANISM
AIR BLAST AMOUNT CHANGING MECHANISM
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Fig. 7

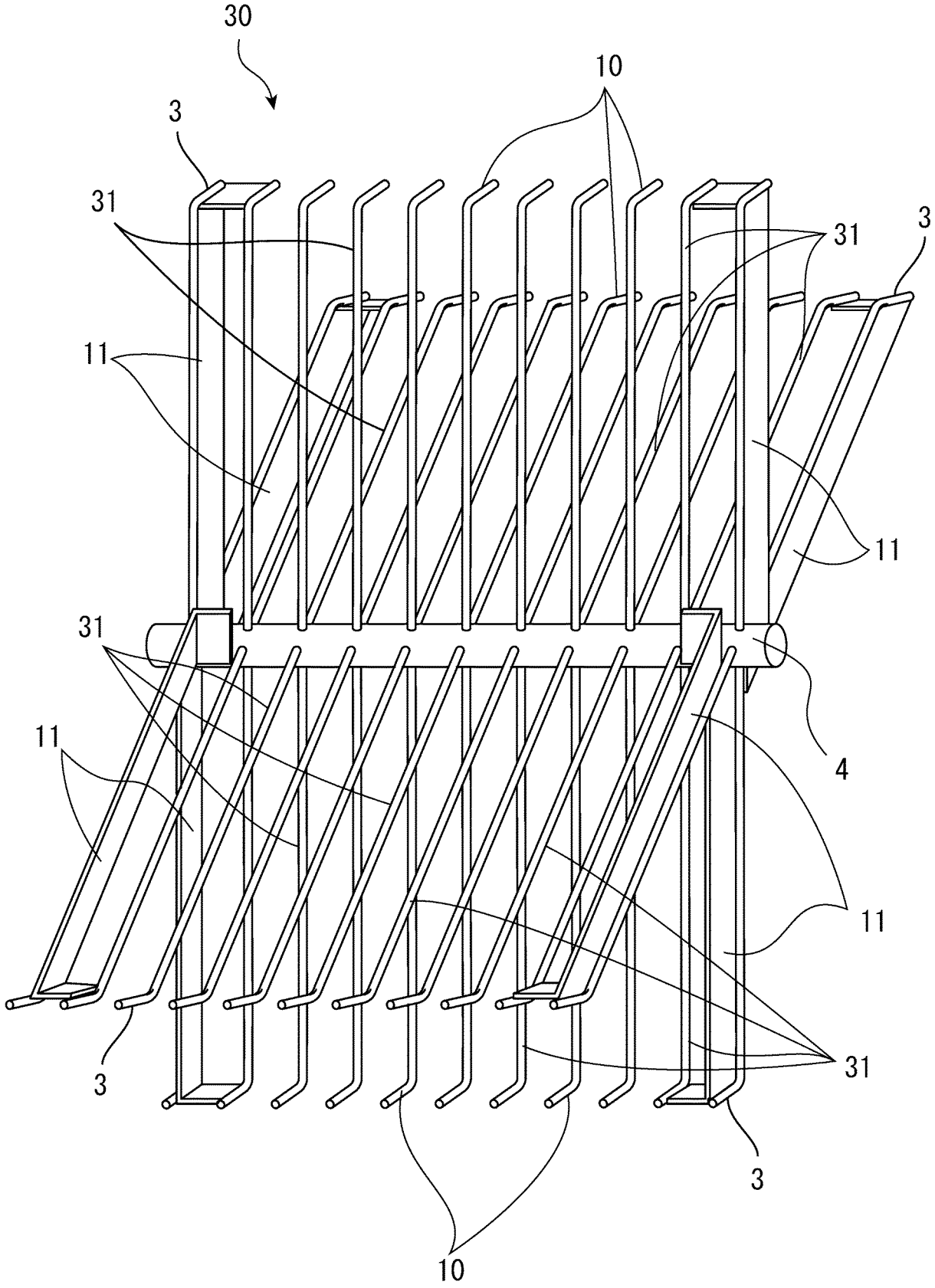


Fig. 8

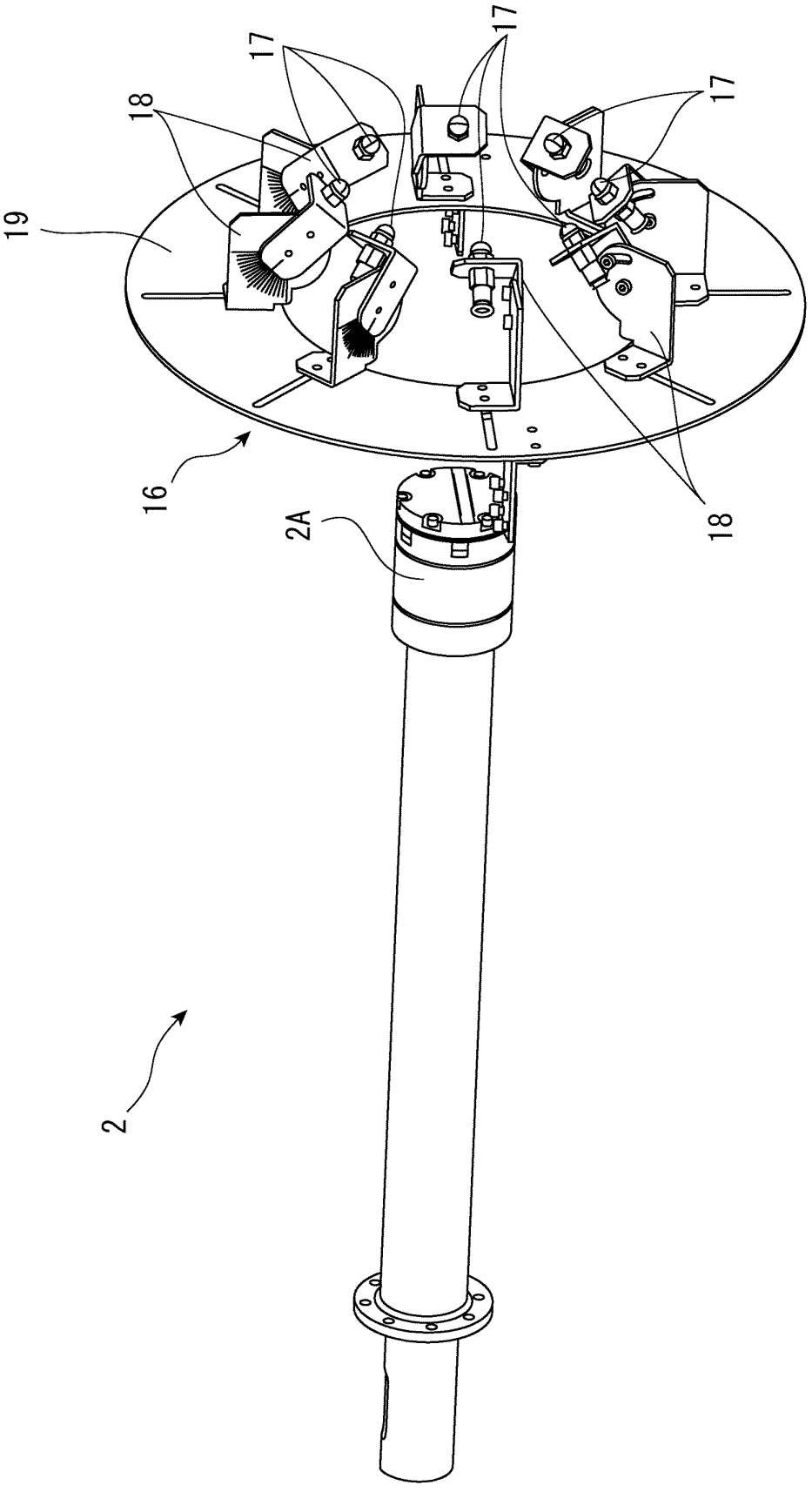
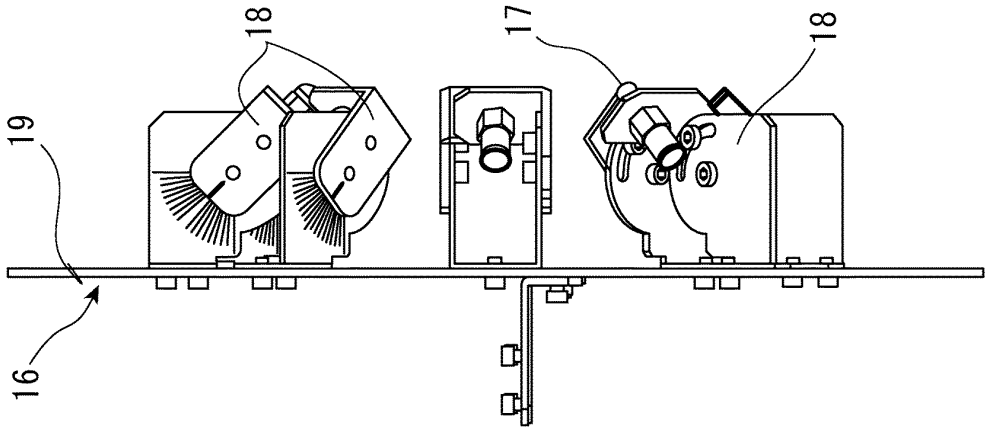


Fig. 9



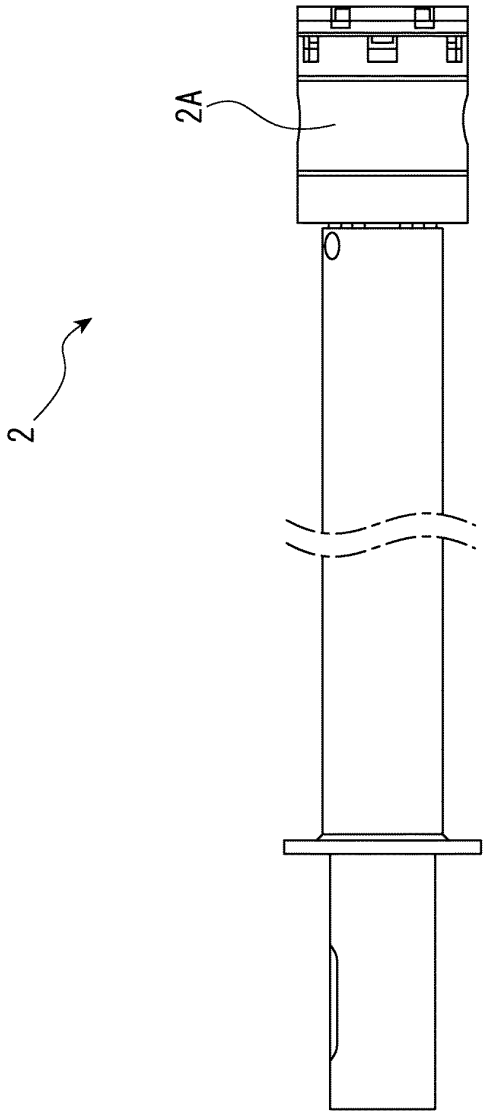
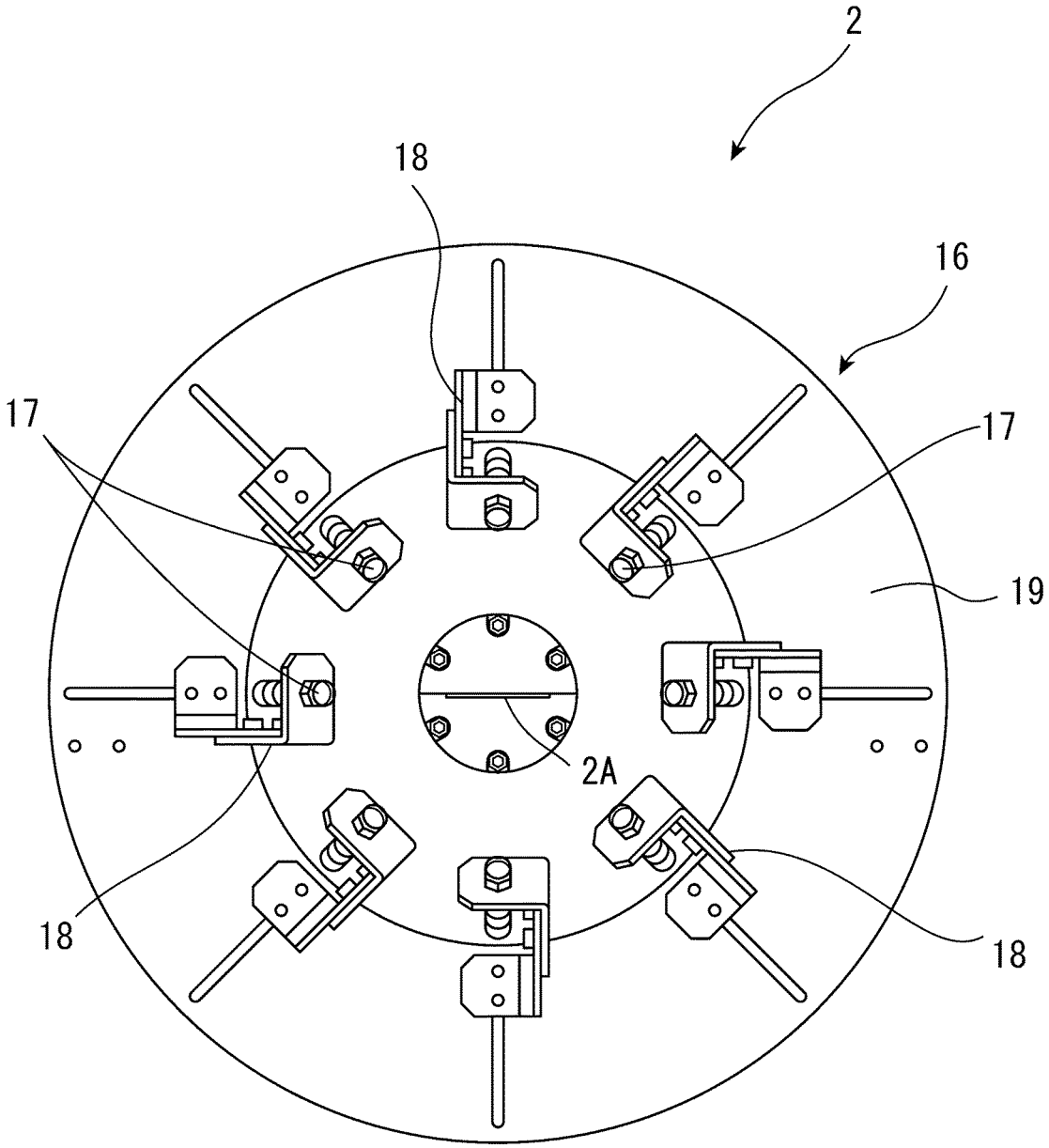


Fig. 10



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/032786

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. D01D7/00(2006.01)i, D01D5/04(2006.01)i, D01D5/08(2006.01)i, D04H1/736(2012.01)i, D04H3/16(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. D01D1/00-13/02, D04H1/00-18/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 7-275293 A (KIMBERLY-CLARK CORPORATION) 24 October 1995, claims, paragraphs [0011], [0012], fig. 2 & US 5700254 A, claims, column 5, line 6 to column 6, line 29, fig. 2 & US 5876388 A & EP 674891 A2	14-17, 20, 21 16, 17 1-13, 18, 19, 22
X Y A	JP 2013-185272 A (TAMARU SEISAKUSHO KK) 19 September 2013, claims, paragraphs [0014]-[0018], fig. 3 (Family: none)	14, 15, 20, 21 16, 17 1-13, 18, 19, 22

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24.10.2018	06.11.2018

Name and mailing address of the ISA/	Authorized officer
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