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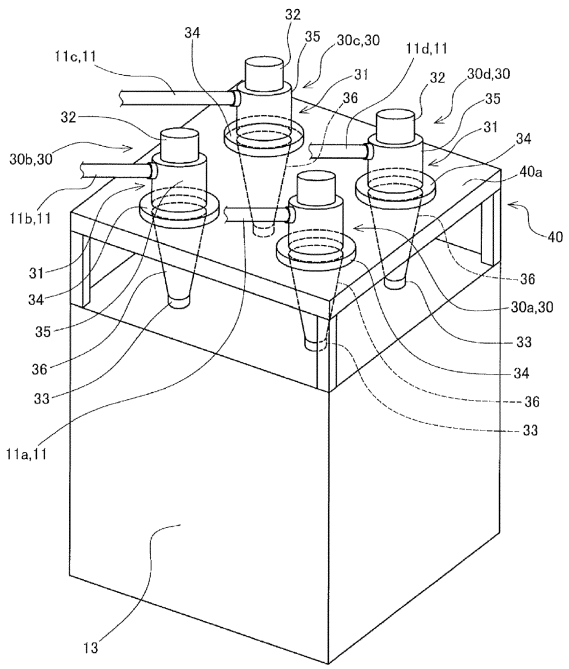
(54) FIBER WASTE COLLECTION DEVICE AND FALSE-TWISTING MACHINE

(57) [Problem to be Solved] A fiber waste collection device is provided to efficiently separate fiber waste from air so as to suppress the discharge of fiber waste to an exterior.

[Solution to Problem] A fiber waste collection device 1 includes: a fiber waste transfer pipe 11; a fiber waste collection unit 13; a fiber waste separation portion 30 arranged between the fiber waste transfer pipe 11 and the fiber waste collection unit 13; and an electrically conductive portion 34. The fiber waste separation portion 30 includes; a separation portion 31 connected to the fiber waste transfer pipe 11 so as to separate fiber waste from air; an air discharge portion 32 for discharging air separated from the fiber waste; and a fiber waste discharge portion 33 for discharging the fiber waste separated from air so as to collect the fiber waste in the fiber waste collection unit 13. The electrically conductive portion 34 electrically connects the separation portion 31 to an external electrical conductor. The separation portion 31 made of electrically conductive resin material includes a body portion 35 in a tubular shape and a fiber waste transfer portion 36 with an inclined portion 39 arranged below the body portion 35 decreasing in diameter toward the fiber waste discharge portion 33.

FIG. 4



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Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to a fiber waste collection device configured to collect fiber waste separated from air and a false-twisting machine including such a fiber waste collection device.

DESCRIPTION OF THE BACKGROUND ART

[0002] In a textile machine such as a false-twisting machine or spinning machine, fiber continues to be supplied even when threading the fiber on the textile machine, or even when replacing a package having the fiber wound on a winder arranged in the textile machine. In textile machines, therefore, it has been customary to suction to collect fiber waste during the yarn-threading or package-replacing operation.

[0003] Patent Document 1, *e.g.*, discloses a suction device for continuously running multi-threads including a suctioning pipe arranged with a plurality of suctioning ports, a fiber waste collection container connected to an end of the suctioning pipe, and a negative pressure pump or suction blower connected to the fiber waste collection container. In the suction device disclosed in Patent Document 1, the pressure within the suctioning pipe becomes negative due to the operation of the negative pressure pump or suction blower, and the fiber waste suctioned into the suctioning pipe from the plurality of suctioning ports is suctioned through the suctioning pipe to be collected in the fiber waste collection container.

(Prior Art Documents)

(Patent Documents)

[0004] Patent Document 1: Japanese Unexamined Patent Application Publication No. H06-40661

(Problems to be Solved)

[0005] In the suction device disclosed in Patent Document 1, the fiber waste is suctioned through the suctioning pipe to be collected as a result of causing the negative pressure pump or suction blower to operate, where the pump or blower is connected via the fiber waste collection container to a downstream end side in a suction direction of the suctioning pipe. Due to such a suction device, there is a probability that the air accompanied with the fiber waste would be discharged to an exterior of the suction device.

SUMMARY OF THE INVENTION

[0006] The present invention has been made in view of the above-described technical problems, and an objective thereof is to provide a fiber waste collection device configured to separate fiber waste from air appropriately thereby capable of suppressing the discharge of the fiber waste to an exterior thereof, and a false-twisting machine including such a device.

(Means for Solving Problems)

[0007] A first aspect of the present invention is a fiber waste collection device comprising:

a fiber waste transfer pipe for transferring therethrough fiber waste together with air,
a fiber waste collection unit for collecting therein the fiber waste transferred through the fiber waste transfer pipe; and
a fiber waste separator arranged between the fiber waste transfer pipe and the fiber waste collection unit configured to separate the fiber waste transferred through the fiber waste transfer pipe from air so as to collect the separated fiber waste in the fiber waste collection unit,
wherein the fiber waste separator includes
a separation portion connected to the fiber waste transfer pipe for separating the fiber waste from air,
an air discharge portion connected to the separation portion for discharging air separated from the fiber waste, and
a fiber waste discharge portion for discharging the fiber waste separated from air by the separation portion so as to collect the fiber waste in the fiber waste collection unit,
said fiber waste collection device further comprising:

an electrically conductive portion for electrically connecting the separation portion to an external electrical conductor,
wherein the separation portion includes
a body portion in a cylindrical shape connected to the fiber waste transfer pipe, and
a fiber waste transfer portion arranged below the body portion so as to be continuous with the fiber waste discharge portion,
wherein the fiber waste transfer portion has an inclined portion decreasing in diameter from a connection portion with the body portion toward the fiber waste discharge portion, and
the separation portion is made of electrically conductive resin material.

[0008] According to the above-described first aspect of the fiber waste collection device, the fiber waste transferred through the fiber waste transfer pipe is collected in the fiber waste collection unit connected from the fiber waste transfer pipe via the fiber waste separator. Subsequently, in the fiber waste separator, the fiber waste transferred from the fiber waste transfer pipe to the body portion of the separation portion is caused by air flow along an inner circumference within the body portion in a tubular shape to move downward to the fiber waste transfer portion. Further subsequently, the fiber waste caused to move downward is collected into a ball shape in the fiber waste transfer portion with the inclined portion and discharged from the fiber waste discharge portion thereby to be collected in the fiber waste collection unit. Air separated from the fiber waste is discharged from the air discharge portion. As a result, according to the above-described first aspect of the fiber waste collection device, the fiber waste can be separated from air appropriately and thereby, the discharge of the fiber waste from the air discharge portion to an exterior thereof can be suppressed.

[0009] It is to be noted that, for using metal material to form a separation portion in a complex shape so as to obtain the body portion in a tubular shape and the inclined portion decreasing in diameter from a connection portion with the body portion toward the fiber waste discharge portion, it is necessary to weld a plurality of members to form such a separation portion. For this reason, burrs are generated at a welded portion. The fiber waste is undesirably caught on such a burr portion which causes a decrease in collection efficiency of the fiber waste in the fiber waste collection unit. According to the above-described first aspect of the fiber waste collection device, however, the separation portion made of resin material can prevent the occurrence of burrs due to welding so that even a complex shape generated by connecting between the body portion in a tubular shape and the inclined portion can easily be realized by resin injection molding. Further, according to the above-described first aspect of the fiber waste collection device, the separation portion is made of electrically conductive resin material and the electrically conductive portion are arranged so as to connect the separation portion electrically to an external electrical conductor. Therefore, static electricity caused by friction between the fiber waste separated from air and the separation portion is allowed to flow from the separation portion to the electrically conductive portion to escape, thereby capable of preventing any undesirable electrification of the separation portion. As a result, the fiber waste can be prevented from being attached by static electricity to the separation portion, thereby capable of preventing any disadvantageous decrease in collection efficiency of the fiber waste in the fiber waste collection unit.

[0010] A second aspect of the present invention is the fiber waste collection device, wherein it is preferred that an electrically conductive portion in a flange shape is arranged as the electrically conductive portion formed in a flange shape along an outer circumference of the body portion.

[0011] According to the above-described second aspect of the fiber waste collection device, the electrically conductive portion formed in a flange shape along an outer circumference of the body portion is arranged for the electrically conductive portion, and as a result, static electricity caused in the separation portion is allowed to escape efficiently from around an entire circumference of the separation portion to an exterior.

[0012] A third aspect of the present invention is the fiber waste collection device, wherein it is preferred that an electrically conductive portion in a tubular shape is arranged as the electrically conductive portion formed in a coupling member in a tubular shape coupling to connect the body portion to the fiber waste transfer pipe, and the electrically conductive portion in a tubular shape is made of electrically conductive rubber material.

[0013] According to the above-described third aspect of the fiber waste collection device, static electricity caused in the separation portion is allowed to escape efficiently from the body portion to the fiber waste transfer pipe. Further, the electrically conductive portion arranged as the coupling member coupling between the body portion and the fiber waste transfer pipe is made of electrically conductive rubber material, and as a result, such an electrically conductive portion can absorb any position displacement between the body portion and the fiber waste transfer pipe, thereby capable of simplifying the connection between the body portion and the fiber waste transfer pipe.

[0014] A fourth aspect of the present invention is the fiber waste collection device, wherein it is preferred that the air discharge portion has a lower end portion arranged above the fiber waste transfer pipe.

[0015] According to the above-described fourth aspect of the fiber waste collection device, the fiber waste can be prevented from being entangled with the air discharge portion so as not to hinder any efficient separation between the fiber waste and air. As a result, the fiber waste can be efficiently separated from air.

[0016] A fifth aspect of the present invention is the fiber waste collection device, wherein it is preferred that the fiber waste transfer pipe includes a plurality of fiber waste transfer pipes, and a plurality of fiber waste separators of the fiber waste separator are arranged for the plurality of fiber waste transfer pipes, respectively.

[0017] According to the above-described fifth aspect of the fiber waste collection device, each of the plurality of fiber waste separators is arranged for each of the plurality of fiber waste transfer pipes. In other words, the plurality of fiber waste transfer pipes and the plurality of fiber waste separators are connected mutually on a one-to-one basis. The plurality of fiber waste transfer pipes and the plurality of fiber waste separators can therefore be connected, respectively, without having any restrictions imposed by another fiber waste transfer pipe. As a result, the plurality of fiber waste transfer pipes and the plurality of fiber waste separators can be connected, respectively, at appropriate positions where the fiber waste can be efficiently separated from air. It is to be noted that the term "appropriate position" corresponds to, *e.g.*, a position where the plurality of fiber waste transfer pipe are below a lower end portion of the air discharge portion.

[0018] A sixth aspect of the present invention is the fiber waste collection device, wherein it is preferred that the fiber waste transfer pipe includes a plurality of fiber waste transfer pipes, and the fiber waste collection unit is smaller in number than the plurality of fiber waste transfer pipes.

[0019] According to the above-described sixth aspect of the fiber waste collection device, the number of the fiber waste collection unit is smaller than the number of the plurality of fiber waste transfer pipes. This can therefore make the overall size of the fiber waste collection device smaller. More specifically, the fiber waste separator arranged to make the fiber waste into a ball to be discharged can suppress the capacity of the fiber waste in the fiber waste collection unit. Further, the fiber waste and air are separated so that the air obtained after having been separated from the fiber waste is discharged from the air discharge portion, and therefore, a volume occupied with the air can be suppressed in comparison to a case of a conventional fiber waste collection device incapable of isolating air itself having a blower connected to a fiber waste transfer pipe. As a result, according to the fiber waste collection device, a larger amount of fiber waste can be accumulated in the fiber waste collection unit in comparison to a case of a conventional fiber waste collection device, and the number of fiber waste collection units can be kept small. Still further, when the number of fiber waste collection units is smaller, a frequency of such replacement can be reduced thereby capable of reducing the burden on a worker.

[0020] It is not necessarily required for the fiber waste collection device according to the present invention to include all the configurations in the above-described first to sixth aspects. The fiber waste collection device in, *e.g.*, the above-described first aspect does not necessarily include all the configurations in the above-described second to sixth aspects. The configuration in the above-described first aspect may also be arbitrarily combined with any of the configurations in the above-described second to sixth aspects, to such an extent that consistency can be achieved, so as to reach the fiber waste collection device according to the present invention.

[0021] A seventh aspect of the present invention is a false-twisting machine comprising the fiber waste collection device according to any one of the above-described first to sixth aspects.

[0022] According to the above-described seventh aspect of the false-twisting machine, the fiber waste can be separated from air appropriately and thereby, the discharge of the fiber waste to an exterior can be suppressed.

(Advantageous Effects of the Invention)

[0023] According to the present invention, it can be possible to provide a fiber waste collection device configured to separate fiber waste from air appropriately thereby capable of suppressing the discharge of the fiber waste to an exterior thereof, and a false-twisting machine including such a device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024]

FIG. 1 depicts a view showing schematically an example of a false-twisting machine as a textile machine arranged with a fiber waste collection device.

FIG. 2 depicts a view showing schematically a fiber waste collection device according to an embodiment of the present invention and a fiber waste separator according to an embodiment of the present invention arranged in the fiber waste collection device.

FIG. 3 depicts a cross-sectional view of an example of a suction unit arranged for a fiber waste transfer pipe of the fiber waste collection device.

FIG. 4 depicts a perspective view of an example of a plurality of fiber waste separators and a fiber waste collection container in the fiber waste collection device.

FIG. 5 depicts a view showing schematically an example of a fiber waste separator.

FIG. 6 depicts a plan view of an example of the fiber waste separator.

FIG. 7 depicts a front view of an example of the fiber waste separator.

FIG. 8 depicts a front view of an example of the fiber waste separator.
FIG. 9 is a graph showing an example of experimental results indicative of a relationship between: a taper angle; and a flow rate of air in an air discharge portion and a flow rate of air in a fiber waste discharge portion.
FIG. 10 depicts a view showing schematically a fiber waste collection device and a fiber waste separator arranged therein according to a first modified example.
FIG. 11 depicts a perspective view of a fiber waste separator and a fiber waste collection container in the fiber waste collection device according to a first modified example.
FIG. 12 depicts a front view (A) of a fiber waste separator according to a first modified example, and a cross-sectional view (B) of an electrically conductive portion according to a first modified example.
FIG. 13 depicts a view showing schematically a fiber waste collection device according to a second modified example.
FIG. 14 depicts a view showing schematically a fiber waste collection device according to a third modified example.
FIG. 15 depicts a plan view of a fiber waste separator according to a fourth modified example.
FIG. 16 depicts a perspective view of a fiber waste separator according to a fifth modified example.

DESCRIPTIONS OF EMBODIMENTS OF THE INVENTION

[0025] Hereinafter, embodiments of the present invention will be described with reference to the drawings. The present invention can be widely applied to various uses for a fiber waste collection device configured to collect fiber waste as a textile machine like a false-twisting machine and a fiber waste separator arranged in the fiber waste collection device.

[0026] FIG. 1 depicts a view showing schematically an example of a false-twisting machine 101 as a textile machine arranged with a fiber waste collection device 1 (see FIG. 2). FIG. 2 depicts a view showing schematically a fiber waste collection device 1 according to an embodiment of the present invention and a fiber waste separator 30 according to an embodiment of the present invention arranged in the fiber waste collection device 1. A fiber waste collection device 1 is arranged in a textile machine such as a false-twisting machine 101 or a spinning machine. In an embodiment according to the present invention, the false-twisting machine 101 will be described as an example of the textile machine arranged with the fiber waste collection device 1. Hereinafter, initially, the false-twisting machine 101 arranged with the fiber waste collection device 1 will be described, and subsequently, the fiber waste collection device 1 according to an embodiment of the present invention and the fiber waste separator 30 according to an embodiment of the present invention arranged therein will be described. For convenience, an up-and-down direction, a forward-and-backward direction, and a left-and-right direction with respect to the false twisting machine 101 and the fiber waste collection device 1 are defined as shown in FIGS. 1, 2.

[FALSE-TWISTING MACHINE]

[0027] The false-twisting machine 101 is configured, as a textile machine, to false-twist thermoplastic synthetic fibers such as polyester and polyamide so as to impart crimps to the false-twisted fibers, thereby producing highly stretchable textured yarns. As shown in FIG. 1, in the false-twisting machine 101, a main machine base 102 is arranged so as to extend in an up-and-down direction. Further, the false-twisting machine 101 includes: a yarn feeding creel 104 arranged so as to face the main machine base 102 across a work space 103 and holding a plurality of yarn feeding packages 105; a false-twisting device 106 arranged above the main machine base 102 so as to false-twist a fiber Y as a yarn supplied from the yarn feeding creel 104; a winder 107 arranged on the main machine base 102 so as to wind the false-twisted fiber Y obtained in the false-twisting device 106; and the like. The winders 107 are arranged in four stages along an up-and-down direction. Still further, a plurality of winders 107 are arranged side by side along a forward-and-backward direction in each of the first to fourth stages. It is to be noted that a forward-and-backward direction in which the plurality of winders 107 are arranged in each of the four stages arranged in an up-and-down direction is a direction along a horizontal direction as well as a direction vertical to a direction (left-and-right direction) in which the yarn feeding creel 104 and the main machine base 102 are arranged.

[0028] A first feeding roller 108, a shifter guide 109, a first heating device 110, and a cooling device 111 are arranged in this order from an upstream side in a yarn traveling direction on a yarn path from the yarn feeding creel 104 to the false-twisting device 106. A second feeding roller 112, an interlace nozzle 113, a second heating device 114, a third feeding roller 115, and an oiling roller 116 are arranged in this order from an upstream side in a yarn traveling direction on a yarn path from the false-twisting device 106 to the winder 107.

[0029] The first feeding roller 108 is arranged above the work space 103. The first heating device 110 is arranged above the work space 103 and further above the first feeding roller 108. The cooling device 111 is arranged closer to the main machine base 102 than to the first heating device 110 above the work space 103. The first heating device 110 and the cooling device 111 are arranged above the work space 103 so as to extend obliquely upward while being separated from the main machine base 102. The shifter guide 109 is arranged between the first feeding roller 108 and the first heating device 110 in an up-and-down direction, and is used to pass a fiber Y through the first heating device

110 and the cooling device 111 when threading a yarn on the false twisting machine 101.

[0030] The second feeding roller 112 is arranged above the main machine base 102. The interlace nozzle 113 is arranged above the main machine base 102 and below the second feeding roller 112. The second heating device 114 is arranged on the main machine base 102 and is arranged on a back side of the winder 107 when viewed from the work space 103 so as to extend in an up-and-down direction from the first stage to the fourth stage of the four-stages of winders 107. The devices are laid out in such a manner, and a yarn path from the yarn feeding creel 104 to the winder 107 is formed so as to surround the work space 103.

[0031] In the false-twisting machine 101, a fiber Y as a yarn supplied from the yarn feeding creel 104 is carried through the above-described devices and wound on the winder 107 to form a package 117. Initially, the first to third feeding rollers (108, 112, 115) are rollers for feeding a fiber Y from an upstream side to a downstream side in a yarn traveling direction. Each yarn feed velocity is set such that the yarn feed velocity of the second feeding roller 112 is faster than that of the first feeding roller 108. The fibers Y are, therefore, drawn between the first feeding roller 108 and the second feeding roller 112. Further, each yarn feeding velocity is set such that the yarn feeding velocity of the third feeding roller 115 is slower than that of the second feeding roller 112. The fiber Y is, therefore, loosened between the second feeding roller 112 and the third feeding roller 115.

[0032] Subsequently, the fibers Y drawn between the first feeding roller 108 and the second feeding roller 112 are twisted by the false-twisting device 106 that is, *e.g.*, a friction disk-type twister so as to be carried. The twist formed by the false-twisting device 106 propagates to the first feeding roller 108, and the fibers Y drawn to be twisted are heated by the first heating device 110 and thereafter cooled by the cooling device 111, and thereby, the twist is fixed. After passing through the false-twisting device 106, the twisted and heat-set fibers Y are untwisted before reaching the second feeding roller 112.

[0033] The fibers Y drawn and false-twisted in such a manner are appropriately entangled in the interlace nozzle 113 so as have bundling properties, and thereafter, are subjected to relaxation heat treatment in the second heating device 114 and wound on a paper tube by the winder 107 via the oiling roller 116 so as to form the package 117. Then, the fully-wound package 117 is removed by a worker from the winder 107. A new paper tube is attached by a worker to the winder 107, and a winding operation on the paper tube is restarted. In such a manner, the package 117 is replaced. The fiber waste collection device 1 of an embodiment according to the present invention is arranged in the false-twisting machine 101 described above, and is used. The fiber waste collection device 1 of an embodiment according to the present invention will be described below

[OUTLINE OF FIBER WATE COLLECTION DEVICE]

[0034] As shown in FIG. 2, the fiber waste collection device 1 mainly includes, e.g., a plurality of fiber waste transfer pipes 11 (11a to 11d), one fiber waste collection container 13 arranged for the plurality of fiber waste transfer pipes 11 (11a to 11d), a plurality of fiber waste separators 30 arranged correspondingly to the plurality of fiber waste transfer pipes 11 (11a to 11d), respectively, and a plurality of electrically conductive portions 34 arranged correspondingly to the plurality of fiber waste separators 30, respectively. The fiber waste collection device 1 therefore includes the plurality of fiber waste transfer pipes 11 (11a to 11d) and the fiber waste separators 30 arranged correspondingly to the plurality of fiber waste transfer pipes 11 (11a to 11d), respectively. The plurality of fiber waste transfer pipes 11 (11a to 11d) are a pipe configured such that the fiber waste is transferred therethrough together with air. The fiber waste collection container 13 is a container configured such that the fiber waste transferred through the plurality of fiber waste transfer pipes 11 (11a to 11d) is collected therein. The plurality of the fiber waste separators 30 are arranged between the plurality of fiber waste transfer pipes 11 (11a to 11d) and the fiber waste collection container 13. Each of the plurality of fiber waste separators 30 separates the fiber waste transferred through each of the plurality of fiber waste transfer pipes 11 from air so that the separated fiber waste is collected into the fiber waste collection container 13, details of which will be described later. It is to be noted that the above-described "fiber waste" includes yarn waste (fiber waste formed as a result of collecting fibers) and the like. The above-described "fiber waste collection container 13" corresponds to a "fiber waste collection unit" in an embodiment according to the present invention.

[0035] As shown in FIG. 1, the fiber waste collection device 1 is arranged in the false-twisting machine 101 described above. The plurality of fiber waste transfer pipes 11 of the fiber waste collection device 1 are arranged correspondingly to their respective stages of the winders 107 arranged vertically in four stages, *e.g.*, in the false-twisting machine 101. For this reason, the fiber waste collection device 1 according to an embodiment of the present invention arranged with such four-stage winders 107 includes four fiber waste transfer pipes 11 (11a to 11d), respectively. Each of the four fiber waste transfer pipes 11 (11a to 11d) is arranged so as to extend along a forward-and-backward direction. Winders 107 are arranged in each of the first to fourth stages of winder 107 side by side in a forward-and-backward direction, and each of the four fiber waste transfer pipes 11 (11a to 11d) is also arranged so as to extend along a forward-and-backward direction. Each fiber waste transfer pipe 11 (11a to 11d) suctions the fiber waste generated as fiber Y from regions in proximity to their respective winders 107 arranged side by side in a forward-and-backward direction at each of stages

arranged in an up-and-down direction, and transfers the fiber Y along with air. Each of the four fiber waste transfer pipes 11 (11a to 11d) is connected to the fiber waste collection container 13 in common. Further, the air accompanied with the fiber Y transferred through each of the four fiber waste transfer pipes 11 (11a to 11d) is separated at each fiber waste separator 30 into fiber waste as the fiber Y and clean air obtained after having been separated from the fiber waste. The fiber waste separated from the air is collected in the fiber waste collection container 13. The clean air obtained after having been separated from the fiber waste is discharged from an air discharge portion 32 (see FIG. 5 to be described later) to an exterior thereof. It is to be noted that the fiber Y includes, *e.g.*, a polyester fiber or a polyamide fiber, and the fiber waste generated as the fiber Y also includes, *e.g.*, a polyester fiber or a polyamide fiber.

[0036] In the meantime, the fiber waste collection device 11 is arranged with the plurality of fiber waste separators 30 so that the air obtained after having been separated from the fiber waste is discharged from the air discharge portion 32 (see FIG. 5 to be described later) to an exterior thereof, and therefore, the number of the fiber waste collection containers 13 can be made smaller than the number of the fiber waste transfer pipes 11 (11a to 11d), and an overall size of the fiber waste collection device 1 can be made smaller. In other words, by arranging the plurality of fiber waste separators 30, the fiber waste can be made into a ball to be discharged and thereby the volume occupied with such a fiber waste within the fiber waste collection container 13 can be suppressed. Further, by separating the fiber waste and air so as to discharge the air obtained after having been separated from the fiber waste from the air discharge portion 32, the volume occupied with the air can be suppressed in comparison to a case of a conventional fiber waste collection device incapable of isolating air itself, *e.g.*, having a blower connected to a fiber waste transfer pipe (11 (11a to 11d)). As a result, according to the fiber waste collection device 1 of an embodiment according to the present invention, a larger amount of fiber waste can be accumulated in the fiber waste collection container 13 in comparison to a case of a conventional fiber waste collection device and thereby, the number of fiber waste collection containers 13 can be suppressed. Still further, when the number of fiber waste collection containers 13 is smaller, a frequency of replacement can be reduced thereby capable of reducing burden on a worker. It is to be noted that, in an embodiment according to the present invention, one fiber waste collection container 13 is arranged for all of the plurality of fiber waste transfer pipes 11 (11a to 11d); however, the number of fiber waste collection containers 13 is not limited to this, and may be smaller than the number of fiber waste transfer pipes 11 (11a to 11d).

[0037] The fiber waste collection device 1 keeps thread when the thread is changed at the winder 107 of the false-twisting machine 101 without cutting the thread so as to collect the thread as yarn waste (fiber waste). In other words, as shown in FIG. 1, when the fiber Y is threaded on the false-twisting machine 101 or when the package 117 on the winder 107 of the false-twisting machine 101 is replaced, the fiber waste collection device 1 is used in order that: the fiber Y is continuously supplied from the thread-feeding creel 104 to a region in proximity to the winder 107 via each device (110, 111, 106, 114) so as to be collected as fiber waste from each suction unit. In such a manner, when the package 117 is replaced at the winder 107 of the false-twisting machine 101, the fiber waste generated as the fiber Y supplied continuously in proximity to the winder 107 can be collected, and therefore, the false-twisting machine 101 can continuously operate without any need of cutting the thread. Further detailed configuration of the fiber waste collection device 1 will be described below.

[FIBER WASTE TRANSFER PIPE]

[0038] As shown in FIG. 2, the plurality of suction units 15 configured to suction the fiber waste as the fiber Y (see FIG. 1) are arranged in proximity to each winder 107, and each of the plurality of fiber waste transfer pipes 11 (11a to 11d) serves as a pipe through which the fiber waste as the fiber Y suctioned from the plurality of suction units 15 is transferred. Each fiber waste transfer pipe 11 is made of metal material as an electrical conductor having electrical conductivity. It is to be noted that each suction unit 15 configured to suction the fiber waste as the fiber Y will be described later. Each fiber waste transfer pipe 11 is formed, *e.g.*, in a hollow tubular shape. A plurality of fiber waste transfer pipes 11 (11a to 11d) are arranged and, in an embodiment according to the present invention, four fiber waste transfer pipes 11 are arranged as described above.

[0039] The four fiber waste transfer pipes 11 (11a to 11d) include a first fiber waste transfer pipe 11a corresponding to a first stage of the winder 107 as the lowest stage, a second fiber waste transfer pipe 11b corresponding to a second stage of the winder 107 above the first stage, a third fiber waste transfer pipe 11c corresponding to a third stage of the winder 107 above the second stage, and a fourth fiber waste transfer pipe 11d corresponding to a fourth stage of the winder 107 above the third stage. Each of the four fiber waste transfer pipes 11 (11a to 11d) is arranged in the false-twisting machine 101 such that a longitudinal direction of each fiber waste transfer pipe 11 (11a to 11d) extends along a forward-and-backward direction. Further, each of the first to fourth fiber waste transfer pipes 11 (11a to 11d) extends along a forward-and-backward direction at each of the first to fourth stage of winder 107. In an embodiment according to the present invention, the fiber waste separator 30 includes: a first fiber waste separator 30a arranged between the first fiber waste transfer pipe 11a and the fiber waste collection container 13; a second fiber waste separator 30b arranged between the second fiber waste transfer pipe 11b and the fiber waste collection container 13; a third fiber separator 30c

arranged between the third fiber waste transfer pipe 11c and the fiber waste collection container 13; and a fourth fiber waste separator 30d arranged between the fourth fiber waste transfer pipe 11d and the fiber waste collection container 13.

[0040] Each of the four fiber waste transfer pipes 11 (11a to 11d) has a longitudinal portion extending along a forward-and-backward direction at one end side (backward-side portion shown in FIG. 2) as closed and a portion at the other end side (forward-side portion shown in FIG.2) connected to each fiber waste separator 30.

[SUCTION UNITS]

[0041] As shown in FIG. 2, a set of plurality of suction units 15 is arranged as a mechanism to suction the fiber waste generated as the fibers Y (see FIG. 1). A plurality of suction units 15 are arranged in each of the plurality of fiber waste transfer pipes 11 (11a to 11d). Each of the plurality of suction units 15 arranged in each fiber waste transfer pipe 11 includes a suction pipe 16 and an opening/closing mechanism 17 (see FIG. 3 to be described later), and the plurality of suction units 15 are arranged side by side in a longitudinal direction of each fiber waste transfer pipe 11 (11a to 11d). The plurality of suction units 15 arranged side by side in each of the fiber waste transfer pipes 11 (11a to 11d) are arranged correspondingly to a plurality of winders 107 in each fiber waste transfer pipe 11 (11a to 11d). More specifically, a plurality of sets of the suction units 15 are arranged in the plurality of fiber waste transfer pipes 11 (11a to 11d) correspondingly to a plurality of stages of the winders 107, *e.g.*, four stages of winders 107 (see FIG. 1) arranged vertically in the false-twisting machine 101 (see FIG. 1), where the plurality of winders 107 in each stage are arranged side by side in a forward-and-backward direction correspondingly to the plurality of suction units 15.

[0042] In a similar manner, the plurality of sets of suction units 15 arranged vertically in the first to fourth fiber waste transfer pipes 11 (11a to 11d), respectively. Further, in a similar manner, the plurality of suction units 15 are arranged side by side in each fiber waste transfer pipe 11 (11a to 11d).

[0043] Each suction pipe 16 is arranged as a tubular member for suctioning the fiber waste generated as the fiber Y (see FIG. 1) smaller in diameter than each of the plurality of fiber waste transfer pipes 11 (11a to 11d) so as to extend with a bend in the middle. Each suction pipe 16 has one end side connected to each of the plurality of fiber waste transfer pipes 11 (11a to 11d) and the other end side arranged with a suction port 16a (see FIG. 3) formed in proximity to the winder 107 (see FIG. 1) through which the fiber waste of the fiber Y is suctioned. The fiber waste of the fiber Y suctioned through the suction port 16a flows into each fiber waste transfer pipe 11.

[0044] FIG. 3 is a cross-sectional view of each suction unit arranged in a fiber waste transfer pipe. It is to be noted that, in FIG. 3, the opening/closing mechanism 19 is in a state of being pushed upward so that a suction port 16a is in an opened state. As shown in FIG. 3, each suction pipe 16 is connected to each of the plurality of fiber waste transfer pipes 11 (11a to 11d) in a tilted state. Each of the plurality of suction pipes 16 is connected to each of the plurality of fiber waste transfer pipes 11 (11a to 11d) at an acute angle with respect to a direction from upstream (backward side shown in FIG. 3) to downstream (forward side shown in FIG. 3) of air flow through each fiber waste transfer pipe 11. In other words, each of the plurality of suction pipes 16 is connected to each fiber waste transfer pipe 11 (11a to 11d) at an acute angle with respect to a direction from one end side (backward side shown in FIG. 3) to the other end side (forward side shown in FIG. 3) connected to the fiber waste collection container 13. As a result, when the fiber waste of the fiber Y (see FIG.1) suctioned from each suction port 16a flows into each fiber waste transfer pipe 11, such a fiber Y flows in a direction from upstream to downstream of air flow in each fiber waste transfer pipe 11. After flowing into each fiber waste transfer pipe 11, the fiber waste of the fiber Y is transferred downstream by air flowing through the fiber waste transfer pipe 11.

[0045] Each of the plurality of suction pipes 16 includes a compressed air injection nozzle hole 16d and a guide path 16e. The compressed air injection nozzle hole 16d is arranged as a nozzle hole for injecting compressed air into each suction pipe 16 between one end side arranged with an outlet opening 16b and the other end side arranged with the suction opening 16a. The compressed air injection nozzle hole 16d is formed so as to inject compressed air toward the one end side arranged with the outlet opening 16b within each suction pipe 16. In an embodiment according to the present invention, two compressed air injection nozzle holes 16d are arranged. Each of such two compressed air injection nozzle holes 16d extends from a side arranged with the suction opening 16a toward a side arranged with the outlet opening 16b as well as from an outer periphery of the suction pipe 16 toward an inner periphery of the suction pipe 16, thereby capable of communicating with a suction flow path 16c. In such a manner, each of the two compressed air injection nozzle holes 16d is configured to inject compressed air toward one end side arranged with the outlet opening 16b within the suction pipe 16. It is to be noted that the number of compressed air injection nozzle holes 16d is not limited to two.

[0046] The guide path 16e of each suction pipe 16 is arranged within the suction pipe 16 as a flow path for compressed air extending annularly along a circumferential direction of the suction pipe 16. The guide path 16e communicating with the compressed air injection nozzle hole 16d and a cylinder chamber 20 to be described below. A compressed air supplied to the cylinder chamber 20 flows into the guide path 16e via the compressed air injection nozzle hole 16d to be injected into the suction flow path 16c.

[0047] The cylinder chamber 20 is defined as a circular cylindrical space of a body portion 18. The cylinder chamber 20 communicating with the guide path 16e of each suction pipe 16 via a communication path 20a arranged within the body portion 18. Accordingly, the compressed air supplied to the cylinder chamber 20 flows into the guide path 16e to further flow into the compressed air injection nozzle hole 16d. Further, the cylinder chamber 20 is connected so as to communicate with a compressed air supply pipe 23 for supplying compressed air thereby to be injected from the compressed air injection nozzle hole 16d of each suction pipe 16. The compressed air supply pipe 23 is connected to a compressed air supply source (not shown) for supplying compressed air. The compressed air supply pipe 23 is arranged with a solenoid valve 24 for controlling the supply of compressed air to the cylinder chamber 20 by opening and closing the valve so that it can be switched between a connected state and a shut-off state. When the solenoid valve 24 is opened, the compressed air supply pipe 23 enters a communicative state so that the compressed air is supplied from the compressed air supply pipe 23 toward the cylinder chamber 20. When the solenoid valve 24 is closed, the supply of the compressed air from the compressed air supply pipe 23 toward the cylinder chamber 20 is interrupted.

[0048] In each suction unit 15, in a state where the solenoid valve 24 is closed and the compressed air is not supplied to the cylinder chamber 20 due to shutting-off of the compressed air supply pipe 23, the opening/closing member 19 is caused to rotate around a rotating shaft 29 so as to close the suction pipe 16a with the aid of a biasing force applied by a spring member 22 arranged in a spring chamber 25. In such a state, an operation of suctioning the fiber waste generated as the fiber Y (see FIG. 1) is not performed by the suction unit 15. On the other hand, in a state where the solenoid valve 24 is opened so as to communicate with the compressed air supply pipe 23 and thereby the compressed air is supplied to the cylinder chamber 20, a piston 21 is caused to move upward so as to push the opening/closing member 19 upward, resulting in opening the suction port 16a. Further, in a state where the compressed air is supplied to the cylinder chamber 20, the compressed air flows into the compressed air injection nozzle hole 16d and the compressed air is injected from the compressed air injection nozzle hole 16d to the suction flow path 16c of the suction pipe 16. The compressed air injected to the suction flow path 16c is injected toward the outlet opening 16b. As a result, the compressed air injected into the suction pipe 16 from the compressed air injection nozzle hole 16d generates air flow within the suction pipe 16 to transfer the fiber waste of the fiber Y toward the fiber waste transfer pipe 11, and further generates air flow within the fiber waste transfer pipe 11 to transfer the fiber waste of the fiber Y toward the fiber waste separator 30 (forward side shown in FIG. 3). In such a manner, the fiber waste of the fiber Y suctioned from the suction port 16a can be transferred to the fiber waste transfer pipe 11.

[0049] It is to be noted that another configuration may be adopted if the fiber waste generated as the fiber Y (see FIG. 1) can be suctioned from each suction port so that the fiber waste of the suctioned fiber Y can be transferred through each of the plurality of fiber waste transfer pipes 11 (11a to 11d). The compressed air, *e.g.*, may be injected into each suction pipe 16 as described above and the pressure within each fiber waste transfer pipe 11 may be reduced by suctioning, *e.g.*, with a blower.

[0050] The air velocity in each of the plurality of fiber waste transfer pipes 11 (11a to 11d) is preferably 1000 m/min or higher. If the air velocity in the fiber waste transfer pipe 11 is less than 1000 m/min, *e.g.*, therefore, a connection unit for supplying the compressed air can be arranged at one end side of fiber waste transfer pipe 11 (11a to 11d) (*e.g.*, at a backward end), and the compressed air supplied from a compressed air supply source (not shown) can be supplied to the fiber waste transfer pipe 11 (11a to 11d) from one end side of the fiber waste transfer pipe 11 (11a to 11d). A conventionally arranged blower may also be arranged in proximity to the fiber waste separator 30 to suction an interior of the fiber waste transfer pipe 11 (11a to 11d) to make up the shortfall required to fulfill, *e.g.*, an air velocity of 1000 m/min.

[FIBER WASTE SEPARATOR AND ELECTIRCALLY CONDUCTIVE PORTION]

[0051] FIG. 4 depicts a perspective view of an example of a plurality of fiber waste separators 30 and a fiber waste collection container 13 in the fiber waste collection device 1. FIG. 5 depicts a view showing schematically an example of a fiber waste separator 30. FIG. 6 depicts a plan view of an example of the fiber waste separator 30. FIG. 7 depicts a front view of an example of the fiber waste separator 30. It is to be noted, as described above, that an embodiment according to the present invention includes the first fiber waste separator 30a to the fourth fiber waste separator 30d, and that the first fiber waste separator 30a to the fourth fiber waste separator 30d are the same in configuration as each other. The first fiber waste separator 30a to the fourth fiber waste separator 30d each corresponds to the "fiber waste separator" in an embodiment according to the present invention.

[0052] As shown in FIGS. 4 to 7, the fiber waste separator 30 includes: a separation portion 31 connected to the fiber waste transfer pipe 11 configured to separate the fiber waste transferred through the fiber waste transfer pipe 11 from air; an air discharge portion 32 arranged at an upper end side of the separation portion 31; and a fiber waste discharge portion 33 arranged at a lower end side of the separation portion 31. An electrically conductive portion 34, arranged correspondingly to the fiber waste separator 30, is arranged such that it is integral with or coupled to the separation portion 31. The air discharge portion 32 connected to an upper end side of the separation portion 31 is configured to discharge air separated from the fiber waste. The fiber waste discharge portion 33 is configured such that the fiber waste

separated from air through the separation portion 31 is discharged toward and collected into the fiber waste collection container 13. The electrically conductive portion 34 is arranged for electrically connecting the separation portion 31 to an external electrical conductor.

[0053] The separation portion 31 has a body portion 35 in a circular cylindrical shape and a tapered portion 36 arranged below the body portion 35. The body portion 35 and the tapered portion 36 are integral with each other. The body portion 35 and the tapered portion 36 arranged integrally are both made of electrically conductive resin material. In other words, the separation portion 31 obtained as a result of integrating the body portion 35 with the tapered portion 36 is made of electrically conductive resin material. The electrically conductive resin material is formed as material obtained as a result of kneading electrical inorganic conductor such as metal powders or carbon fiber into resin material.

[0054] The body portion 35 of the separation portion 31 formed in a circular cylindrical shape is arranged so as to be connected with the fiber waste transfer pipe 11. The body portion 35 has a circular tubular portion 37 as a circular cylindrical side wall and a top face portion 38 as a top end surface of the circular tubular portion 37. The top face portion 38 has an opening 38a concentric with the circular tubular portion 37 as well as smaller in diameter than the circular tubular portion 37. The circular tubular portion 37 has a connection port 37a connected with the fiber waste transfer pipe 11. The connection port 37a is arranged as a circular tube-shaped short portion communicating with an interior of the circular tubular portion 37 as well as being opened to an exterior thereof. As a result of causing an exterior opening of the connection port 37a to tightly mate with an end of the fiber waste transfer pipe 11, the fiber waste transfer pipe 11 is connected to the circular tubular portion 37 of the body portion 35.

[0055] The tapered portion 36 is arranged below the body portion 35 so as to be continuous with the fiber waste discharge portion 33. The tapered portion 36 has a circular top end portion the same in diameter as the circular tubular portion 37 and a circular bottom end portion smaller in diameter than the circular top end portion. The tapered portion 36 has the top end portion and the bottom end portion both opened, and has an inclined portion 39 linearly narrowing from the top end portion to the bottom end portion in a plan view. The inclined portion 39 of the tapered portion 36 is formed to decrease in diameter from a connection portion with the body portion 35 toward the fiber waste discharge portion 33. The inclined portion 39 preferably has an angle θ (hereinafter, referred to as "taper angle θ") as an acute angle between a vertical direction and a direction of the inclined portion 39 within a range from 7 to 10[°] (inclusive of upper and lower limits), details of which will be described later. The tapered portion 36 has a top end portion connected to a bottom end portion of the circular tubular portion 37. Further, there is no partitioning member to partition between the tapered portion 36 and the body portion 35, and an interior of the tapered portion 36 communicates with an interior of the body portion 35. The "tapered portion 36" corresponds to a "fiber waste transfer portion" in an embodiment according to the present invention.

[0056] The electrically conductive portion 34 is arranged so as to electrically connect the separation portion 31 to an external electrical conductor. In an embodiment according to the present invention, the electrically conductive portion 34 is arranged so as to be integral with the body portion 35 of the separation portion 31, and thereby a flange portion is formed along an outer circumference of the body portion 35. The electrically conductive portion 34 corresponds to an "electrically conductive portion in a flange shape" in an embodiment according to the present invention. The electrically conductive portion 34 arranged as the electrically conductive portion in a flange shape is formed in a ring shape along an outer circumference of the circular tubular portion 37 of the body portion 35, and is integrated with an outer circumference thereof. The electrically conductive portion 34 is made of, *e.g.*, electrically conductive resin material integrated with the body portion 35.

[0057] As shown in FIG. 4, a bottom end side of the fiber waste separator 30 is connected to a top end portion of the fiber waste collection container 13 and is supported by a supporting frame 40 arranged above the fiber waste collection container 13. The fiber waste collection container 13 and the supporting frame 40 are both made of metal material and are an electrical conductor. The supporting frame 40 has a supporting table 40a for supporting the fiber waste separator 30. The supporting table 40a includes therein a through-hole for supporting the fiber waste separator 30 such that it can snugly receive the fiber waste separator 30. The fiber waste separator 30 is supported by the supporting table 40a of the supporting frame 40 such that the separation portion 31 of the fiber waste separator 30 is fitted into the through-hole of the supporting table 40a. In a state where the separation portion 31 of the fiber waste separator 30 is fitted into the through-hole of the supporting table 40a, the electrically conductive portion 34 of the fiber waste separator 30 is abutting an edge of the through-hole of the supporting table 40a so that the electrically conductive portion 34 is supported by the supporting table 40a. As a result, the fiber waste separator 30 is supported by the supporting frame 40. In a state where the electrically conductive portion 34 integrated with the separation portion 31 abuts the supporting table 40a, the electrically conductive portion 34 is connected electrically to the supporting frame 40 as an electrical conductor. In such a manner, the electrically conductive portion 34 is configured to electrically connect the electrically conductive portion 31 to the supporting frame 40 as an external electrical conductor.

[0058] As shown in FIGS. 4 to 7, the fiber waste discharge portion 33 is in a circular cylindrical shape having both ends thereof opened. The fiber waste discharge portion 33 is the same in inner diameter as a bottom end portion of the tapered portion 36. The fiber waste discharge portion 33 has a top end portion connected to a bottom end portion of the

tapered portion 36 such that the fiber waste discharge portion 33 is concentric with a bottom end portion of the tapered portion 36. The fiber waste discharge portion 33 has a bottom end portion connected to the fiber waste collection container 13 (see FIG. 4). The fiber waste discharge portion 33 and the tapered portion 36 have no partitioning member therebetween to partition their respective interiors so that an interior of the fiber waste discharge portion 33 and an interior of the body unit 35 can communicate with each other. The fiber waste discharge portion 33 may be arranged so as to be integrated with or coupled to a bottom end portion of the tapered portion 36 of the separation portion 31. When the fiber waste discharge portion 33 is arranged so as to be integrated with the tapered portion 36, the fiber waste discharge portion 33 is made of electrically conductive resin material for the tapered portion 36.

[0059] As shown in FIGS. 4 to 7, the air discharge portion 32 for discharging air separated from the fiber waste to an exterior is connected to the separation portion 31 at an upper side of the separation portion 31. The air discharge portion 32 has a pipe member in a circular cylindrical shape having both ends thereof opened. The air discharge portion 32 is the same in inner diameter as the opening 38a of the top face portion 38. The air discharge portion 32 has a bottom end portion connected to the opening 38a such that the air discharge portion 32 is concentric with the opening 38a. More specifically, the air discharge portion 32 is connected to the body portion 35 in such a manner that: a portion in a circular cylindrical shape of the air discharge portion 32 is not within or very slightly within an interior of the body portion 35 of the separation portion 31; and a bottom edge of a portion in a circular cylindrical shape of the air discharge portion 32 is flush with a bottom surface of the top face portion 38 of the separation portion 31 (more specifically, the body portion 35), or a bottom edge of a portion in a circular cylindrical shape of the air discharge portion 32 protrudes slightly from a bottom surface of the top face portion 38 of the separation portion 31.

[0060] As shown in an example of FIG. 7, the air discharge portion 32 is preferably configured such that, even when a bottom edge 32a of a portion in a circular cylindrical shape of the air discharge portion 32 protrudes slightly from a bottom surface of the top face portion 38, the bottom edge 32a of the air discharge portion 32 is above a top end portion 11e of the fiber waste transfer pipe 11. This is because, based upon the findings of the present inventors, when the bottom edge 32a of a portion in a circular cylindrical shape of the air discharge portion 32 is below the top end portion 11e of the fiber waste transfer pipe 11, the fiber waste is undesirably entangled with a portion in a circular cylindrical shape of the air discharge portion 32, which hinders suitable separation of the fiber waste from air. To address this, the bottom edge 32a of a portion in a circular cylindrical shape of the air discharge portion 32 is arranged at least above the top end portion 11e of the fiber waste transfer pipe 11 thereby to prevent a case where the fiber waste is entangled with a portion in a circular cylindrical shape of the air discharge portion 32, which results in good separation of the fiber waste from air. In an embodiment according to the present invention, as shown in FIG. 5 described above, when a bottom edge of a portion in a circular cylindrical shape of the air discharge portion 32 is flush with a bottom surface of the top face portion 38 of the body portion 35 (see FIG. 5), the bottom edge 32a of a portion in a circular cylindrical shape of the air discharge portion 32 is above the top end portion 11e of the fiber waste transfer pipe 11, which results in good separation of the fiber waste from air.

[0061] In the meantime, when the plurality of fiber waste transfer pipes 11 (11a to 11d) are connected to one fiber waste separator 30, there is a probability that the connection positions between the plurality of fiber waste transfer pipes 11 (11a to 11d) and the fiber waste separator 30 would be restricted. A connection position between, *e.g.*, one fiber waste transfer pipe 11a out of the plurality of fiber waste transfer pipes 11 (11a to 11d) and the fiber waste separator 30 is restricted by the other fiber waste transfer pipes 11b to 11d. In such a case, it would be difficult to connect one fiber waste transfer pipe 11a to the fiber waste separator 30 such that the one fiber waste transfer pipe 11a is below a bottom edge of a portion in a circular cylindrical shape of the air discharge portion 32. To address this, connecting each of the plurality of fiber waste transfer pipes 11 (11a to 11d) to the fiber waste separator 30 on a one-to-one basis makes it possible to connect the fiber waste transfer pipe 11 (11a to 11d) and the fiber waste separator 30 at an appropriate position where the fiber waste and air are satisfactorily separated, *i.e.*, a position where the fiber waste transfer pipe 11 (11a to 11d) is lower than the bottom edge of a portion in a circular cylindrical shape of the air discharge portion 32.

[0062] There is no partitioning member to partition between the air discharge portion 32 and the separation portion 31 (more specifically, the body portion 35), and an interior of the air discharge portion 32 communicates with an interior of the separation portion 31. Further, based upon the findings of the present inventors, when an inner diameter of the fiber waste discharge portion 33 (*i.e.,* an inner diameter of the bottom end portion of the tapered portion 36) is larger than an inner diameter of the air discharge portion 32 (*i.e.*, an inner diameter of the opening 38a), there is a probability that the fiber waste and air would be insufficiently separated and therefore some fiber waste would be discharged from the air discharge portion 32. For this reason, an inner diameter of the fiber waste discharge portion 33 (*i.e.,* an inner diameter of the bottom end portion of the tapered portion 36) is preferably smaller than an inner diameter of the air discharge portion 32 (*i.e.,* an inner diameter of the opening 38a).

[0063] It is to be noted that, in an embodiment according to the present invention, both the air discharge portion 32 and the fiber waste discharge portion 33 are in a circular cylindrical shape; however, the shape is not limited to this, and a prismatic tubular shape may be adopted. In such a case, an open area of a portion communicating with an interior of the body portion 35 (*i.e.,* a portion of being connected with the top face portion 38) in a horizontal direction is preferably

larger than an open area of the fiber waste discharge portion 33 in a horizontal direction.

[0064] As shown in FIG. 6, the fiber waste transfer pipe 11 is connected to the circular tubular portion 37 of the body portion 35 at an upper portion of the body portion 35 such that a longitudinal direction of the fiber waste transfer pipe 11 follows an inner peripheral wall 37b of the circular tubular portion 37 of the body portion 35. In other words, in a plan view, the fiber waste transfer pipe 11 is connected to the body portion 35 so as to be tangent to the circular tubular portion 37 of the body portion 35 of the separation portion 31. Further in other words, the fiber waste transfer pipe 11 is connected to the body portion 35 of the separation portion 31 such that a direction of travel of air containing fibers as the fiber waste transferred through the fiber waste transfer pipe 11 is along the inner peripheral wall 37b of the circular tubular portion 37. When the fiber waste transfer pipe 11 is connected to the separation portion 31 in such a way, as shown in FIG. 5, the air containing the fiber waste transferred through the fiber waste transfer pipe 11 travels in a circumferential direction along the inner peripheral wall 37b of the circular tubular portion 37. The fiber waste contained in the air is, therefore, transferred downward while turning in a circumferential direction along the inner peripheral wall 37b of the circular tubular portion 37 due to a centrifugal force, *i.e.*, a centrifugation action. The fiber waste having been caused to move downward while turning along the inner peripheral wall 37b of the circular tubular portion 37 is further transferred to the fiber waste discharge portion 33 along an inner peripheral wall 39a of the inclined portion 39. After having been transferred to the fiber waste discharge portion 33, the fiber waste is transferred from the fiber waste discharge portion 33 toward the fiber waste collection container 13 (see FIG. 4). In such a manner, the fiber waste having been transferred through the fiber waste transfer pipe 11 is separated from the air containing fiber waste, and the separated fiber waste is collected in the fiber waste collection container 13. Meanwhile, the air separated from the fiber waste is discharged from the air discharge portion 32 to an exterior thereof.

[0065] It is to be noted that, when each of the plurality of fiber waste transfer pipes 11 (11a to 11d) and the separation portion 31 are connected on a one-to-one basis, such fiber waste transfer pipes 11 (11a to 11d) and the separation portion 31 may be connected at their respective appropriate positions so that the inner peripheral wall 37b of the circular tubular portion 37 can be secured to ensure that the fiber waste is transferred to the tapered portion 36.

[EFFECTS]

[0066] According to the fiber waste collection device 1 and the fiber waste separator 30 in an embodiment of the present invention, the fiber waste transferred from the fiber waste transfer pipe 11 to the body portion 35 of the separation portion 31 is caused to move through the body portion 35 in a tubular shape by air flow along an inner circumference of the body portion 35 to the tapered portion 36 as a fiber waste transfer portion at a downward side. As a result, the fiber waste caused to move to a downward side is collected into a ball in the tapered portion 36 with the inclined portion 39 and the fiber waste in a ball shape is discharged from the fiber waste discharge portion 33 so as to be collected in the fiber waste collection container 13 serving as a fiber waste collection unit. Air separated from the fiber waste is discharged from the air discharge portion 32. The fiber waste collection device 1 and the fiber waste separator 30 in an embodiment according to the present invention can therefore result in suitable separation of the fiber waste from air thereby capable of suppressing the fiber waste discharged from the air discharge portion 32 to an exterior thereof.

[0067] If metal material is used to form the separation portion 31 in a complex shape having the body portion 35 in a tubular shape and the inclined portion 39 decreasing in diameter from a connection portion with the body portion 35 in a tubular shape toward the fiber waste discharge portion 33, a plurality of members must be welded to establish such a shape. This causes a burr at a welded portion and the fiber waste is undesirably caught by the burr, which results in disadvantageous decline of efficiency in collecting the fiber waste in the fiber waste collection container 13. According to the fiber waste collection device 1 and the fiber waste separator 30 in an embodiment of the present invention, however, the separation portion 31 made of resin material can eliminate such burrs caused by welding and can easily realize, by resin injection molding, even a complex shape with connection between the body portion 35 in a tubular shape and the inclined portion 39. Also, according to the fiber waste collection device 1 and the fiber waste separator 30 in an embodiment of the present invention, the separation portion 31 is made of electrically conductive resin material and an electrically conductive portion is arranged so as to electrically connect the separation portion 31 to the supporting frame 40 as an external electrical conductor. Static electricity caused by the friction in the separation portion 31 between the fiber waste separated from air and the separation portion 31 is therefore allowed to flow from the separation portion 31 to the electrically conductive portion 34 to escape, thereby capable of preventing any undesirable electrification of the separation portion 31. This can consequently prevent the fiber waste from being attached to the separation portion 31 due to static electricity, thereby capable of preventing any disadvantageous decline of efficiency in collecting the fiber waste in fiber waste collection container 13.

[0068] Further, according to the fiber waste collection device 1 and the fiber waste separator 30 in an embodiment of the present invention, the fiber waste is caused by a centrifugal force to move along the inner circumference wall 37b of the body portion 35 in a tubular shape to the tapered portion 36 at a lower side, and the fiber waste is collected in the tapered portion 36 with the inclined portion 39 in a ball shape, and the resultant waste can be collected in the fiber waste

collection container 13. The fiber waste can therefore be separated from air in a further favorable manner, thereby capable of further suppressing the discharge of the fiber waste from the air discharge portion 32 to an exterior thereof.

[0069] Still further, according to the fiber waste collection device 1 in an embodiment of the present invention, the electrically conductive portion 34 is arranged as an electrically conductive portion in a flange shape along an outer circumference of the body portion 35. Static electricity caused in the separation portion 31 is therefore allowed to efficiently escape around an entire circumference of the separation portion 31 to an exterior thereof.

[0070] Still further, according to the fiber waste collection device 1 and the fiber waste separator 30 in an embodiment of the present invention, the air discharge portion 32 is arranged so as to communicate with an interior of the separation portion 31 while not being inserted into an interior of the separation portion 31. The fiber waste can therefore be prevented from being entangled with the air discharge portion 32 thereby capable of resulting in favorable separation of the fiber waste from air.

[0071] According to the general electrification order, polyester is easily negatively charged while polyamide is easily positively charged. When the separation portion 31 is made of, *e.g.*, electrically nonconductive polyester, therefore, static electricity can be prevented from attracting fiber waste of polyester to the separation portion 31 but undesirably attracts fiber waste of polyamide fiber to the separation portion 31 more easily. For this reason, when the separation portion 31 is made of, *e.g.*, electrically nonconductive polyester, it is difficult to prevent polyamide fiber from being attracted. In contrast, the separation portion 31 made of electrically conductive resin material can prevent, according to the fiber waste separator 30 in an embodiment of the present invention, even fiber waste made of any of polyester fiber and polyamide fiber from causing any undesirable electrification of the separation portion 31 by allowing static electricity generated by the friction between the fiber waste and the separation portion 31 to escape from the separation portion 31 to the electrically conductive portion 34. Even when the fiber waste is made of any of polyester fiber and polyamide fiber, therefore, static electricity can be prevented from attracting the fiber waste in the separation portion 31 thereby capable of preventing any disadvantageous decline of efficiency in collecting the fiber waste in the fiber waste collection container 13.

[0072] Further, according to the fiber waste collection device 1 and the fiber waste separator 30 in an embodiment of the present invention, the tapered portion 36 has the inclined portion 39 decreasing in diameter from a connection portion with the body portion 35 toward the fiber waste discharge portion 33. The fiber waste can be separated from air in such an inclined portion 39 thereby further suppressing any disadvantageous discharge of the fiber waste from the air discharge portion 32 to an exterior thereof. The above-described inclined portion 39 is in a tapered shape having an angle to a vertical direction in a range from 7 to 10[°] (inclusive of upper and lower limits). This can prevent the fiber waste from being clogged in the fiber waste discharge portion 33 while providing precise separation of the fiber waste from air thereby capable of realizing favorable discharge of the fiber waste from the fiber waste discharge portion 33.

[0073] Still further, according to fiber waste collection device 1 and the fiber waste separator 30 in an embodiment of the present invention, a portion of the air discharge portion 32 communicating with an interior of the body portion 35 has an aperture area in a horizontal direction larger than an aperture area of the fiber waste discharge portion 33 in a horizontal direction. This can consequently suppress the discharge of the fiber waste from the air discharge portion 32 in further effectively.

[EXPERIMENTAL EXAMPLES]

[0074] An embodiment according to the present invention was supported by the following experimental examples. The results of such experimental examples will be described. FIG. 8 is a front view illustrating a fiber waste separator 30. FIG. 9 is a graph showing an example of test results indicative of a relationship among a taper angle θ, a flow rate of air in an air discharge portion 32, and a flow rate of air in a fiber waste discharge portion 33. The fiber used in EXPERIMENTAL EXAMPLES 1, 2, and 3 below is 75 denier false-twisted yarn.

[0075] It is to be noted that, in FIGS. 8 and 9, a vertical direction is defined as a Y-direction, and in particular, an upper direction is defined as a Y-direction at a positive side and a lower direction is defined as a Y-direction at a negative side. The flow rate shown in FIG. 9 represents the flow rate of a vector component in a Y-direction. When the value of the flow rate is positive, the flow of air is in a Y-direction at a positive side and when the value of the flow rate is negative, the flow of air is in a Y-direction at a negative side.

[0076] Further, as shown in FIG. 8, the dimensions of each part of the fiber waste separator 30 are as follows: Y-direction length a of the entire fiber waste separator 30; Y-direction length b of the body portion 35; inner diameter c of the body portion 35; Y-direction length d of the air discharge portion 32; inner diameter e of the air discharge portion 32; Y-direction length f of the inclined portion 39; Y-direction length g of the fiber waste discharge portion 33; inner diameter h of the fiber waste discharge portion 33; and taper angle θ. In EXPERIMENTAL EXAMPLE 2 described below, an inner diameter of an inlet of the fiber waste transfer pipe 11 at a point of connecting with the fiber waste separator 30, is expressed as i.

[EXPERIMENTAL EXAMPLE 1]

[0077] In EXPERIMENTAL EXAMPLE 1, the dimensions of each part of the fiber waste separator 30 were a = 280 mm, b = 80 mm, c (inner diameter) = 80 mm, d = 50 mm, e (inner diameter) = 48 mm, g = 10 mm, h (inner diameter) = 31 mm, and the taper angle θ was changed, and the favorability of the fiber waste discharged from the fiber waste discharge portion 33 (hereinafter, referred to as "favorability of fiber waste discharge") was evaluated. Evaluation was performed at taper angles θ of 10°, 15°, 30°, and 40°. It is to be noted that the Y-direction length f of the inclined portion 39 is a dimension set according to the taper angle θ.

[0078] The evaluation results obtained in EXPERIMENT 1 are shown in TABLE 1. TABLE 1 is an example of experiment results showing the relationship between the taper angle θ and the favorability of fiber waste discharge. To ensure favorable discharge from the fiber waste discharge portion 33, it is important that the fiber waste be made into a ball. The fiber waste having formed a ball and been satisfactorily discharged from the fiber waste discharge portion 33 was judged as "Good", the fiber waste having not formed a ball and not been discharged from the fiber waste discharge portion 33 was judged as "Bad", and the fiber waste having formed a ball but clogged the fiber waste discharge portion 33 once out of five times was judged as "Middle".

[TABLE 1]

Taper angle θ	10°	15°	30°	45°
Favorability of fiber waste discharge	Middle	Bad	Bad	Bad

[0079] As shown in TABLE 1, when the taper angle θ exceeds 10°, the favorability of fiber waste discharge had a "Bad" determination. When the taper angle θ was 10°, in EXPERIMENT 1, once of five times, the fiber waste clogged in the fiber waste discharge portion 33, resulting in a "Middle" judgment, but four out of five times, the fiber waste formed a ball and was discharged from the fiber waste discharge portion 33, resulting in a judgment close to a "Middle" judgment. Although not shown in TABLE 1, when the taper angle θ was less than 10°, the favorability of fiber waste discharge in all cases resulted in a "Good" judgment.

[0080] The above evaluation results indicate that a taper angle θ of 10° or less is preferable from the perspective of good fiber waste discharged from the fiber waste discharge portion 33.

[EXPERIMENTAL EXAMPLE 2]

[0081] In EXPERIMENTAL EXAMPLE 2, the dimensions of each part of the fiber waste separator 30 were a = 300.1 mm, b = 90 mm, c = 90 mm, d = 30 mm, e = 48 mm, f = 170.1 mm, g = 10 mm, i = 21 mm, only the taper angle θ was changed, the changes in the flow rate of air in a Y-direction in the air discharge portion 32 and the flow rate of air in a Y-direction in the fiber waste discharge portion 33 were evaluated. Evaluation was performed at taper angles θ of 10°, 9°, 7°, and 5°. It is to be noted that the inner diameter h of the fiber waste discharge portion 33 is a dimension set according to the taper angle θ. Further, the air velocity within an interior of the fiber waste transfer pipe 11 is assumed to be 1000 m/min, and the mass flow rate of air at the inlet of fiber waste transfer pipe 11 is 0.014896 kg/s.

[0082] The evaluation results obtained in EXPERIMENT 2 indicate, assuming that the inner diameter e of the air discharge portion 32 and the inner diameter h of the fiber waste discharge portion 33 are constant sizes, the flow rate of air discharged from the air discharge portion 32 (the flow rate in a Y-direction at a positive side) decreases when the flow rate of air discharged from the fiber waste discharge portion 33 (the flow rate in a Y-direction at a negative side) increased, as shown in FIG. 9. Further, the flow rate of air discharged from the air discharge portion 32 decreases as the taper angle θ decreases. On the other hand, the flow rate of air discharged from the fiber waste discharge portion 33 stayed constant without decreasing at a taper angle θ of 7° or higher. Incidentally, when the inner diameter e of the air discharge portion 32 and the inner diameter h of the fiber waste discharge portion 33 were constant and the taper angle θ was small, the Y-direction length f of the inclined portion 39 increased as a result. When the Y-direction length f of the inclined portion 39 increases, the Y-direction length a of the overall fiber waste separator 30 increases and pressure loss is thought to increase. Accordingly, when the taper angle θ is less than 7°, the ratio of the flow rate of air discharged from the fiber waste discharge portion 33 to the flow rate of air discharged from the air discharge portion 32 is thought to increase. According to the inventor's findings, if a ratio of the flow rate of air discharged from the fiber waste discharge portion 33 relative to the flow rate of air discharged from the air discharge portion 32 becomes larger, the fiber waste and air will not be satisfactorily separated. Therefore, the lower limit of the taper angle θ is preferably 7° or more.

[0083] The results of EXPERIMENTS 1 and 2 above indicate that the taper angle θ is preferably in the range of 7° to 10° (inclusive of upper and lower limits).

[EXPERIMENTAL EXAMPLE 3]

[0084] In EXPERIMENTAL EXAMPLE 3, a relationship between the inner diameter h of the fiber waste discharge portion 33 and the ratio of the flow rate of air discharged from the fiber waste discharge portion 33 to the flow rate of air discharged from the air discharge portion 32 was evaluated. It is to be noted that, since the role of the air discharge portion 32 is to discharge the air obtained after having been separated from the fiber waste to an outside air, the inner diameter e of the air discharge portion 32 is fixed at 48 mm, for example. While results of the experiment are not shown in the figures, the flow rate (absolute value) of air in a Y-direction at a negative side in the fiber waste discharge portion 33 increases as the inner diameter h of the fiber waste discharge portion 33 increases and decreases as the inner diameter h of the fiber waste discharge portion33 decreases. On the other hand, the air flow rate (absolute value) in a Y-direction at a positive side at the air discharge portion 32 tends to decrease as the inner diameter h of the fiber waste discharge portion 33 increases and tends to increase as the inner diameter h of the fiber waste discharge portion 33 decreases. As described above, according to the findings by the present inventors, the inner diameter h of the fiber waste discharge portion 33 is preferably smaller than the inner diameter e of the air discharge portion 32. However, when the inner diameter h of the fiber waste discharge portion 33 is 27 mm or less, the present inventors found that it is difficult to discharge the fiber waste from the fiber waste discharge portion 33. It is to be noted that, when the inner diameter h of the fiber waste discharge portion 33 is 27 mm, the ratio of the flow rate of air discharged from the air discharge portion 32 to the flow rate of air discharged from the fiber waste discharge portion 33 is approximately 7:3. This ratio decreases as the inner diameter h of the fiber waste discharge portion 33 increases. For example, when the inner diameter h of the fiber waste discharge portion 33 is in a range from 27 mm to 35 mm, as the inner diameter h of the fiber waste discharge portion 33 increases, the ratio of the flow rate of air discharged from the air discharge portion 32 to the flow rate of air discharged from the fiber waste discharge portion 33 decreases. Additionally, the present inventors found that when the inner diameter h of the fiber waste discharge portion 33 is 35 mm, the ratio of the flow rate of air discharged from the air discharge portion 32 to the flow rate of air discharged from the fiber waste discharge portion 33 is approximately 1:1. As described above, as the ratio of the flow rate of air discharged from the fiber waste discharge portion 33 to the flow rate of air discharged from the air discharge portion 32 increases, separation between the fiber waste and air does not become more favorable, and hence the inner diameter h of the fiber waste discharge portion 33 is preferably 35 mm or less.

[0085] EXPERIMENTAL EXAMPLE 1, EXPERIMENTAL EXAMPLE 2 and EXPERIMENTAL EXAMPLE 3 are the results when doing experiments using a 75 denier false-twisted fiber as described above, but the present inventors also conducted similar verifications on other fibers. The results of these experiments indicate that, for a false-twisted fiber, a polyester fiber, and a polyamide fiber, forming the inclined portion 39 in a tapered shape having an angle formed with a vertical direction of 7° to 10° (inclusive of upper and lower limits) made it possible to accurately separate the fiber waste and air and prevented the fiber waste discharge portion 33 from being clogged with the fiber waste, which allowed the fiber waste to be satisfactorily discharged from the fiber waste discharge portion 33. Significant results were found particularly for a 75 to 450 denier false-twisted fiber, a 150 denier PET, and nylon.

[MODIFIED EXAMPLES]

[0086] Embodiments of the present invention have been described above, but the present invention is not limited to the above-described embodiments and may be subject to various changes within the scope of the claims. For example, the present invention can be changed in the following manner.

[0087] In the above-described embodiments, an embodiment was exemplarily described where the electrically conductive portion 34 corresponds to an electrically conductive portion in a flange shape along an outer circumference of the body portion 35. The present invention is, however, not limited to such an example. The electrically conductive portion for connecting the separation portion 31 electrically to an external electrical conductor may also be arranged as a first modified example to be described below.

[FIRST MODIFIED EXAMPLE]

[0088] FIG. 10 depicts a view showing schematically a fiber waste collection device 1A and a fiber waste separator 30 arranged therein according to a first modified example. FIG. 11 depicts a perspective view of a fiber waste separator 30 and a fiber waste collection container 13 in the fiber waste collection device 1A according to a first modified example. FIG. 12 depicts a front view (A) of a fiber waste separator 30 according to a first modified example, and a cross-sectional view (B) of an electrically conductive portion (electrically conductive portion in a tubular shape) 41 according to a first modified example.

[0089] As shown in FIGS. 10 to 12, a fiber waste collection device 1A in a first modified example is configured such that the fiber waste separator 30 includes the electrically conductive portion 34 as an electrically conducive portion in a

flange shape for connecting the separation portion 31 electrically to an external electrical conductor as well as an electrically conductive portion 41 as an electrically conductive portion in a tubular shape.

[0090] The electrically conductive portion 41 corresponds to an electrically conductive portion in a tubular shape as a tubular coupling member for coupling and connecting the body portion 35 to the fiber waste transfer pipe 11. The electrically conductive portion 41 is a member in a circular cylindrical shape made of electrically conductive rubber material. The electrically conductive portion 41 in a circular cylindrical shape is configured such that both ends thereof are opened, of which one end opening is mated with so as to be connected to the connection port 37a of the circular tubular portion 37 of the body portion 35, and of which the other end opening is mated with so as to be connected to an end of fiber waste transfer pipe 11. One end of the electrically conductive portion 41 is connected to the connection port 37a of the circular tubular portion 37 and the other end of the electrically conductive portion 41 is connected to the fiber waste transfer pipe 11 thereby to couple the body portion 35 and the fiber waste transfer pipe 11 via the electrically conductive portion 41. The fiber waste transfer pipe 11 is made of electrically conductive metal material so that it is an electrical conductor. The body portion 35 of the separation 31 is coupled to the fiber waste transfer pipe 11 via the electrically conductive portion 41 which results in electrical connection between the separation portion 31 and the fiber waste transfer pipe 11. As described above, the electrically conductive portion 41 arranged as an electrically conductive portion in circular cylindrical shape is configured to connect the separation portion 31 electrically to the fiber waste transfer pipe 11 thereby serving as an external electrical conductor.

[0091] According to the above-described fiber waste collection device 1A in a first modified example, static electricity generated in the separation portion 31 is allowed to escape from the body portion 35 to the fiber waste transfer pipe 11 in an efficient manner. The electrically conductive portion 41 as a coupling member to couple the body portion 35 to the fiber waste transfer pipe 11 is made of electrically conductive rubber material. The electrically conductive portion 41 can therefore absorb a position displacement between the body portion 35 and the fiber waste transfer pipe 11 thereby capable of simplifying connection between the body portion 35 and the fiber waste transfer pipe 11.

[0092] According to the above-described embodiment in a first modified example, an electrically conductive portion for connecting the separation portion 31 to an external electrical conductor includes both the electrically conductive portion 34 in a flange shape and the electrically conductive portion 41 in a circular cylindrical shape. The present invention is, however, not limited to such an example. Another configuration may be adopted where the electrically conductive portion 34 in a flange shape is not arranged and only the electrically conductive portion 41 in a circular cylindrical shape is arranged. The electrically conductive portion for connecting the separation portion 31 electrically to an external electrical conductor may be an electrically conductive portion other than the such electrically conductive portion in a flange shape and in a circular cylindrical shape. For example, any electrically conductive portion may be arranged as an electrical conductor coupled to the separation portion 31 and the supporting frame 40.

[0093] In the above-described embodiment, the fiber waste separator 30 corresponding to each of the fiber waste transfer pipes 11 (11a to 11d) is arranged between each of the plurality of fiber waste transfer pipes 11 (11a to 11d) and one fiber waste collection container 13, but no limitation is intended. For example, any one of the aspects according to second to fifth modified examples can be adopted.

[SECOND MODIFIED EXAMPLE]

[0094] FIG. 13 is a schematic view showing a fiber waste collection device 1B according to a second modified embodiment of the present invention. As shown in FIG. 13, in a second modified example, the fiber waste collection device 1B includes a plurality of fiber waste collection containers 13 (13a to 13d) and a plurality of fiber waste separators 30 (30a to 30d) for each of a plurality of fiber waste transfer pipes 11 (11a to 11d).

[0095] More specifically, the fiber waste collection container 13 includes a first fiber waste collection container 13a corresponding to the first fiber waste transfer pipe 11a, a second fiber waste collection container 13b corresponding to the second fiber waste transfer pipe 11b, a third fiber waste collection container 13c corresponding to the third fiber waste transfer pipe 11c, and a fourth fiber waste collection container 13d corresponding to the fourth fiber waste transfer pipe 11d. Further, the fiber waste separator 30 (30a to 30d) includes a first fiber waste separator 30a arranged between the first fiber waste transfer pipe 11a and the first fiber waste collection container 13a, a second fiber waste separator 30b arranged between the second fiber waste transfer pipe 11b and the second fiber waste collection container 13b, a third fiber waste separator 30c arranged between the third fiber waste transfer pipe 11c and the third fiber waste collection container 13c, and a fourth fiber waste separator 30d arranged between the fourth fiber waste transfer pipe 11d and the fourth fiber waste collection container 13d. The first to fourth fiber waste transfer pipes 11a to 11d are each connected to a body portion (no reference numeral) such that their longitudinal direction follows an inner peripheral wall (no reference numeral) of the body portion (no reference numeral) of the fiber waste separator 30. In other words, similar to the fiber waste transfer pipes 11 (11a to 11d) described with reference to FIG. 6, in a plan view, the first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d are connected to the body portion of the fiber waste separator 30 (30a to 30d) so as to be tangent to a tubular portion of the body portion of the fiber waste separator 30 (30a to 30d).

[0096] Even with the aspect described in a second modified example, the fiber waste can be satisfactorily separated from air, the fiber waste can be satisfactorily discharged from the fiber waste discharge portion 33 (see FIG. 5), and the air separated from the fiber waste can be satisfactorily discharged from the air discharge portion 32 (see FIG. 5).

[THIRD MODIFIED EXAMPLE]

[0097] FIG. 14 is a schematic view showing a fiber waste collection device 1C according to a third modified embodiment of the present invention. As shown in FIG. 14, in a third modified example, the fiber waste collection device 1C includes a plurality of fiber waste transfer pipes 11 (11a to 11d), one fiber waste collection container 13, and one fiber waste separator 30.

[0098] The fiber waste separator 30 is arranged between the plurality of fiber waste transfer pipes 11 (11a to 11d) and the fiber waste collection container 13. The plurality of fiber waste transfer pipes 11 (11a to 11d) merge on the upstream side of the fiber waste separator 30 and are connected to a body portion 35 of the fiber waste separator 30 such that the longitudinal direction of each pipe after merging follows an inner peripheral wall (no reference numeral) of the body portion 35 of the fiber waste separator 30. In other words, similar to the fiber waste transfer pipes 11 described with reference to FIG. 6, in a plan view, the fiber waste transfer pipes 11 are preferably connected to the body portion such that the pipe after merging (no reference numeral) is tangent to the circular tubular portion 37 of the body portion 35 of the fiber waste separator 30.

[0099] An embodiment shown in a third modified example can also separate efficiently the fiber waste from air, and discharge efficiently the fiber waste from the fiber waste discharge portion 33, and further discharge efficiently air separated from the fiber waste from the air discharge portion 32.

[0100] In an embodiment of a third modified example, the plurality of fiber waste transfer pipes 11 (11a to 11d) are all merged at an upstream side of one fiber waste separator 30. Another configuration may also be adopted where the plurality of fiber waste separators 30 are arranged such that two or more fiber waste transfer pipes out of the plurality of fiber waste transfer pipes 11 (11a to 11d) are merged at a upstream side of the fiber waste separator 30. For example, two fiber waste transfer pipes may be merged at a upstream side of one fiber waste separator to be connected to the one fiber waste separator and the other two fiber waste transfer pipes may be merged at an upstream side of another fiber waste separator to be connected to another fiber waste separator.

[FOURH MODIFIED EXAMPLE]

[0101] FIG. 15 depicts a plan view of a fiber waste separator 30 according to a fourth modified example. The fiber waste collection device (no reference numeral) in a fourth modified example includes, as in the fiber waste collection device 1C in a third modified example, a plurality of the fiber waste transfer pipes 11 (11a to 11d), one fiber waste collection container (no reference numeral), and one fiber waste separator 30. In a third modified example, a plurality of the fiber waste transfer pipes 11 (11a to 11d) are merged at an upstream side of the fiber waste separator 30. A fourth modified example adopts another configuration where one fiber waste separator 30 is connected to the plurality of fiber waste transfer pipes 11 (11a to 11d).

[0102] More specifically, as illustrated in FIG. 15, in a fourth modified example, a first fiber waste transfer pipe 11a, a second fiber waste transfer pipe 11b, a third fiber waste transfer pipe 11c, and a fourth fiber waste transfer pipe 11d are connected at positions shifted in a circumferential direction of a body portion 35 of the one fiber waste separator 30. The first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d are each connected to the body portion 35 such that their longitudinal direction follows an inner peripheral wall 37b of the body portion 35 of the fiber waste separator 30. In other words, similar to the fiber waste transfer pipes 11 described with reference to FIG. 6, in a plan view, the first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d are connected to the body portion 35 so as to be tangent to a tubular portion 35 of the body portion 35 of the fiber waste separator 30. Even with the aspect described in a fourth modified example, the fiber waste can be satisfactorily separated from air, the fiber waste can be satisfactorily discharged from the fiber waste discharge portion 33, and the air separated from the fiber waste can be satisfactorily discharged from the air discharge unit 32.

[0103] The first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d shown in FIG. 15 are each preferably connected to an upper portion of the body portion 35. However, it is not necessary that all of the first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d are arranged at the same position in an up-and-down direction. The first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d may also be partially or entirely connected so that they are dislocated in an up-and-down direction.

[FIFTH MODIFIED EXAMPLE]

[0104] FIG. 16 depicts a perspective view of the fiber waste separator 30 according to a fifth modified example. The

fiber waste collection device (no reference numeral) in a fifth modified example includes, as in the fiber waste collection device 1C in a third modified example, the plurality of fiber waste transfer pipes 11 (11a to 11d), one fiber waste collecting container (no reference numeral), and one fiber waste separator 30.

[0105] As shown in FIG. 16, in a fifth modified example, the first fiber waste transfer pipe 11a, the second fiber waste transfer pipe 11b, the third fiber waste transfer pipe 11c, and the fourth fiber waste transfer pipe 11d are connected to the body portion 35 of one fiber waste separator 30 such that they are dislocated in an up-and-down direction. The first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d are each connected to the body portion 35 so as to have a longitudinal direction in an inner circumference wall 37b of the body portion 35 of the fiber waste separator 30. More specifically, as in the fiber waste transfer pipe 11 described with reference to FIG. 6, the first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d are connected, when seen in a plan view, to the body portion 35 so as to follow a tangential line of the circular tubular portion 37 of the body portion 35 of the fiber waste separator 30. A fifth modified example can also separate efficiently the fiber waste from air, and discharge efficiently the fiber waste from the fiber waste discharge portion 33, and further discharge efficiently air separated from the fiber waste from the air discharge portion 32.

[0106] It is to be noted that while the first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d shown in FIG. 16 are connected to the body portion 32 at different positions in the up-and-down position but at the same position in the circumferential direction of the body portion 35, no limitation is intended. For example, some or all of the first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d may be connected to the body portion 35 at different positions in the circumferential direction of the body portion 35.

[OTHERS]

[0107] In the embodiments described above, the fiber waste collection device 1 is a device installed in the false-twisting machine 101, but no limitation is intended. The fiber waste collection device 1 may be a device installed in a textile machine other than the false-twisting machine 101. For example, the fiber waste collection device 1 may be installed in a spinning machine.

[0108] In the embodiments described above, the winder 107 is described as being installed in the false-twisting machine 101 in which the winder 107 is arranged in four stages in the up-and-down direction, but no limitation is intended. The winder 107 may be installed in a false-twisting machine 101 in which the winder 107 is arranged in three or less stages or five or more stages in the up-and-down direction. In this case, the same number of fiber waste transfer pipes 11 as the number of winders 107 arranged in the up-and-down direction may be arranged.

[0109] The above-described embodiment deals with a case in which a plurality of the fiber waste transfer pipes 11 are arranged, but a different configuration may be adopted. An embodiment in which one fiber waste transfer pipe 11 is arranged may also be adopted.

(Reference Numerals)

[0110]

1	Fiber waste collection device
11	Fiber waste transfer pipe
13	Fiber waste collection container (fiber waste collection unit)
15	Suction unit
30	Fiber waste separator
31	Separation portion
32	Air discharge portion
33	Fiber waste discharge portion
34	Electrically conductive portion
35	Body portion
36	Tapered portion (fiber waste transfer portion)
39	Inclined portion
101	False twisting machine
Y	fibers

Claims

1. A fiber waste collection device (1, 1A, 1B, 1C) comprising:

a fiber waste transfer pipe (11) for transferring therethrough fiber waste together with air,
a fiber waste collection unit (13) for collecting therein the fiber waste transferred through the fiber waste transfer pipe (11); and
a fiber waste separator (30) arranged between the fiber waste transfer pipe (11) and the fiber waste collection unit (13) configured to separate the fiber waste transferred through the fiber waste transfer pipe (11) from air so as to collect the separated fiber waste in the fiber waste collection unit (13),
wherein the fiber waste separator (30) includes
a separation portion (31) connected to the fiber waste transfer pipe (11) for separating the fiber waste from air,
an air discharge portion (32) connected to the separation portion (31) for discharging air separated from the fiber waste, and
a fiber waste discharge portion (33) for discharging the fiber waste separated from air by the separation portion (31) so as to collect the fiber waste in the fiber waste collection unit (13),
said fiber waste collection device (1, 1A, 1B, 1C) further comprising:

an electrically conductive portion (34, 41) for electrically connecting the separation portion (31) to an external electrical conductor,
wherein the separation portion (31) includes
a body portion in a cylindrical shape (35) connected to the fiber waste transfer pipe (11), and
a fiber waste transfer portion (36) arranged below the body portion (35) so as to be continuous with the fiber waste discharge portion (33),
wherein the fiber waste transfer portion (36) has an inclined portion (39) decreasing in diameter from a connection portion with the body portion (35) toward the fiber waste discharge portion (33), and
the separation portion (31) is made of electrically conductive resin material.

2. The fiber waste collection device (1, 1A, 1B, 1C) as claimed in claim 1, wherein
an electrically conductive portion in a flange shape is arranged as the electrically conductive portion (34) formed in a flange shape along an outer circumference of the body portion (35).

3. The fiber waste collection device (1, 1A, 1B, 1C) as claimed in claim 1 or 2, wherein

an electrically conductive portion in a tubular shape is arranged as the electrically conductive portion (41) formed in a coupling member in a tubular shape coupling to connect the body portion (35) to the fiber waste transfer pipe (11), and
the electrically conductive portion in a tubular shape is made of electrically conductive rubber material.

4. The fiber waste collection device (1, 1A, 1B, 1C) as claimed in any one of claims 1 to 3, wherein
the air discharge portion (32) has a lower end portion arranged above the fiber waste transfer pipe (11).

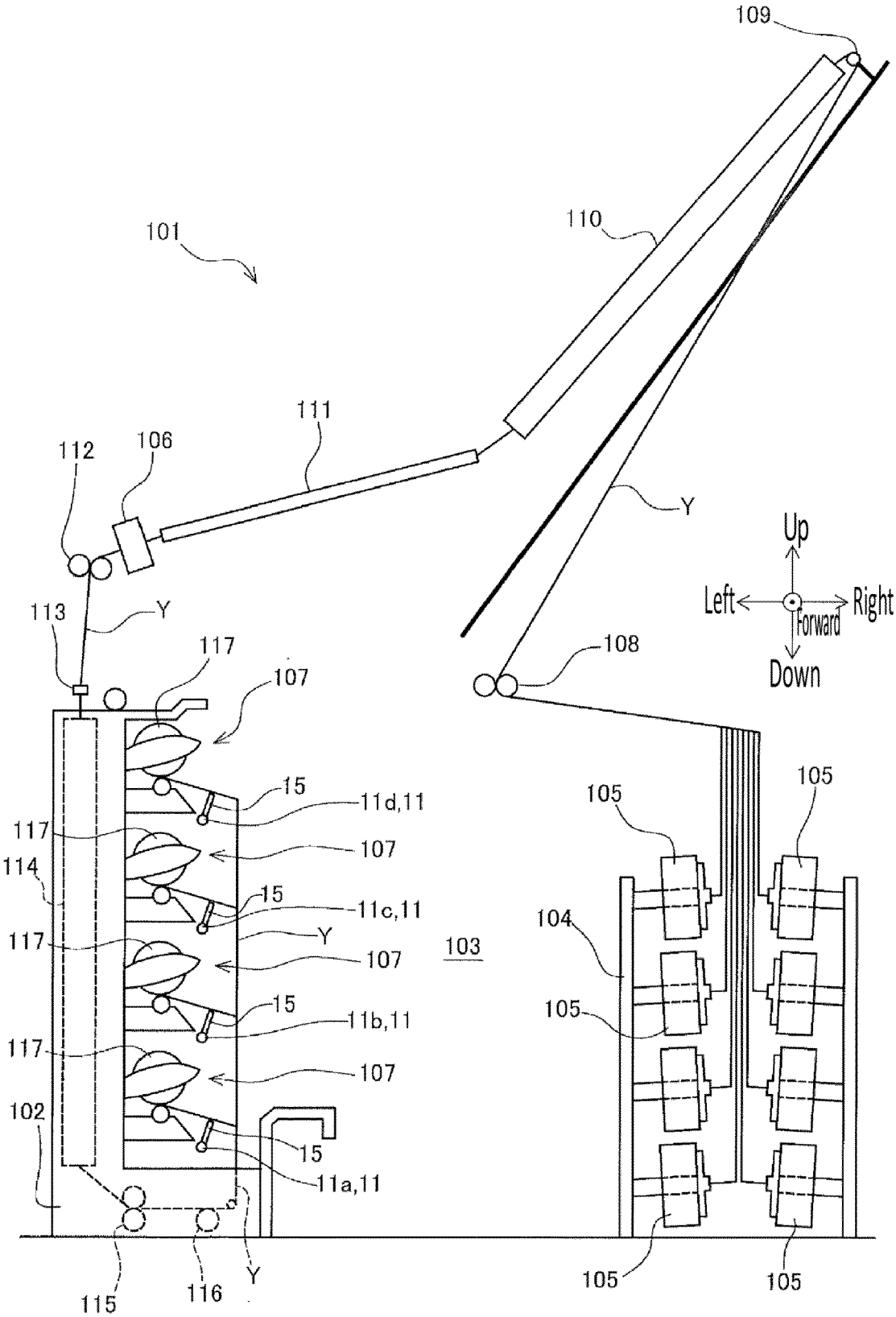
5. The fiber waste collection device (1, 1A, 1B, 1C) as claimed in any one of claims 1 to 4, wherein
the fiber waste transfer pipe (11) includes a plurality of fiber waste transfer pipes (11), and a plurality of fiber waste separators (30) of the fiber waste separator (30) are arranged for the plurality of fiber waste transfer pipes (11), respectively.

6. The fiber waste collection device (1, 1A, 1B, 1C) as claimed in any one of claims 1 to 5, wherein

the fiber waste transfer pipe (11) includes a plurality of fiber waste transfer pipes (11), and
the fiber waste collection unit (13) is smaller in number than the plurality of fiber waste transfer pipes (11).

7. A false-twisting machine (101) comprising the fiber waste collection device (1, 1A, 1B, 1C) as claimed in any one of claims 1 to 6.

FIG. 1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11c,11
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107
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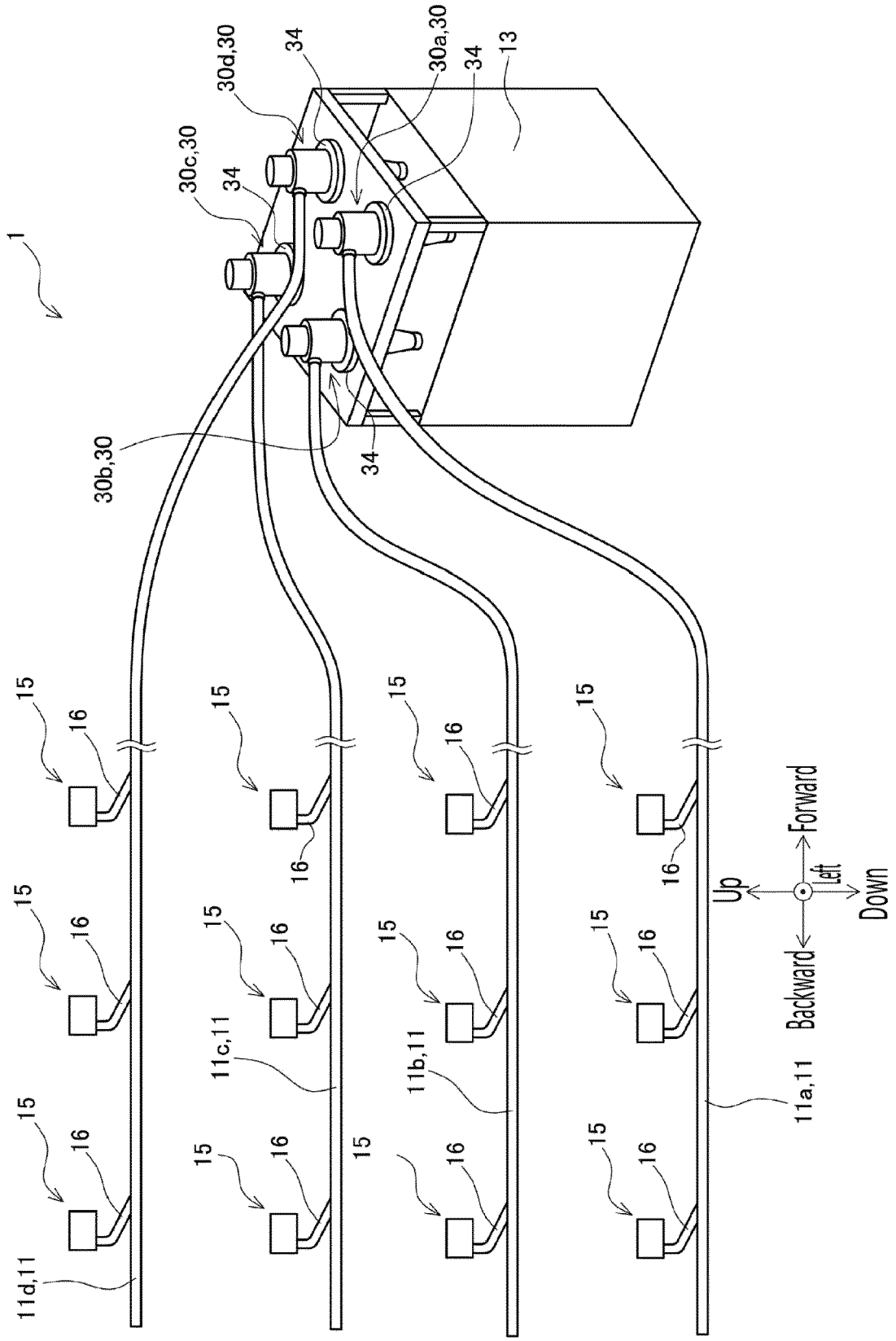
FIG. 2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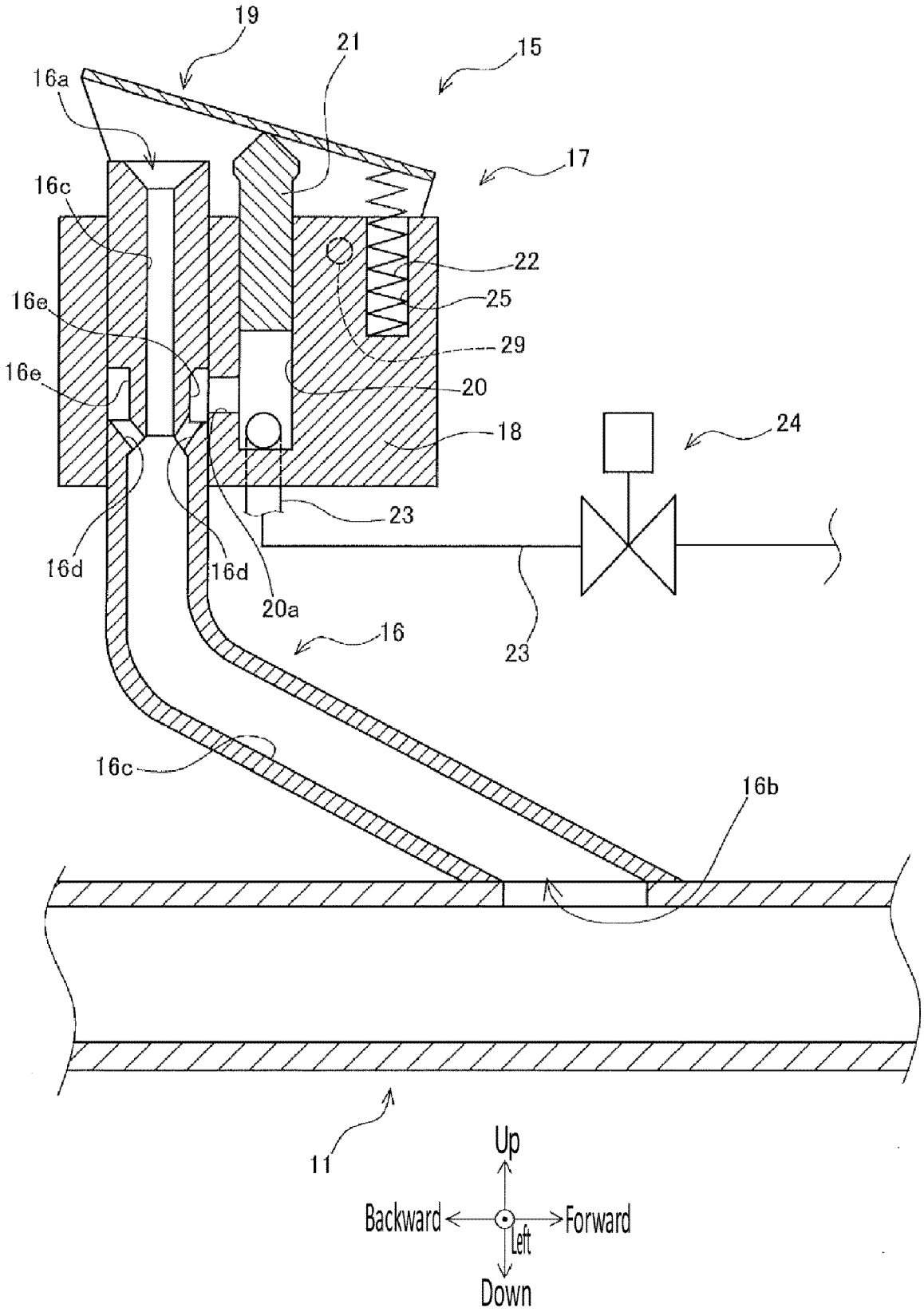
Left
Up
Down

FIG. 3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22
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16e
29
16e
20
18
24
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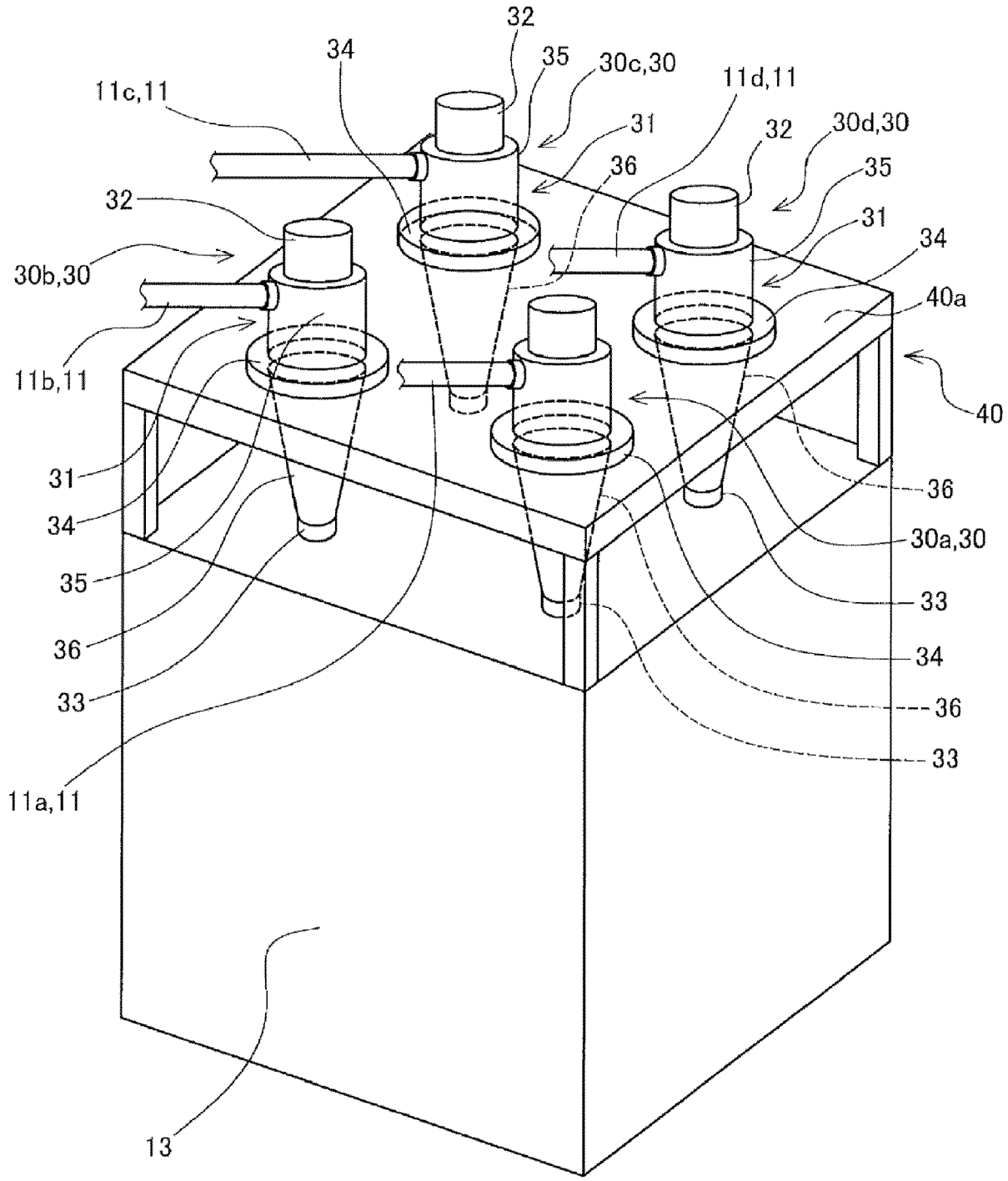
16d
16d
20a
16
23
16c
16b
11
Up
Backward
Forward
Left
Down

FIG. 4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34
35
30c,30
11d,11
11c,11
31
32
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32
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30b,30
40a
11b,11
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36
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35
33
36
34
33
36
11a,11
33
13

FIG. 5

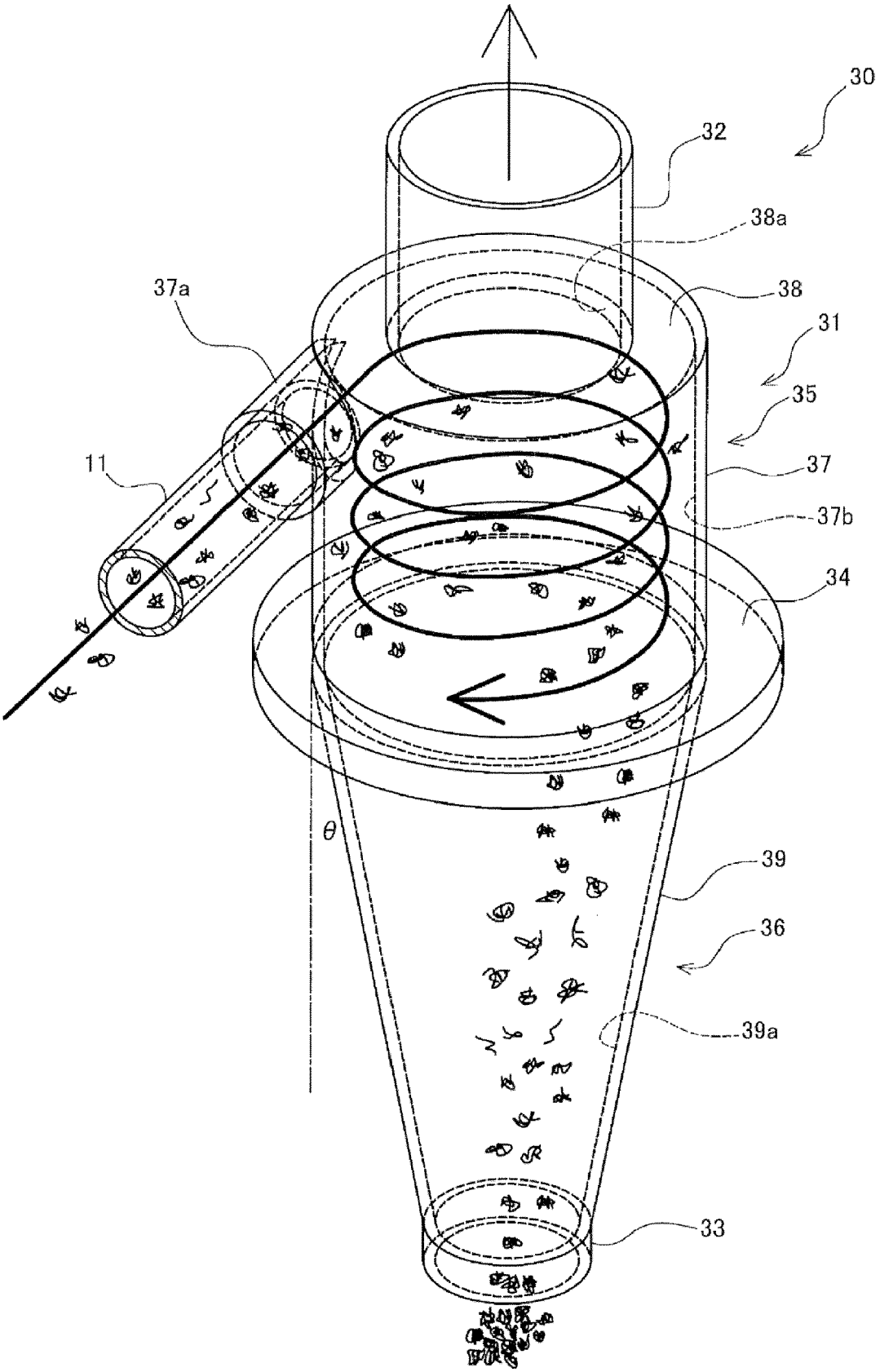


FIG. 6

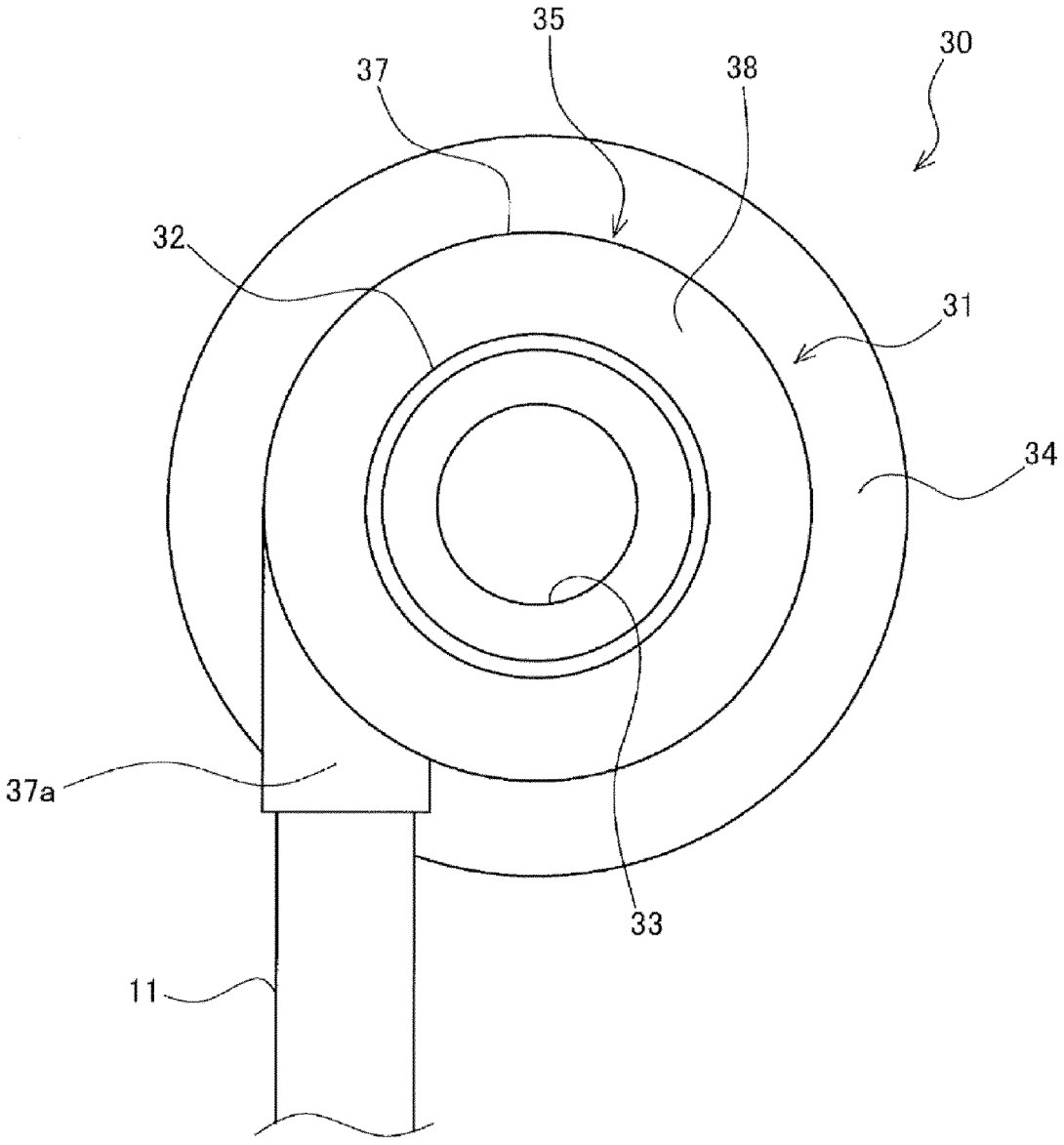


FIG. 7

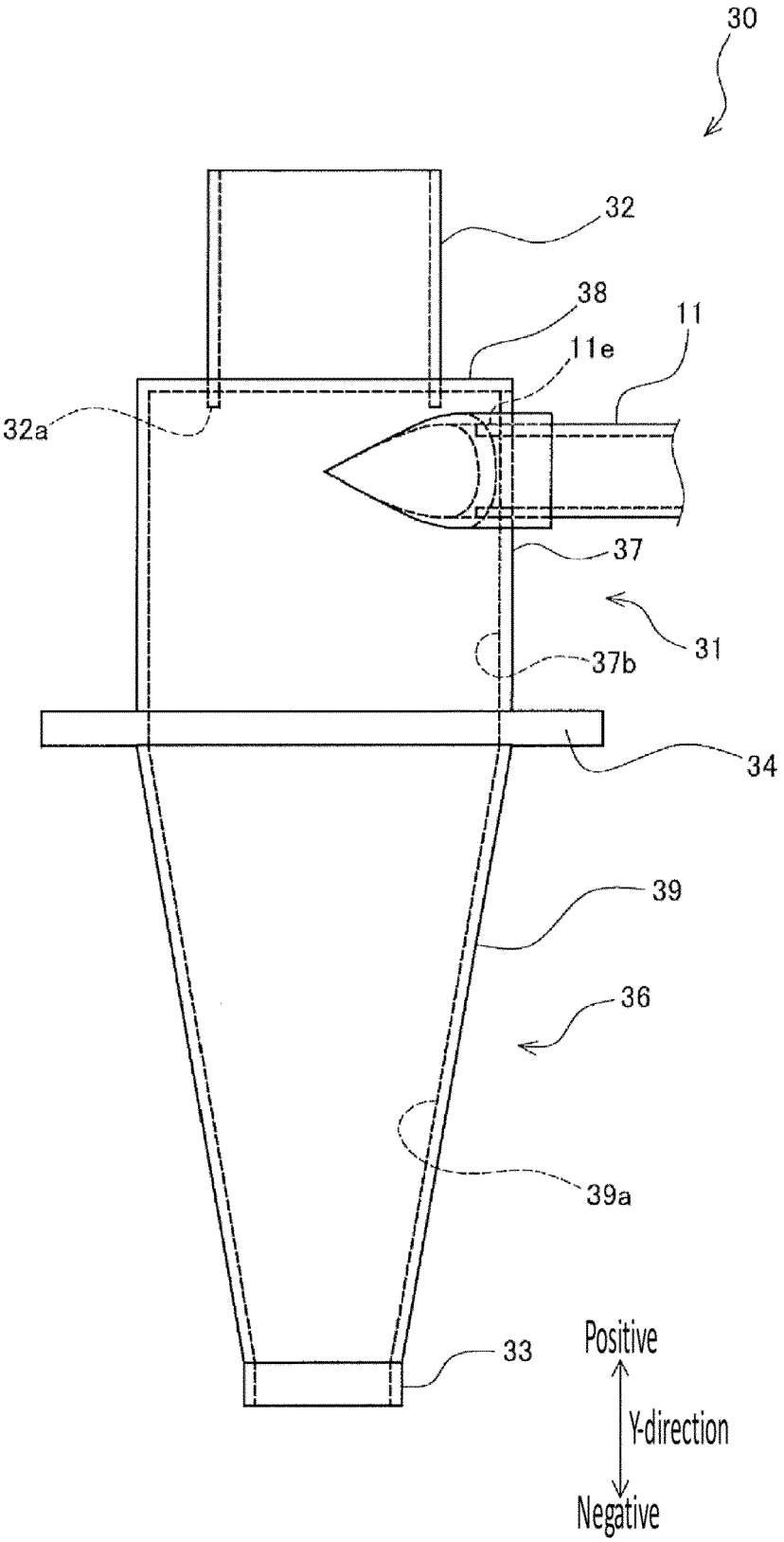

30
32
38
11
11e
32a
37
31
37b
34
39
36
39a
33
Positive
Y-direction
Negative

FIG. 8

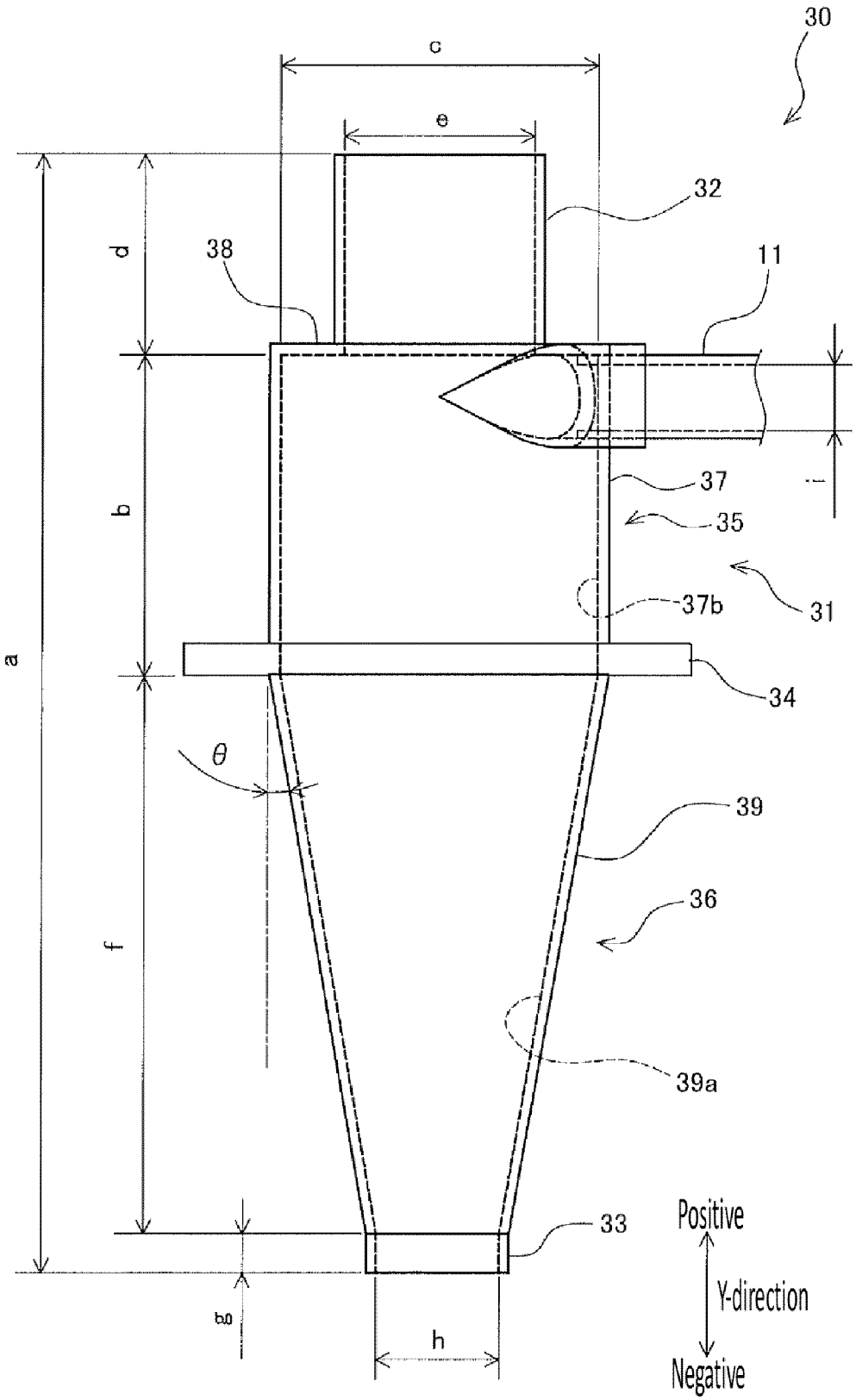
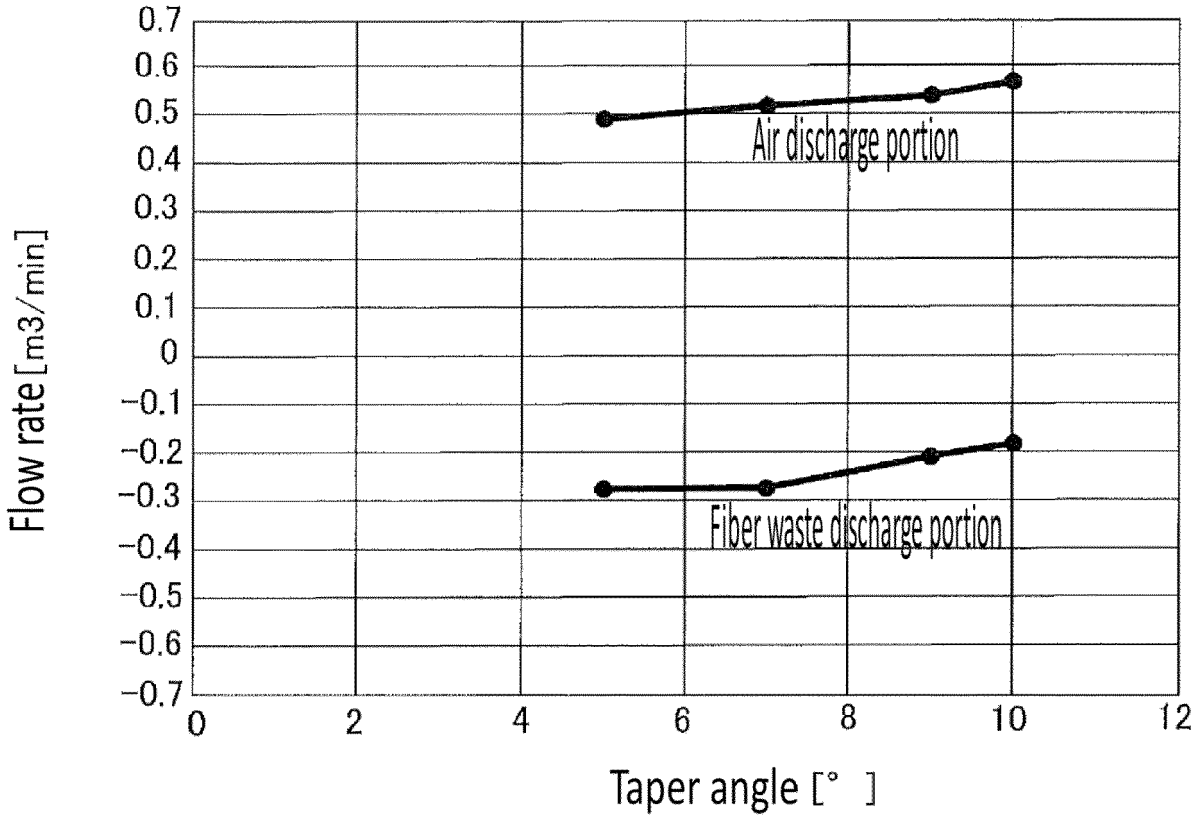

30
c
e
32
38
11
d
b
37
35
31
37b
a
34
θ
39
36
f
39a
33
Positive
Y-direction
Negative
h

FIG. 9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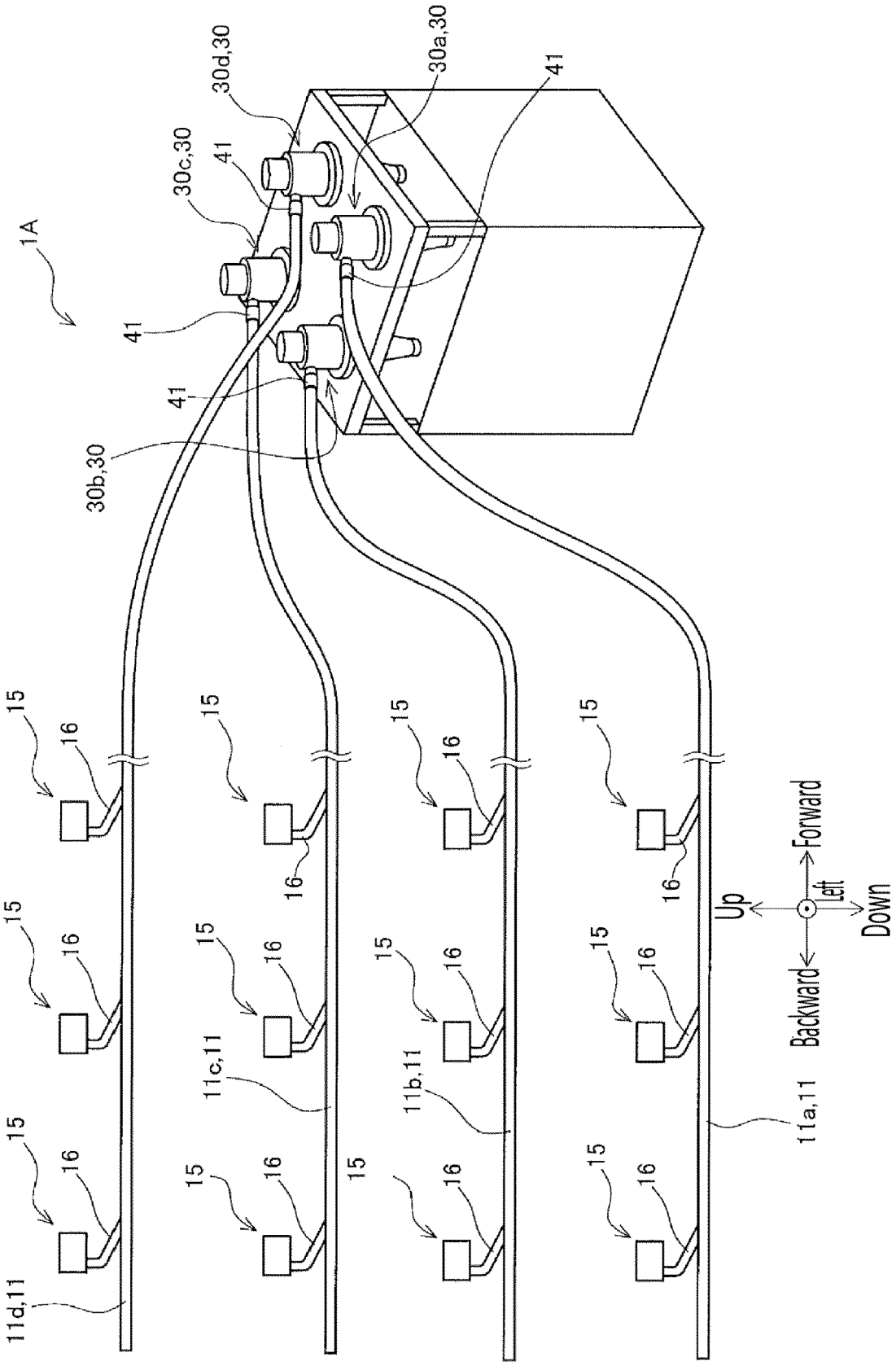
0.6
0.5
0.4
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.7
0
2
4
6
8
10
12
Flow rate [m3/min]
Taper angle [°]
Air discharge portion
Fiber waste discharge portion

FIG. 10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30a,30
41
30c,30
41
41
41
30b,30
15
16
11c,11
11b,11
11a,11
11d,11
Up
Forward
Left
Down
Backward

FIG. 11

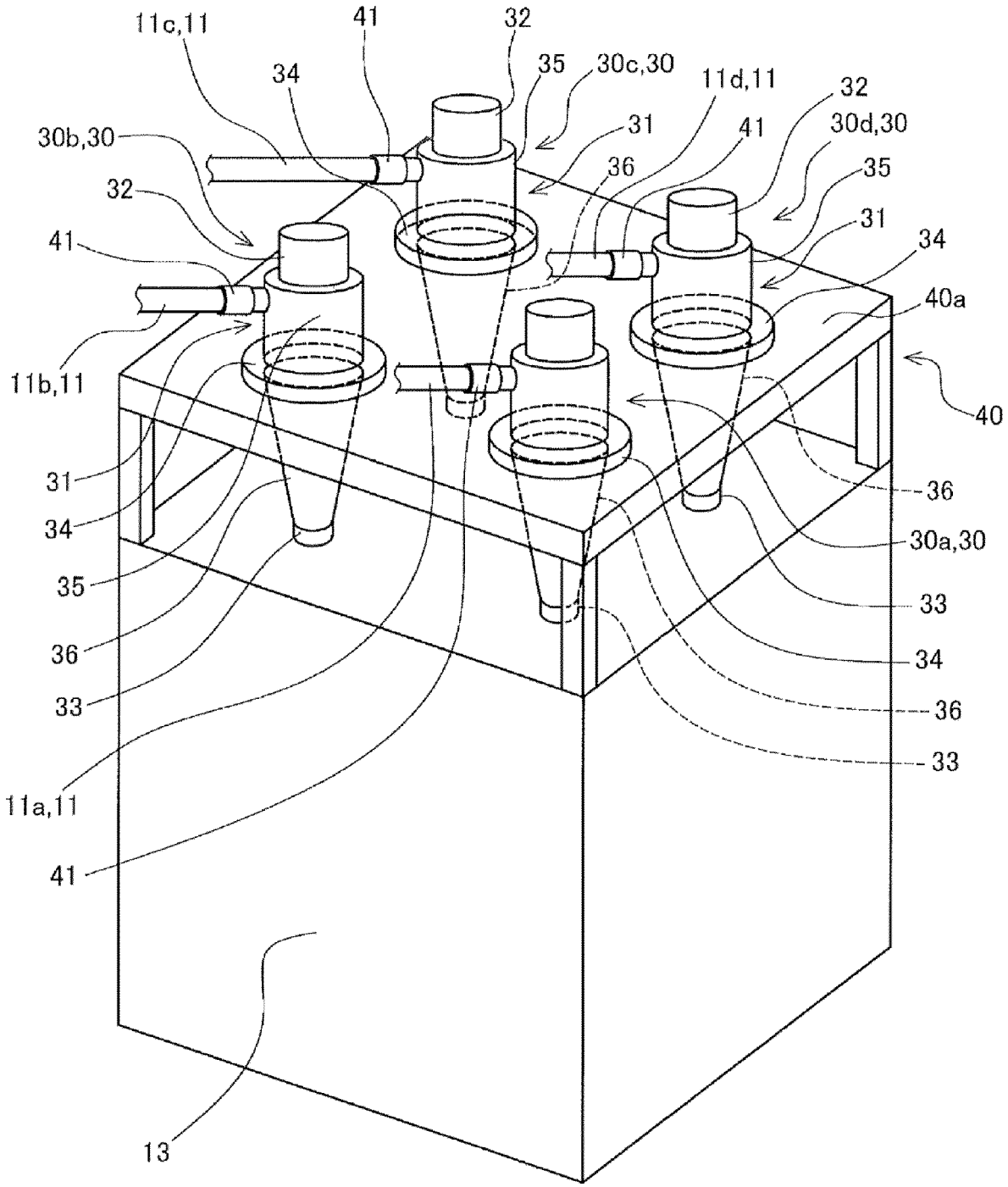

11c,11
41
32
34
35
30c,30
11d,11
32
30b,30
31
41
30d,30
36
35
32
31
41
34
40a
11b,11
40
31
36
34
30a,30
35
33
36
34
33
36
11a,11
33
41
13

FIG. 12

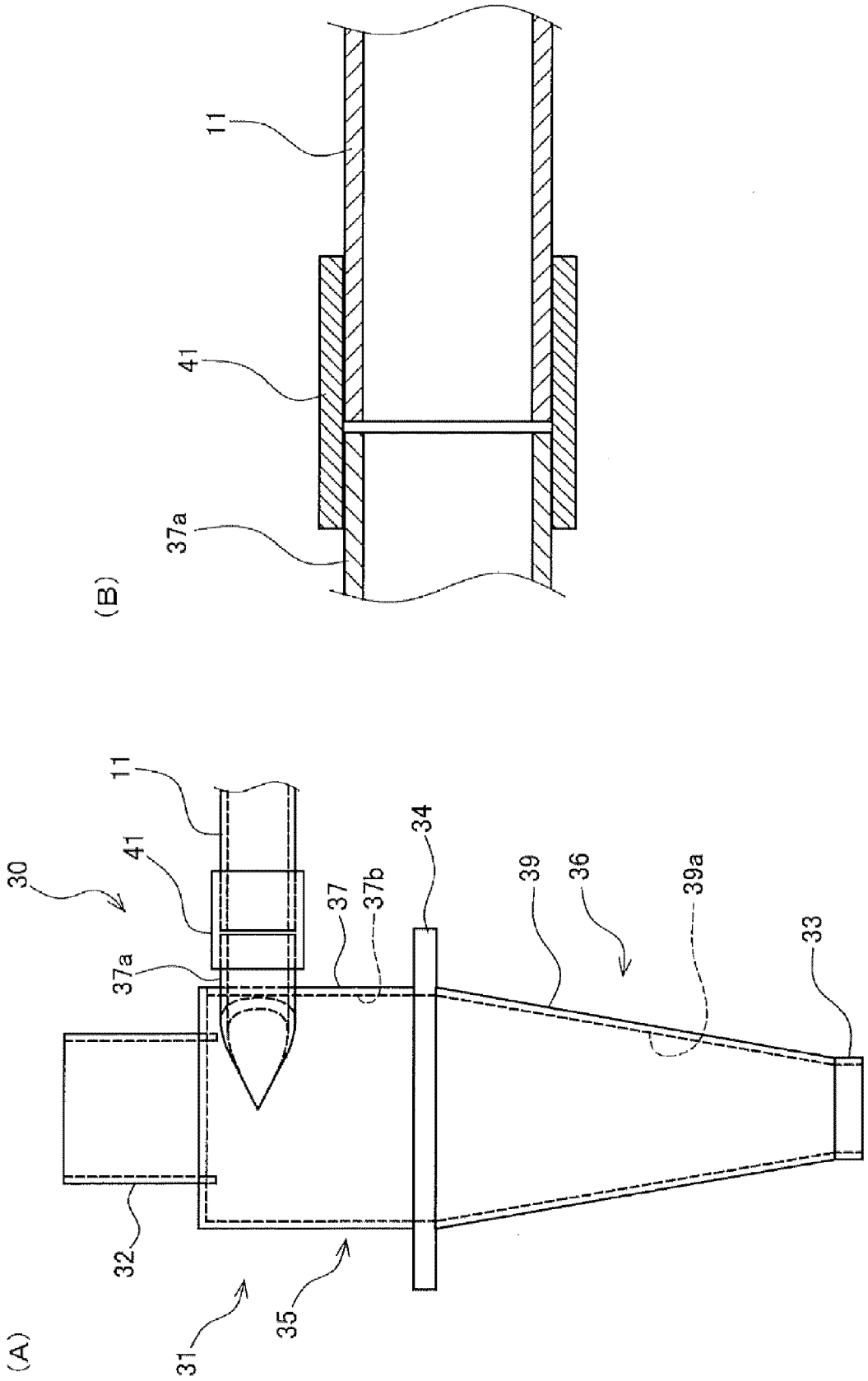


FIG. 13

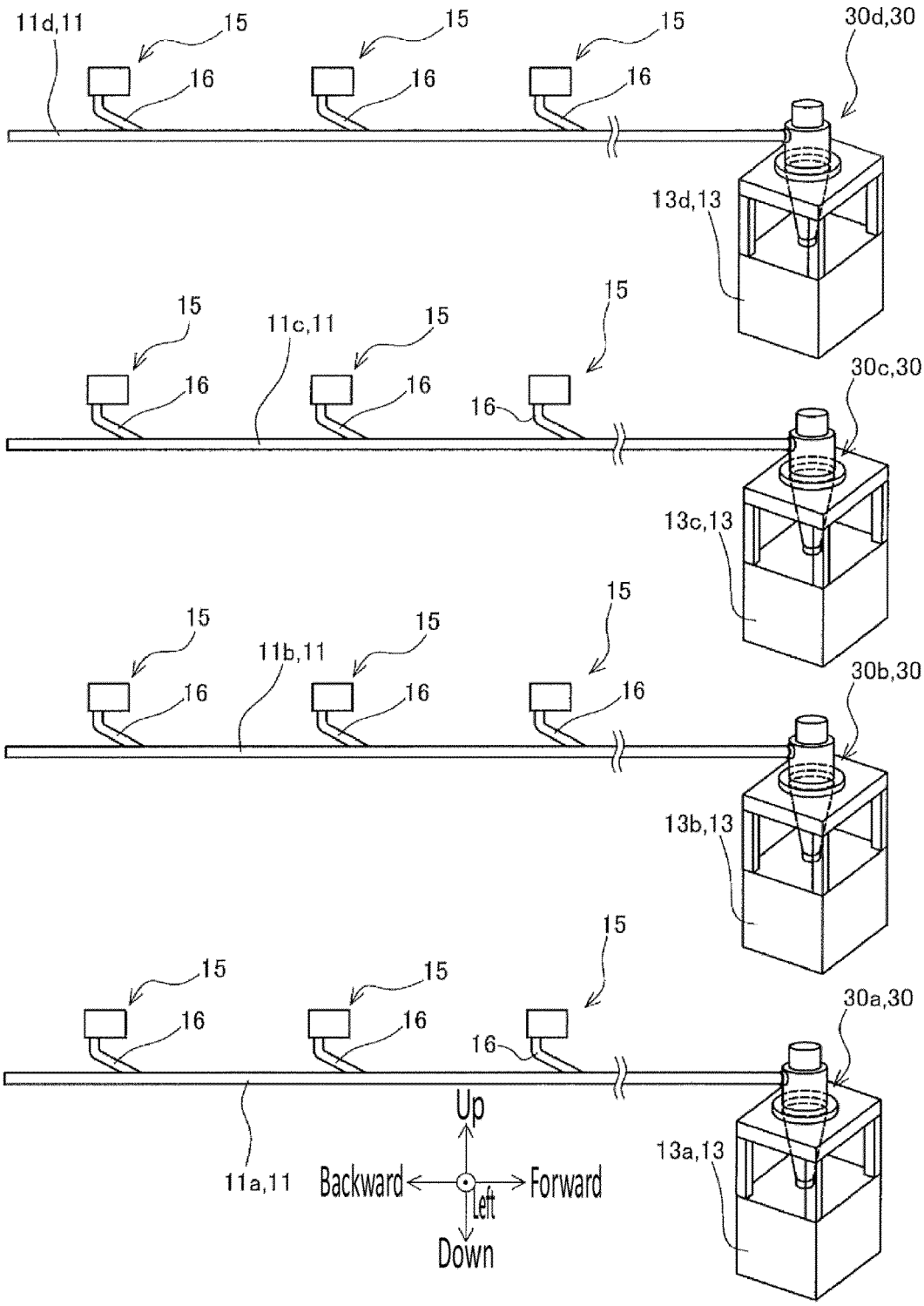

11d,11
15
16
30d,30
13d,13
11c,11
30c,30
13c,13
11b,11
30b,30
13b,13
30a,30
13a,13
11a,11
Up
Backward
Forward
Left
Down

FIG. 14

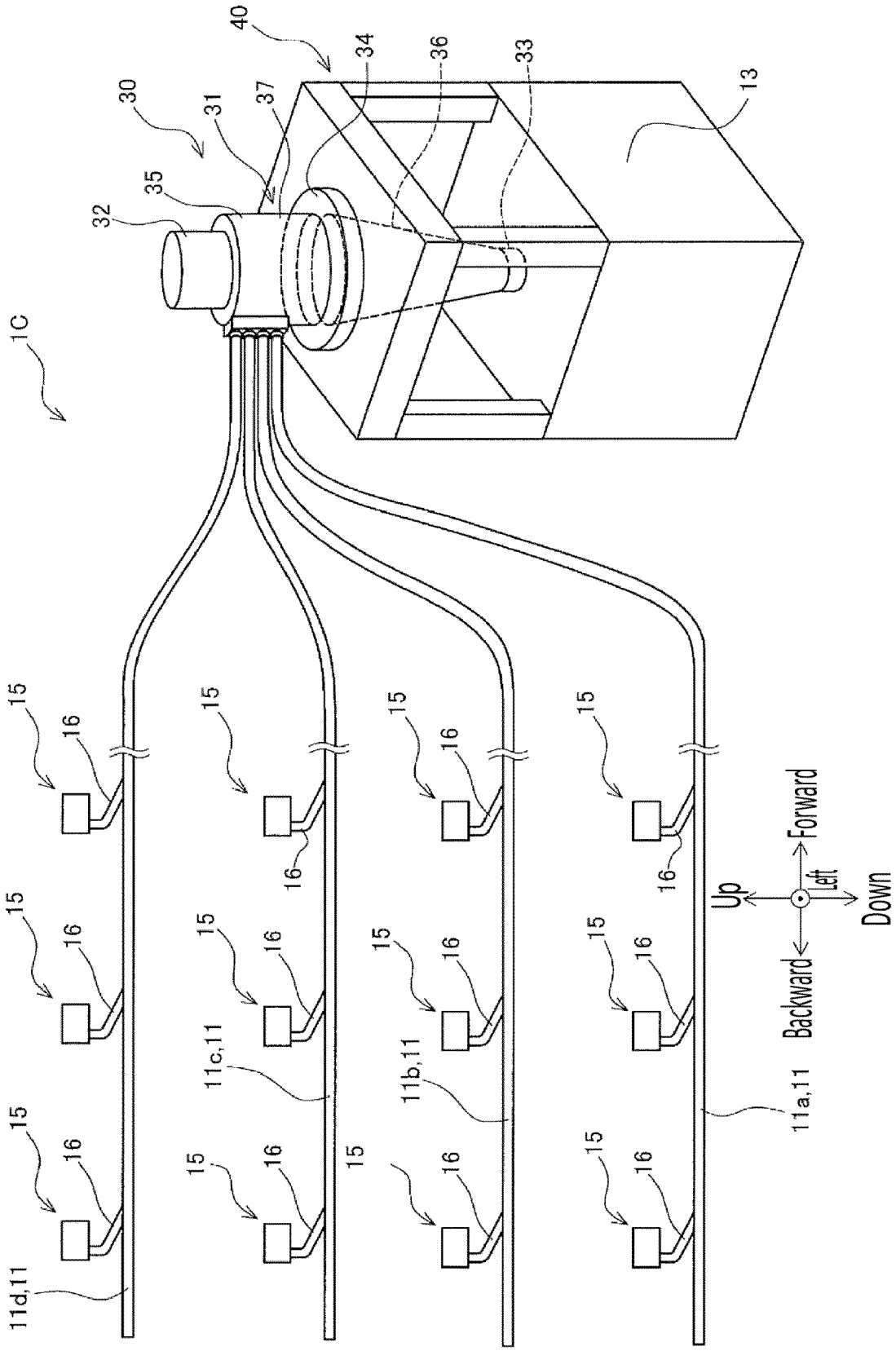

40
34
36
33
13
30
31
37
35
32
1C
15
16
11c,11
11b,11
11a,11
11d,11
Up
Forward
Left
Down
Backward

FIG. 15

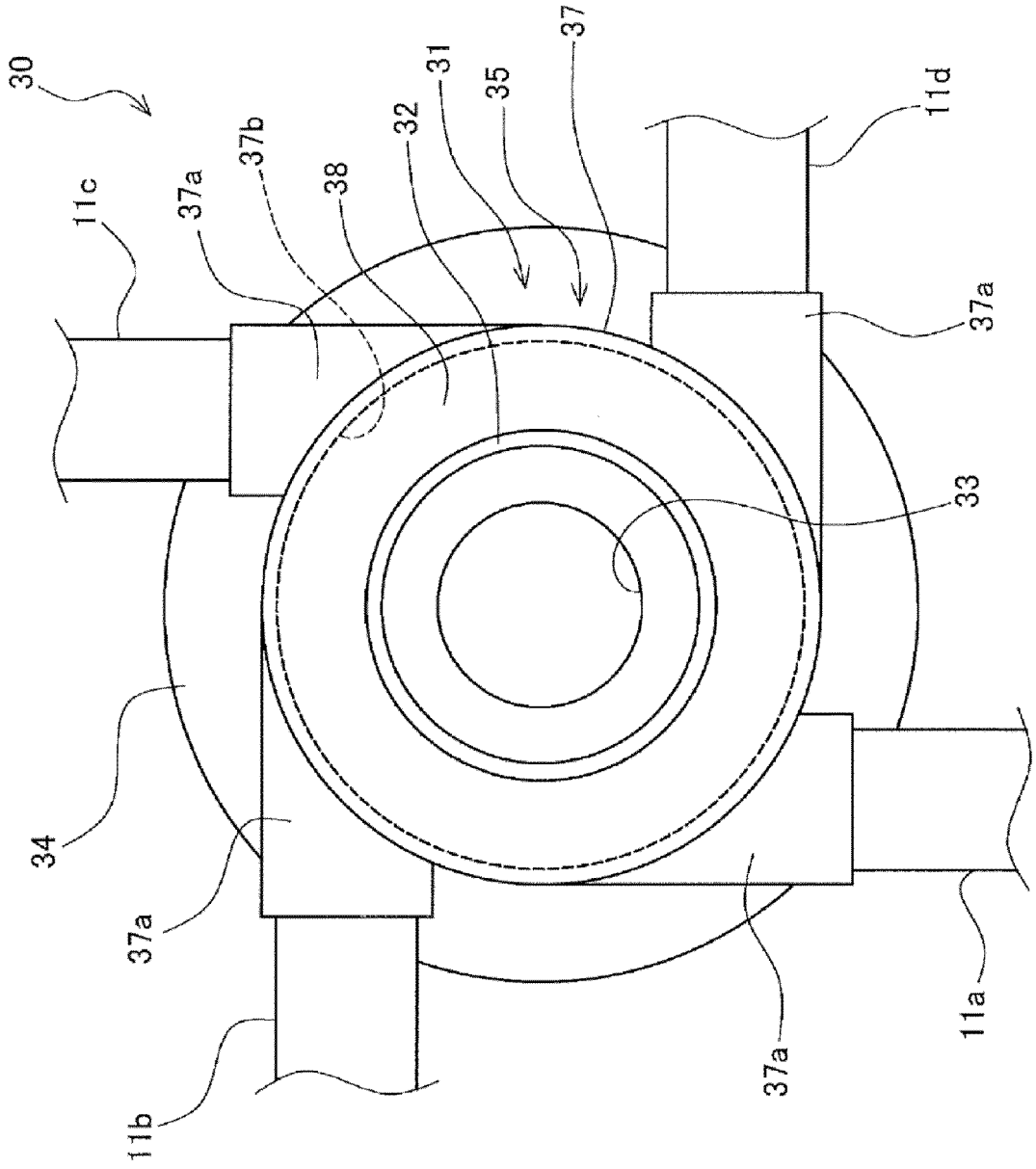
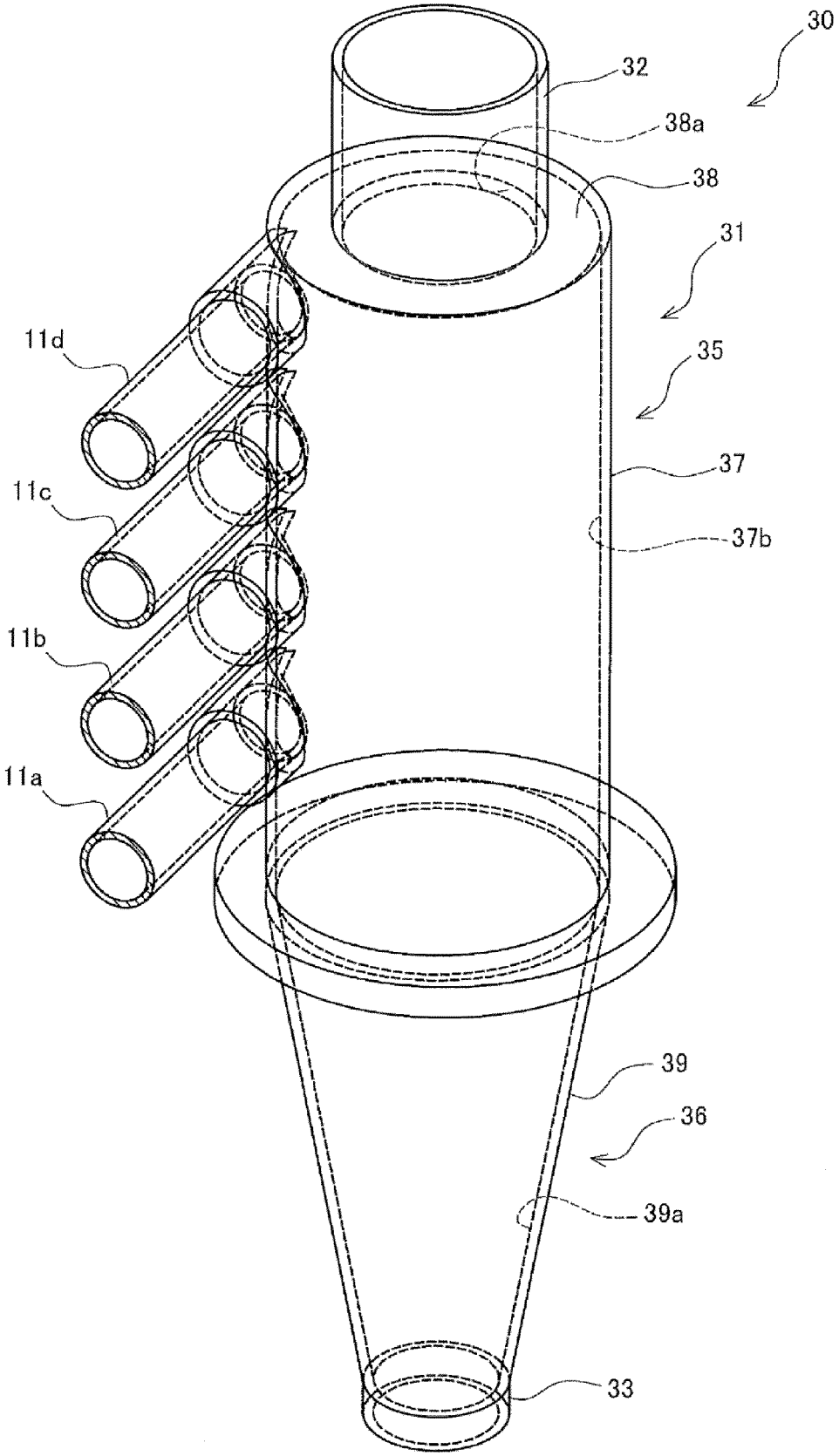


FIG. 16



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Application Number
EP 24 17 6206

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Place of search	Date of completion of the search	Examiner
Munich	25 July 2024	Wendl, Helen

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