

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
07.10.2026 Bulletin 2026/41

(51) International Patent Classification (IPC):
B65H 54/88^(2006.01) **B65H 54/70**^(2006.01)

(21) Application number: **26162353.2**

(52) Cooperative Patent Classification (CPC):
B65H 54/707; B65H 54/702; B65H 2701/31

(22) Date of filing: **04.03.2026**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
 GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
 NO PL PT RO RS SE SI SK SM TR**
 Designated Extension States:
BA
 Designated Validation States:
GE KH LA MA MD TN

(72) Inventors:

- **IMANAKA, Akihito**
Kyoto-shi, Kyoto, 612-8686 (JP)
- **TAKASU, Shiori**
Kyoto-shi, Kyoto, 612-8686 (JP)
- **KITAGAWA, Shigeki**
Kyoto-shi, Kyoto, 612-8686 (JP)

(30) Priority: 31.03.2025 JP 2025058643

(74) Representative: **Hoffmann Eitle**
Patent- und Rechtsanwälte PartmbB
Arabellastraße 30
81925 München (DE)

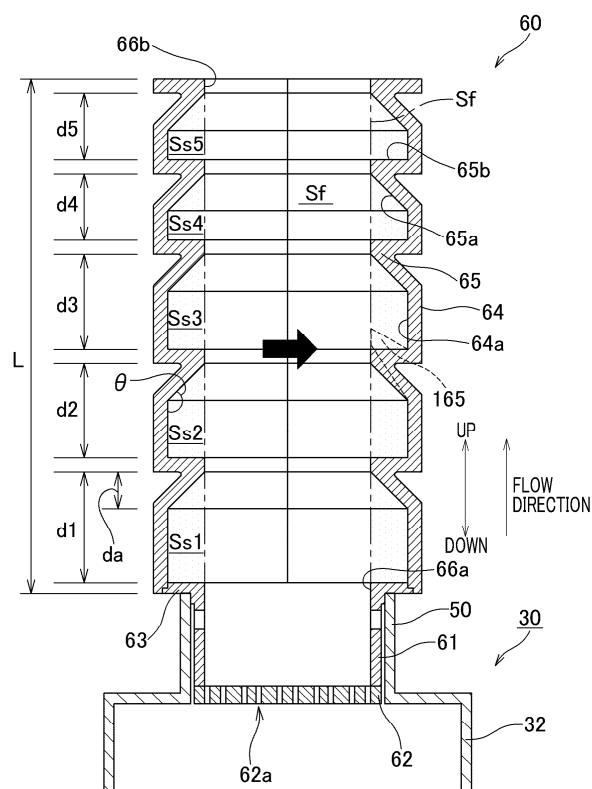
(71) Applicant: **TMT Machinery, Inc.**
Osaka-shi, Osaka 541-0041 (JP)

(54) **FIBER WASTE RECOVERY DEVICE AND FALSE-TWIST TEXTURING MACHINE**

(57) An object of the present invention is to effectively suppress discharge sound of air discharged from a cyclone separator.

A discharge sound suppressor 60 is provided to suppress discharge sound of air discharged from an air discharge unit 50 of a cyclone separator 30 configured to separate fiber waste from air and to discharge (i) the separated fiber waste into a fiber waste recovery container and (ii) the air separated from the fiber waste from the air discharge unit 50. The discharge sound suppressor 60 includes a main body portion 64 which is substantially cylindrical in shape and in which a passage space S_f is formed to extend from one end portion to the other end portion of the main body portion 64 in a flow direction, and one end portion of the main body portion 64 is connected to the air discharge unit 50. In the main body portion 64, stagnation spaces S_s are formed outside of the passage space S_f in a direction orthogonal to the flow direction, aligned in the flow direction, and have at least two stagnation spaces S_s with different capacities.

FIG.5



Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to: a fiber waste recovery device configured to separate and collect fiber waste from air; and a false-twist texturing machine including the fiber waste recovery device.

[0002] A known false-twist texturing machine is configured to false-twist a yarn supplied from a yarn supply package, to wind the yarn by using a winding device, and to form a wound package. Patent Literature 1 (Japanese Laid-Open Patent Publication No. 2024-52577) discloses a fiber waste recovery device which sucks a yarn kept supplied and collects the yarn as fiber waste when yarn threading is performed in a false-twist texturing machine or when package replacement is performed in a winding device. Such a fiber waste recovery device includes: a fiber waste transfer pipe (pipe) in which fiber waste sucked through a suction part flows along with air; a fiber waste collector configured to collect the fiber waste sent through the fiber waste transfer pipe; and a cyclone separator which is provided between the fiber waste transfer pipe and the fiber waste collector and which is configured to separate the fiber waste sent through the fiber waste transfer pipe from the air. The cyclone separator is configured to send the fiber waste separated from the air to the fiber waste collector, and to discharge the air separated from the fiber waste to the outside from an air discharge unit. As such, because the fiber waste separated from the air is sent to the fiber waste collector, the size of the fiber waste collector is decreased as compared to a case where the fiber waste is collected without being separated from the air.

SUMMARY OF THE INVENTION

[0003] The above-described fiber waste recovery device makes discharge sound of air discharged from the cyclone separator. To suppress the deterioration of a working environment, it is required to effectively suppress such discharge sound of air.

[0004] An object of the present invention is to provide a fiber waste recovery device and a false-twist texturing machine which are configured to effectively suppress the discharge sound of air discharged from the cyclone separator while separation capability of the cyclone separator is maintained.

[0005] According to a first aspect of the invention, a fiber waste recovery device includes: a pipe in which fiber waste flows along with air; a fiber waste collector configured to collect the fiber waste sent through the pipe; and a cyclone separator which is provided between the pipe and the fiber waste collector and which is configured to separate the fiber waste from the air sent through the pipe and to discharge the separated fiber waste into the fiber waste collector. The cyclone separator includes an air discharge unit provided with an opening allowing the air

separated from the fiber waste to flow out, a discharge sound suppressor being provided to suppress discharge sound of the air discharged from the air discharge unit. The discharge sound suppressor includes a tubular portion which is a tubular member provided with a passage space extending from one end portion to the other end portion of the tubular portion in a flow direction, and the one end portion of the tubular portion is connected to the air discharge unit. Furthermore, stagnation spaces are formed outside of the passage space in a direction orthogonal to the flow direction of the tubular portion and include a first stagnation space and a second stagnation space which are aligned in the flow direction and which have different capacities.

[0006] The "tubular member" indicates a hollow and long member. Examples of the "tubular member" include a so-called "cylindrical member" which is hollow and which extends along one direction. The "tubular member" may be partially or entirely curved.

[0007] The cross-sectional area of the passage space in the direction orthogonal to the flow direction is equal to the area of an inflow port allowing the air to flow into the tubular portion from the cyclone separator.

[0008] In the present invention, the discharge sound suppressor is configured to allow a part of the air flowing from the air discharge unit of the cyclone separator to stagnate in the tubular portion by means of the stagnation spaces so as to decrease the flow rate of the air flowing in the passage space of the tubular portion. This attenuates an energy of the air so as to suppress the discharge sound of the air discharged from the cyclone separator. As a result of diligent investigation, the present inventor concluded that the capacity of the stagnation spaces has relationship with the frequency of sound to be suppressed. The present invention makes it possible to suppress sounds of different frequencies by means of the first stagnation space and the second stagnation space which have different capacities. It is therefore possible to effectively suppress the discharge sound of air.

[0009] According to a second aspect of the invention, the fiber waste recovery device of the first aspect is arranged such that the tubular portion includes protrusions which protrude from an inner wall surface of the tubular portion, which extend in a direction intersecting with the flow direction, and which are aligned in the flow direction, each of the stagnation spaces is defined by two of the protrusions and a part of the inner wall surface between these two of the protrusions, and these two of the protrusions are adjacent in the flow direction.

[0010] This achieves the stagnation spaces allowing the air to stagnate, with a relatively simple structure.

[0011] According to a third aspect of the invention, the fiber waste recovery device of the second aspect is arranged such that an upstream surface of each of the protrusions extends from the inner wall surface toward a downstream side in the flow direction.

[0012] In the present invention, as detailed below with

reference to figures, the air flowing from the cyclone separator is guided by upstream surfaces of the protrusions in the flow direction so as to easily flow into the stagnation spaces. Therefore, because a larger amount of the air is taken into the stagnation spaces, the discharge sound of air is further effectively suppressed.

[0013] According to a fourth aspect of the invention, the fiber waste recovery device of the second or third aspect is arranged such that, among the protrusions, an interval between two protrusions defining the first stagnation space is different from an interval between two protrusions defining the second stagnation space.

[0014] In the present invention, the first stagnation space and the second stagnation space have different capacities with a relatively simple structure.

[0015] According to a fifth aspect of the invention, the fiber waste recovery device of any one of the second to fourth aspects is arranged such that the first stagnation space is provided at one part of the tubular portion, the second stagnation space is provided at another part of the tubular portion, and the cross-sectional area of the internal space of the tubular portion in the direction orthogonal to the flow direction is different among the one part and another part of the tubular portion.

[0016] In the present invention, the cross-sectional area of the internal space of the tubular portion partially varies so that the first stagnation space and the second stagnation space have different capacities.

[0017] According to a sixth aspect of the invention, the fiber waste recovery device of any one of the second to fifth aspects is arranged such that the each of the protrusions is shaped not to overlap the inner wall surface when viewed in a direction orthogonal to the inner wall surface in the tubular portion.

[0018] In the present invention, as detailed below with reference to the figures, the protrusions are shaped so that the protrusions are formed with a relatively-simple mold when the tubular portion is formed by mold processing.

[0019] According to a seventh aspect of the invention, the fiber waste recovery device of any one of the first to sixth aspects is arranged such that the capacity of the first stagnation space is larger than the capacity of the second stagnation space, and the first stagnation space is provided upstream of the second stagnation space in the flow direction.

[0020] When stagnation spaces with different capacities are provided in the tubular portion, the air easily flows from the cyclone separator into a stagnation space with a large capacity. Therefore, in the flow direction, when a stagnation space with a small capacity is located on the upstream side (the near side) while a stagnation space with a large capacity is located on the downstream side (the far side), the air flows from the cyclone separator into the stagnation space with a large capacity on the far side rather than the stagnation space with a small capacity on the near side. In this case, the stagnation space with a small capacity is not effectively utilized. In the present

invention, because the first stagnation space whose capacity is larger than the capacity of the second stagnation space is located upstream of the second stagnation space in the flow direction, the air flows from the cyclone separator into the first stagnation space on the near side at first and then flows into the second stagnation space on the far side. Because each stagnation space is effectively utilized, the discharge sound of air is further effectively suppressed.

[0021] According to an eighth aspect of the invention, the fiber waste recovery device of the seventh aspect is arranged such that, in the flow direction, each adjacent two of the stagnation spaces are aligned so that the capacity of upstream one of the each adjacent two of the stagnation spaces is equal to or larger than the capacity of downstream one of the each adjacent two of the stagnation spaces.

[0022] In the present invention, the stagnation spaces are aligned in descending order of capacity so that a stagnation space having a larger capacity is provided upstream of a stagnation space having a smaller capacity in the flow direction. The air flows from the air discharge unit into the nearest (upstream) one of the stagnation spaces at first and then flows into far (other) stagnation spaces in order. Therefore, because all the stagnation spaces are effectively utilized, the discharge sound of air is further effectively suppressed.

[0023] According to a ninth aspect of the invention, a false-twist texturing machine includes the fiber waste recovery device according to any one of the first to eighth aspects.

[0024] The present invention makes it possible to effectively suppress the discharge sound of air discharged from the cyclone separator.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

FIG. 1 schematically shows an example of a false-twist texturing machine functioning as a textile machine in which a fiber waste recovery device is provided.

FIG. 2 schematically shows an example of a fiber waste recovery device of an embodiment of the present invention.

FIG. 3 is a perspective view of an example of a cyclone separator.

FIG. 4 is a perspective view of an example of the cyclone separator to which a discharge sound suppressor is attached.

FIG. 5 is a cross section of the discharge sound suppressor and its surroundings on a plane parallel to an up-down direction.

FIGs. 6(a) and 6(b) are provided for explaining a process of forming a part used for a main body of the discharge sound suppressor. FIG. 6(a) is a perspective view of the part, and FIG. 6(b) is a cross section

of the part.

FIG. 7 is provided for explaining a principle of suppression of discharge sound.

FIG. 8 is a table showing conditions of a comparison test between Example 1 and Comparative Examples 1 to 8.

FIG. 9 is a graph showing noise measurement results of discharge sound suppressors of Example 1 and Comparative Examples 1 to 8.

FIG. 10 is a table showing conditions of a comparison test between Examples 1 to 6.

FIG. 11 is a graph showing noise measurement results of discharge sound suppressors of Examples 1 to 6.

FIG. 12 is a cross section of a discharge sound suppressor of a modification on a plane parallel to the up-down direction.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] The following will describe a preferred embodiment of the present invention with reference to figures. Hereinafter, assume that a fiber waste recovery device of the present invention is provided in a false-twist texturing machine. The fiber waste recovery device of the present invention is applicable to a textile machine other than the false-twist texturing machine.

(False-Twist Texturing Machine)

[0027] To begin with, the following will describe the overall structure of a false-twist texturing machine 101 with reference to FIG. 1. For the sake of convenience, an up-down direction on the sheet of FIG. 1 will be used as an up-down direction (a vertical direction in which the gravity acts) of the false-twist texturing machine 101. A left-right direction on the sheet of FIG. 1 will be used as a left-right direction of the false-twist texturing machine 101. A direction perpendicular to the sheet of FIG. 1 will be used as a front-rear direction of the false-twist texturing machine 101. The left-right direction and the front-rear direction are along a horizontal direction. The left-right direction is orthogonal to the front-rear direction.

[0028] For example, the false-twist texturing machine 101 is formed as a textile machine configured to false-twist a thermoplastic synthetic fiber such as polyester or polyamide so as to impart crimp to the fiber, and to produce a processed yarn with high elasticity. The false-twist texturing machine 101 mainly includes: a yarn supplying unit 103 for supplying yarns Y; a processing unit 105 configured to false-twist the yarns Y supplied from the yarn supplying unit 103; and a winding unit 107 configured to wind the yarns Y processed by the processing unit 105 onto winding bobbins Bw.

[0029] The yarn supplying unit 103 includes a yarn supply creel 104 holding yarn supply packages Ps, and is configured to supply the yarns Y to the processing

unit 105. The following components are provided in the processing unit 105 in this order from an upstream side in a yarn running direction in which the yarns Y run: a first feed roller 108; a shifter guide 109; a first heater 110; a cooler 111; a false-twisting device 106; a second feed roller 112; an interlace nozzle 113; a second heater 114; a third feed roller 115; and an oiling roller 116. The winding unit 107 includes winding devices 117. Each winding device 117 is configured to wind a yarn Y processed by the processing unit 105, so as to form a wound package Pw.

[0030] The false-twist texturing machine 101 includes main frame 102 spaced apart from the yarn supply creel 104 in the left-right direction. The main frame 102 extends in the up-down direction. Various devices forming the second heater 114 of the processing unit 105, the winding unit 107, etc. are attached to the main frame 102. The main frame 102 is opposite to the yarn supply creel 104 in the left-right direction. A space between the main frame 102 and the yarn supply creel 104 is a working space So for an operator to perform operation such as yarn threading, etc. for each device.

[0031] The first feed roller 108 is provided above the working space So. The first heater 110 is provided above the working space So and the first feed roller 108. The cooler 111 is provided on the main frame 102 side of the first heater 110 provided above the working space So. The first heater 110 and the cooler 111 are provided above the working space So to extend obliquely upward away from the main frame 102. The shifter guide 109 is provided between the feed roller 108 and the first heater 110 in the up-down direction, and used for introducing the yarns Y into the first heater 110 and the cooler 111 at the time of yarn threading to the false-twist texturing machine 101.

[0032] The false-twisting device 106 and the second feed roller 112 are provided above the main frame 102. The interlace nozzle 113 is provided above the main frame 102 and below the false-twisting device 106 and the second feed roller 112. The second heater 114, the third feed roller 115, and the oiling roller 116 are provided at the main frame 102. Each device forming the winding unit 107 is attached to the main frame 102 on the working space So side. As each device is laid out in this way, yarn paths from the yarn supplying unit 103 to the winding unit 107 are formed to surround the working space So.

[0033] In the winding unit 107, the winding devices 117 are provided to form four stages along the up-down direction. The winding devices 117 are aligned in the front-rear direction on each of the first to fourth stages. A sucking unit 15 which is able to suck and hold a yarn Y supplied from a yarn supply package Ps is provided in the vicinity of each winding device 117.

[0034] In the false-twist texturing machine 101, the yarns Y supplied from the yarn supply packages Ps are sent to a downstream side in the yarn running direction by the first to third feed rollers (108, 112, 115). Each yarn feeding speed is set so that the yarn feeding speed

of the second feed roller 112 is faster than that of the first feed roller 108. The yarns Y are therefore drawn between the first feed roller 108 and the second feed roller 112. Furthermore, each yarn feeding speed is set so that the yarn feeding speed of the third feed roller 115 is slower than that of the second feed roller 112. The yarns Y are therefore relaxed between the second feed roller 112 and the third feed roller 115.

[0035] The yarns Y having been drawn between the first feed roller 108 and the second feed roller 112 are twisted and sent by the false-twisting device 106 which is, e.g., a friction-disc twister. The twist formed by the false-twisting device 106 propagates to the first feed roller 108, and the yarns Y having been twisted and drawn are heated by the first heater 110 and then cooled by the cooler 111 so that the twist is set. The yarns Y having been twisted and thermally set pass through the false-twisting device 106, and are then unwound before reaching the second feed roller 112.

[0036] On the yarns Y having been drawn and false-twisted in this way, interlacing portions are properly formed by the interlace nozzle 113 and thus the yarns Y are bundled. After that, the yarns Y are subjected to relaxation heat treatment by the second heater 114, and wound onto the winding bobbins Bw by the winding devices 117 via the oiling roller 116. When a wound package Pw formed by winding a yarn Y onto a winding bobbin Bw is fully wound, this wound package Pw is detached from a winding device 117 by the operator. A new winding bobbin Bw is then attached to this winding device 117 by the operator, and the yarn Y restarts being wound onto the winding bobbin Bw. When the replacement of the wound package Pw is performed, the yarn Y kept supplied from the yarn supply package Ps is temporarily stored in a sucking unit 15. Because of this, there is no need to cut the yarn Y at the time of replacement of the wound package Pw, and the false-twist texturing machine 101 can continue the operation.

[0037] The fiber waste recovery device of the present embodiment is provided and used in the above-described false-twist texturing machine 101. The following will describe a fiber waste recovery device of the present embodiment.

(Summary of Fiber Waste Recovery Device)

[0038] When the replacement of the wound package Pw is performed in the winding device 117 as described above, or when the yarn threading is performed in the false-twist texturing machine 101, each yarn Y kept supplied from a yarn supply package Ps is stored in a sucking unit 15. A fiber waste recovery device 1 is used for collecting each yarn Y kept supplied from the yarn supply package Ps, as fiber waste from the sucking unit 15. In addition to relatively-short fiber wastes, the "fiber waste" includes: fiber wastes formed of the relatively-short fiber wastes; and relatively-long yarn wastes. The following will describe the schematic structure of the fiber waste

recovery device 1 with reference to FIG. 2.

[0039] As shown in FIG. 2, the fiber waste recovery device 1 mainly includes: pipes 11; a single fiber waste recovery container 13 shared by the pipes 11; cyclone separators 30 provided for the respective pipes 11; and discharge sound suppressors 60 provided for the respective cyclone separators 30. In each pipe 11, a yarn Y (fiber waste) sucked by a sucking unit 15 flows along with air. The fiber waste recovery container 13 is configured to collect fiber waste sent through each pipe 11. Each cyclone separator 30 is provided between a corresponding pipe 11 and the fiber waste recovery container 13. Each cyclone separator 30 is configured to separate fiber waste from air sent through a pipe 11, and to discharge the separated fiber waste to the fiber waste recovery container 13. Each discharge suppressor 60 is provided for suppressing discharge sound when air separated from fiber waste is discharged to the outside from a cyclone separator 30. The fiber waste recovery container 13 is equivalent to a "fiber waste collector" of the present invention.

[0040] Each pipe 11 is, e.g., hollow and cylindrical in shape. The pipes 11 are provided to correspond to the stages formed by the winding devices 117 aligned in the up-down direction of the false-twist texturing machine 101. The fiber waste recovery device 1 of the present embodiment is used in the false-twist texturing machine 101 in which the winding devices 117 forming the four stages are provided, and includes four pipes 11. Each pipe 11 is provided to extend in the front-rear direction. In the front-rear direction, one end portion (a rear end portion shown in FIG. 2) of each pipe 11 is closed while the other end portion (a front end portion shown in FIG. 2) of each pipe 11 is connected to the cyclone separator 30.

[0041] As shown in FIG. 2, branched tubes 16 are branched from each pipe 11. Base end portions of the branched tubes 16 branched from each pipe 11 are aligned in a longitudinal direction (front-rear direction) of the pipe 11. A sucking unit 15 is provided at a leading end portion of each branched tube 16. That is, each pipe 11 is provided with sucking units 15 through the branched tubes 16. The sucking units 15 provided at each pipe 11 are the above-described sucking units 15 provided near the respective winding devices 117 on a stage corresponding to the pipe 11. To the pipe 11, each branched tube 16 is connected while being obliquely inclined. To be more specific, each branched tube 16 is provided so that its leading end portion at which a sucking unit 15 is provided is positioned rearward of its base end portion connected to the pipe 11.

[0042] Each branched tube 16 is able to inject compressed air supplied from a compressed-air supply source (not illustrated) into the branched tube 16. In each branched tube 16, the compressed air is injected toward the pipe 11 side from an intermediate portion of the branched tube 16. The compressed air injected in the branched tube 16 generates an airflow to send fiber waste in the branched tube 16 toward the pipe 11 side.

As a result, an airflow is generated in the pipe 11 to send the fiber waste toward the cyclone separator 30 side (forward in FIG. 2). Such airflows allow each sucking unit 15 to suck a yarn Y and to send the yarn Y to a cyclone separator 30 as fiber waste.

(Cyclone Separator)

[0043] The following will describe the structure of each cyclone separator 30 with reference to FIG. 3. The cyclone separator 30 is configured to separate air which includes fiber waste and which is sent through each pipe 11, into (i) fiber waste and (ii) clean air having been separated from the fiber waste. The fiber waste separated from the air is discharged into the fiber waste recovery container 13 (see FIG. 2). The clean air having been separated from the fiber waste is discharged from an air discharge unit 50. The cyclone separator 30 is not configured to completely separate the air from the fiber waste. The fiber waste having been separated from the air also includes some air. Therefore, not only fiber waste but also not-separated air is discharged into the fiber waste recovery container 13 along with the fiber waste.

[0044] When the cyclone separator 30 is provided, the fiber waste is discharged in a ball form. This suppresses the percentage of fiber waste relative to the capacity of the fiber waste recovery container 13. Furthermore, when (i) the cyclone separator 30 is configured to separate the fiber waste from the air and (ii) the air having been separated from the fiber waste is discharged from the air discharge unit 50, the air sent to the fiber waste recovery container 13 is decreased so as to suppress the percentage of air relative to the capacity of the fiber waste recovery container 13. Because of this, the size of the fiber waste recovery container 13 is decreased as compared to a case where there is no cyclone separator 30.

[0045] As shown in FIG. 3, the cyclone separator 30 mainly includes: a main body portion 32; a tapered portion 42 provided below the main body portion 32; a fiber waste discharge portion 46 configured to discharge fiber waste separated from air into the fiber waste recovery container 13 (see FIG. 2); and the air discharge unit 50 configured to discharge the air having been separated from the fiber waste.

[0046] The main body portion 32 extends along the up-down direction, and is cylindrical in shape. Both ends of the main body portion 32 are open. A pipe 11 is connected to an upper end portion of the main body portion 32. The pipe 11 is connected to the main body portion 32 so that the longitudinal direction of the pipe 11 is along an inner circumferential surface of the main body portion 32. With this arrangement, air which includes fiber waste and which is sent to the main body portion 32 through the pipe 11 flows in a circumferential direction along the inner circumferential surface of the main body portion 32. Therefore, the fiber waste included in the air is sent downward while rotating in the circumferential direction along the inner circumferential surface of the main body

portion 32 because of the centrifugal force, i.e., by means of the centrifugal separation. The air having been separated from the fiber waste flows out through an upper end opening of the main body portion 32.

[0047] The tapered portion 42 extends along the up-down direction, and is circular frustum in shape. Both end portions of the tapered portion 42 are open. In the tapered portion 42, the diameter of an upper end portion is larger than that of a lower end portion. That is, when viewed from the front, the tapered portion 42 tapers from its upper end portion toward the lower end portion. The inner diameter of the upper end portion of the tapered portion 42 has the same length as that of the main body portion 32. The upper end portion of the tapered portion 42 is connected to the lower end portion of the main body portion 32. The inside of the main body portion 32 communicates with that of the tapered portion 42.

[0048] The fiber waste discharge portion 46 is cylindrical in shape. Both ends of the fiber waste discharge portion 46 are open. The fiber waste discharge portion 46 extends downward from the lower end portion of the tapered portion 42. The inner diameter of the fiber waste discharge portion 46 has the same length as that of the lower end portion of the tapered portion 42. The inside of the tapered portion 42 communicates with that of the fiber waste discharge portion 46. The lower end portion of the fiber waste discharge portion 46 is connected to the fiber waste recovery container 13 (see FIG. 2).

[0049] The air discharge unit 50 extends along the up-down direction, and is cylindrical in shape. Both ends of the air discharge unit 50 are open. A lower end portion of the air discharge unit 50 is provided with a flange portion 51. The shape of an outer circumference of the flange portion 51 is circular, and has substantially the same diameter as the main body portion 32. The air discharge unit 50 is connected to the upper end portion of the main body portion 32 at an edge portion of the flange portion 51 so as to be concentric with the main body portion 32. The inside of the main body portion 32 communicates with that of the air discharge unit 50. Air separated from fiber waste by the main body portion 32 is sent to the air discharge unit 50, and flows out through an upper end opening 50a. As described later, the discharge sound suppressor 60 (see FIG. 2) is attached to the air discharge unit 50, and the air sent to the air discharge unit 50 is discharged to the outside via the discharge sound suppressor 60.

[0050] In the cyclone separator 30, air including fiber waste is sent to the main body portion 32 through the pipe 11. In this regard, the fiber waste included in the air is sent downward along the inner circumferential surface of the main body portion 32 because of the centrifugal separation, and this fiber waste is further sent toward the fiber waste discharge portion 46 along an inner circumferential surface of the tapered portion 42. The fiber waste sent toward the fiber waste discharge portion 46 is discharged to the fiber waste recovery container 13 (see FIG. 2) from the fiber waste discharge portion 46. As such, air which

includes fiber waste and which is sent through the pipe 11 is separated from the fiber waste, and the separated fiber waste is collected by the fiber waste recovery container 13. Meanwhile, the air having been separated from the fiber waste is sent to the air discharge unit 50 from the main body portion 32 and discharged to the outside via the later-described discharge sound suppressor 60.

(Discharge Sound Suppressor)

[0051] The following will describe the structure of each discharge sound suppressor 60 with reference to FIG. 5. As shown in FIG. 4 and FIG. 5, the discharge sound suppressor 60 is attached to an air discharge unit 50 of a cyclone separator 30. The discharge sound suppressor 60 is configured to prevent fiber waste from being discharged to the outside from the cyclone separator 30, and to suppress discharge sound of air discharged from the cyclone separator 30. The discharge sound suppressor 60 mainly includes an attaching portion 61 and a main body portion 64.

[0052] The attaching portion 61 extends along the up-down direction, and is cylindrical in shape. The outer diameter of the attaching portion 61 is slightly smaller than the inner diameter of the air discharge unit 50. The attaching portion 61 is fitted into the air discharge unit 50. The attaching portion 61 may be engaged with an outer surface of the air discharge unit 50. When the attaching portion 61 is fitted into the air discharge unit 50, a gap between the attaching portion 61 and the air discharge unit 50 is preferably as small as possible. In the up-down direction, the length of the attaching portion 61 is substantially the same as that of the air discharge unit 50. As shown in FIG. 5, when the attaching portion 61 is fitted into the air discharge unit 50, an upper end portion of the attaching portion 61 is positioned at an upper end portion of the air discharge unit 50. Furthermore, a lower end portion of the attaching portion 61 is positioned at a lower end portion of the air discharge unit 50. Air flowing toward the air discharge unit 50 from the main body portion 32 of the cyclone separator 30 flows into the attaching portion 61 of the discharge sound suppressor 60 provided inside the air discharge unit 50.

[0053] As shown in FIG. 5, a shielding cover 62 is attached to the lower end portion of the attaching portion 61. The shielding cover 62 is provided for suppressing fiber waste having missed a downward flow along the inner circumferential surface of the main body portion 32 of the cyclone separator 30, from being discharged to the outside via the air discharge unit 50. The shielding cover 62 is configured to partially block a passage from the air discharge unit 50 to the outside. The shielding cover 62 is provided with holes 62a penetrating the cover in the up-down direction. The shielding cover 62 is configured to block the discharge of fiber waste to the outside while allowing the discharge of air to the outside from the air discharge unit 50. The flange portion 63 is provided at the upper end portion of the attaching portion 61. The shape

of an outer circumference of the flange portion 63 is circular. The diameter of the outer circumference of the flange portion 63 is larger than that of the air discharge unit 50.

[0054] The main body portion 64 extends along the up-down direction, and is substantially cylindrical in shape. The length of the main body portion 64 along the up-down direction will be referred to as the entire length L. The main body portion 64 is equivalent to a "tubular portion" of the present invention. The main body portion 64 has substantially the same diameter as the flange portion 63. The lower end portion of the main body portion 64 is connected to the edge portion of the flange portion 63 so as to be concentric with the attaching portion 61. The inside of the attaching portion 61 communicates with that of the main body portion 64. The internal space of the main body portion 64 is connected to that of the air discharge unit 50 at the lower end portion of the main body portion 64. With this arrangement, air flows from the cyclone separator 30 into the main body portion 64 via the attaching portion 61 (air discharge unit 50) and then flows from the lower end portion to upper end portion of the main body portion 64. That is, a flow direction of air in the main body portion 64 (hereinafter, this will be simply referred to as the "flow direction") is an upward direction. An upper end of the attaching portion 61 is an inflow port 66a allowing air to enter the main body portion 64 from the cyclone separator 30. An upper end of the main body portion 64 is an outflow port 66b allowing air to flow out of the main body portion 64 to the outside.

[0055] In the main body portion 64, a passage space Sf (indicated by dashed lines in FIG. 5) is formed to extend in the flow direction. The passage space Sf extends from the inflow port 66a to the outflow port 66b. The cross-sectional area of the passage space Sf in a direction orthogonal to the flow direction is equal to the area of the inflow port 66a. When viewed from above, the passage space Sf entirely overlaps the inflow port 66a. In the main body portion 64, stagnation spaces Ss (Ss1, Ss2, Ss3, Ss4, and Ss5 in FIG. 5) are formed so that a part of air flowing into the main body portion 64 from the cyclone separator 30 stagnates. The stagnation spaces Ss will be detailed later.

[0056] As shown in FIG. 5, the main body portion 64 includes protrusions 65 protruding from an inner wall surface 64a of the main body portion 64. Each protrusion 65 is formed by partially denting a side wall of the main body portion 64 inward. Each protrusion 65 extends along the circumferential direction of the main body portion 64. That is, each protrusion 65 extends in a direction intersecting with the flow direction. Each protrusion 65 extends over the entire circumference of the main body portion 64, and is annular in shape. Each protrusion 65 may not extend over the entire circumference of the main body portion 64, but may be partitioned into plural parts in the circumferential direction of the main body portion 64. The protrusions 65 are aligned in the flow direction. In the present embodiment, five protrusions 65 are aligned in

the flow direction.

[0057] Each protrusion 65 is provided outside the passage space Sf in a direction orthogonal to the flow direction. In the present embodiment, apexes of the protrusions 65 aligned in the flow direction are provided on a straight line (line indicated by a dashed line in FIG. 6) which extends along the flow direction and which passes through an edge of the inflow port 66a. That is, when viewed from above, the apexes of the protrusions 65 overlap the edge of the inflow port 66a. The apexes of the protrusions 65 may be spaced apart from the edge of the inflow port 66a when viewed from above.

[0058] A space is defined by each two protrusions 65 adjacent in the flow direction and a part of the inner wall surface 64a between these two protrusions 65. This space functions as a stagnation space Ss. Another space is defined by the most upstream (lowermost) one of the protrusions 65 in the flow direction, the flange portion 63, and a part of the inner wall surface 64a between this protrusion 65 and the flange portion 63. This space also functions as a stagnation space Ss. That is, the flange portion 63 functions as a "protrusion" of the present invention. In the present embodiment, five stagnation spaces Ss are aligned in the flow direction. Each stagnation space Ss is provided outside the passage space Sf in a direction orthogonal to the flow direction. Hereinafter, these five stagnation spaces Ss will be referred to as a stagnation space Ss1, a stagnation space Ss2, a stagnation space Ss3, a stagnation space Ss4, and a stagnation space Ss5 in this order from the upstream side in the flow direction. In FIG. 5, the stagnation spaces Ss are indicated with polka-dot hatching.

[0059] The stagnation spaces Ss include at least two stagnation spaces Ss with different capacities. At least two stagnation spaces Ss with different capacities are equivalent to a "first stagnation space" and a "second stagnation space" in the present invention. In the flow direction of the stagnation spaces Ss of the present embodiment, each two adjacent stagnation spaces Ss are aligned so that the capacity of the upstream stagnation space Ss is equal to or larger than that of the downstream stagnation space Ss. In the example of a pair of the stagnation spaces Ss2 and Ss3 adjacent in the flow direction, the capacity of the upstream stagnation space Ss2 is equal to or larger than that of the downstream stagnation space Ss3 in the flow direction. That is, the stagnation spaces Ss are aligned in descending order of capacity so that a stagnation space Ss having a larger capacity is provided upstream of a stagnation space Ss having a smaller capacity in the flow direction.

[0060] Assume that an interval between the flange portion 63 and a protrusion 65 which define the stagnation space Ss1 is d1, an interval between two protrusions 65 defining the stagnation space Ss2 is d2, an interval between two protrusions 65 defining the stagnation space Ss3 is d3, an interval between two protrusions 65 defining the stagnation space Ss4 is d4, and an interval between two protrusions 65 defining the stagnation

space Ss5 is d5. In this regard, the relationship between these intervals is $d1 \geq d2 \geq d3 \geq d4 \geq d5$. At least two of the intervals d1, d2, d3, d4, and d5 are different from each other. The inner diameter of the main body portion 64 is constant, except its parts provided with the protrusions 65. In other words, the cross-sectional area of the internal space of the main body portion 64 in a direction orthogonal to the flow direction is constant except its parts with the protrusions 65. That is, in the present embodiment, an interval between two protrusions 65 defining each stagnation space Ss (an interval between the flange portion 63 and a protrusion 65 in regard to the stagnation space Ss1) is adjusted so that at least two of the stagnation spaces Ss have different capacities.

[0061] An upstream surface of each protrusion 65 in the flow direction is a lower surface 65a, and extends from the inner wall surface 64a toward the downstream side in the flow direction. That is, in the lower surface 65a, a leading end portion on the leading end side of the protrusion 65 is provided downstream of a base end portion connected to the inner wall surface 64a in the flow direction. Meanwhile, a downstream surface of each protrusion 65 in the flow direction is an upper surface 65b and extends in a direction orthogonal to the flow direction (up-down direction). That is, the upper surface 65b is orthogonal to the inner wall surface 64a.

[0062] As shown in FIG. 5, the length between the upstream end and downstream end of the lower surface 65a of each protrusion 65 in the flow direction will be referred to as the length da. The length da is equal among the protrusions 65. An angle between the lower surface 65a of each protrusion 65 and the inner wall surface 64a will be referred to as the angle θ . The angle θ is equal among the lower surfaces 65a of the protrusions 65.

[0063] The discharge sound suppressor 60 is made of, e.g., resin. The discharge sound suppressor 60 is formed by injection molding. The main body portion 64 is formed as plural parts divided in the circumferential direction, by the injection molding. For example, two parts 64p which are substantially semi-cylindrical in shape as shown in FIG. 6(a) and FIG. 6(b) are formed by the injection molding and joined so as to form the main body portion 64. In the injection molding, each part 64p is demolded in a direction (demolding direction) perpendicular to a virtual plane P which is parallel to an adhesion surface with a corresponding part 64p. That is, the demolding direction is orthogonal to the flow direction of the main body portion 64 of the discharge sound suppressor 60 which is a finished product. FIG. 6(a) and FIG. 6(b) indicate the demolding direction by arrows.

[0064] The shape of each protrusion 65 is able to demold a part 64p. That is, as shown in FIG. 5, when viewed in a direction (indicated by an arrow in FIG. 5) orthogonal to the inner wall surface 64a in the main body portion 64, each protrusion 65 is shaped not to overlap both parts of the inner wall surface 64a immediately on both sides of this protrusion 65 in the flow direction. For

example, when viewed in a direction orthogonal to the inner wall surface 64a in the main body portion 64, a protrusion 165 indicated by dotted lines in FIG. 5 overlaps an downstream part of the inner wall surface 64a immediately on the downstream side of this protrusion 165 in the flow direction. The shape of the protrusion 165 makes it impossible to demold each part 64p in the direction indicated by arrows in FIG. 6(a) and FIG. 6(b).

[0065] The following will describe a principle of suppression of discharge sound in each discharge sound suppressor 60 with reference to FIG. 7. Most of air flowing into the main body portion 64 of the discharge sound suppressor 60 from a cyclone separator 30 flows along the flow direction in the passage space Sf as indicated by a bold arrow in FIG. 7. A part of the air flowing into the main body portion 64 flows into the stagnation spaces Ss as indicated by small arrows in FIG. 7.

[0066] The air flowing into the main body portion 64 tends to flow into a stagnation space Ss with a large capacity. In the present embodiment, the stagnation spaces Ss are aligned in descending order of capacity so that a stagnation space Ss having a larger capacity is provided upstream of a stagnation space Ss having a smaller capacity in the flow direction. With this arrangement, a part of the air flowing into the main body portion 64 flows into the nearest (most upstream) one of the stagnation spaces Ss at first and then flows into far (other) stagnation spaces Ss in order.

[0067] When a part of the air flowing toward the stagnation spaces Ss hits a lower surface 65a of one protrusion 65, this part of the air is guided downward in the flow direction along the lower surface 65a so as to flow into a stagnation space Ss provided immediately above this protrusion 65.

[0068] The stagnation spaces Ss allow a part of the air flowing into the main body portion 64 of the discharge sound suppressor 60 from the air discharge unit 50 of the cyclone separator 30, to stagnate in the main body portion 64. As such, the flow rate of air flowing along the flow direction in the passage space Sf is decreased by disturbing the flow of the air. That is, this attenuates an energy of the air flowing in the main body portion 64. As such, when discharge sound is generated as air is discharged from the cyclone separator 30 through the outflow port 66b of the main body portion 64, the discharge sound is suppressed.

(Comparison Test 1)

[0069] The present inventor performed a comparison test between a case (Example 1) with a discharge sound suppressor including stagnation spaces Ss at least two of which have different capacities as in the present embodiment and cases (Comparative Examples 1 to 8) with a discharge sound suppressor including stagnation spaces Ss which all have the same capacity. In each of the discharge sound suppressors of Example 1 and Comparative Examples 1 to 8, the inner diameter of a

main body portion in which the stagnation spaces Ss are formed is constant. That is, in Example 1, an interval between two protrusions defining each stagnation space Ss is adjusted so that at least two stagnation spaces Ss have different capacities. The inner diameter of the main body portion of the discharge sound suppressor is equal among Example 1 and Comparative Examples 1 to 8.

[0070] A table of FIG. 8 shows conditions of the above-described comparison test. Intervals each of which is provided between two protrusions defining each stagnation space Ss will be referred to as d1, d2, ..., dn (see FIG. 5) in order from the interval corresponding to the most upstream one of the stagnation spaces Ss in the flow direction. In this regard, the "n" indicates the number of the stagnation spaces Ss formed in each discharge sound suppressor. That is, in Example 1, there are five stagnation spaces Ss. Furthermore, d1 is 30 mm, d2 is 26 mm, d3 is 26 mm, d4 is 18 mm, and d5 is 18 mm. In Comparative Example 1, there are four stagnation spaces Ss, and each of d1 to d4 is 30 mm. In Comparative Example 2, there are five stagnation spaces Ss, and each of d1 to d5 is 26 mm. In Comparative Example 3, there are four stagnation spaces Ss, and each of d1 to d4 is 26 mm. In Comparative Example 4, there are six stagnation spaces Ss, and each of d1 to d6 is 22 mm. In Comparative Example 5, there are five stagnation spaces Ss, and each of d1 to d5 is 22 mm. In Comparative Example 6, there are seven stagnation spaces Ss, and each of d1 to d7 is 18 mm. In Comparative Example 7, there are six stagnation spaces Ss, and each of d1 to d6 is 18 mm. In Comparative Example 8, there are eight stagnation spaces Ss, and each of d1 to d8 is 14 mm. The entire length L (see FIG. 5) of the main body portion in which each stagnation space Ss is formed is 141 mm in Example 1, 139 mm in Comparative Example 1, 153 mm in Comparative Example 2, 123 mm in Comparative Example 3, 159 mm in Comparative Example 4, 133 mm in Comparative Example 5, 157 mm in Comparative Example 6, 135 mm in Comparative Example 7, and 147 in Comparative Example 8.

[0071] FIG. 9 shows noise measurement results of Example 1 and Comparative Examples 1 to 8 when each discharge sound suppressor is used in the operation of a fiber waste recovery device. As shown in FIG. 9, the noise measurement results were 73 db in Example 1, 73.5 db in Comparative Example 1, 73.5 db in Comparative Example 2, 73.3 db in Comparative Example 3, 73.4 db in Comparative Example 4, 73.6 db in Comparative Example 5, 73.4 db in Comparative Example 6, 73.6 db in Comparative Example 7, and 73.4 db in Comparative Example 8. That is, the measurement result of Example 1 in which the stagnation spaces Ss include stagnation spaces Ss with different capacities is lower than the measurement results of Comparative Examples 1 to 8 in which the stagnation spaces Ss have all the same capacity by 0.3 to 1.6 db.

(Comparison Test 2)

[0072] A comparison test was also performed for discharge sound suppressors (Examples 1 to 6) including stagnation spaces Ss with three types of capacities, i.e., large, medium, and small capacities. The order of alignment of stagnation spaces Ss of three types is different among the discharge sound suppressors of Examples 1 to 6. In each Example, there are one stagnation space Ss with the "large" capacity, two stagnation spaces Ss with the "medium" capacity, and two stagnation spaces Ss with the "small" capacity. There are five stagnation spaces Ss in total. In each of the discharge sound suppressors of Examples 1 to 6, the inner diameter of a main body portion in which the stagnation spaces Ss are formed is constant. That is, an interval between two protrusions defining each stagnation space Ss is adjusted so that the stagnation spaces Ss of three types have different capacities. The inner diameter of the main body portion of the discharge sound suppressor is equal among Examples 1 to 6.

[0073] A table of FIG. 10 shows conditions of the above-described comparison test. Example 1 is described above. In Example 2, d1 and d2 are 26 mm, d3 is 30 mm, and d4 and d5 are 18 mm. In Example 3, d1 is 30 mm, d2 and d3 are 18 mm, and d4 and d5 are 26 mm. In Example 4, d1 and d2 are 26 mm, d3 and d4 are 18 mm, and d5 is 30 mm. In Example 5, d1 and d2 are 18 mm, d3 is 30 mm, and d4 and d5 are 26 mm. In Example 6, d1 and d2 are 18 mm, d3 and d4 are 26 mm, and d5 is 50 mm. In Examples 1 to 6, the entire length L (see FIG. 5) of the main body portion in which the stagnation spaces Ss are formed is 141 mm.

[0074] FIG. 11 shows noise measurement results of Examples 1 to 6 when each discharge sound suppressor is used in the operation of a fiber waste recovery device. As shown in FIG. 11, the noise measurement results were 73 db in Example 1, 73.1 db in Example 2, 73.3 db in Example 3, 73.4 db in Example 4, 73.4 db in Example 5, and 73.4 db in Example 6. In Example 1, the stagnation spaces Ss are aligned in descending order of capacity so that a stagnation space Ss having a larger capacity is provided upstream of a stagnation space Ss having a smaller capacity in the flow direction. The noise measurement result of this Example 1 is the lowest.

(Characteristics of Embodiment)

[0075] As described above, the fiber waste recovery device 1 of the present embodiment includes: the pipes 11 in which fiber waste flows along with air; the fiber waste recovery container 13 configured to collect the fiber waste sent through the pipes 11; and each cyclone separator 30 which is provided between a pipe 11 and the fiber waste recovery container 13 and which is configured to separate the fiber waste from the air sent through the pipe 11 and to discharge the separated fiber waste into the fiber waste recovery container 13. Each

cyclone separator 30 includes an air discharge unit 50 in which an opening 50a allowing the air separated from the fiber waste to flow out is formed. The fiber waste recovery device 1 further includes each discharge sound suppressor 60 configured to suppress discharge sound of air discharged from the air discharge unit 50. Each discharge sound suppressor 60 includes a main body portion 64 which is substantially cylindrical in shape and in which a passage space Sf is formed to extend from one end portion (lower end portion) to the other end portion (upper end portion) of the main body portion 64 in the flow direction. In this regard, the one end portion of the main body portion 64 is connected to the air discharge unit 50. In the main body portion 64, stagnation spaces Ss are formed outside of the passage space Sf in a direction orthogonal to the flow direction. These stagnation spaces Ss are aligned in the flow direction, and include at least two stagnation spaces Ss with different capacities.

[0076] With the above-described arrangement, the discharge sound suppressor 60 is configured to allow a part of air flowing from the air discharge unit 50 of the cyclone separator 30 to stagnate in the main body portion 64 by means of the stagnation spaces Ss so as to decrease the flow rate of the air flowing in the passage space Sf of the main body portion 64. This attenuates an energy of the air so as to suppress the discharge sound of the air discharged from the cyclone separator 30. Furthermore, the stagnation spaces Ss with different capacities suppress sounds of different frequencies. It is therefore possible to effectively suppress the discharge sound of air. Because the stagnation spaces Ss are provided outside of the passage space Sf, the passage of air from the air discharge unit 50 of the cyclone separator 30 is secured. It is therefore possible to maintain the separation capability of the cyclone separator 30 without preventing the discharge of air from the air discharge unit 50 of the cyclone separator 30.

[0077] In the fiber waste recovery device 1 of the present embodiment, the main body portion 64 includes the protrusions 65 and the flange portion 63 which protrude from the inner wall surface 64a of the main body portion 64, which extend in a direction intersecting with the flow direction, and which are aligned in the flow direction. Each stagnation space Ss is defined by two protrusions 65 (or a protrusion 65 and the flange portion 63) adjacent in the flow direction and a part of the inner wall surface 64a between these two protrusions 65 (or between a protrusion 65 and the flange portion 63). This achieves the stagnation spaces Ss allowing air to stagnate, with a relatively simple structure.

[0078] In the fiber waste recovery device 1 of the present embodiment, the lower surface 65a which is an upstream surface of each protrusion 65 in the flow direction extends from the inner wall surface 64a toward the downstream side in the flow direction. With this arrangement, air flowing from the cyclone separator 30 is easily guided by the lower surface 65a of the protrusion 65 so as to flow into each stagnation space Ss. Therefore, be-

cause a larger amount of air is taken into each stagnation space Ss, the discharge sound of air is further effectively suppressed.

[0079] In the fiber waste recovery device 1 of the present embodiment, the stagnation spaces Ss include at least two stagnation spaces Ss between which an interval of two protrusions 65 (or a protrusion 65 and the flange portion 63) defining each stagnation space Ss is different. As such, an interval of two protrusions 65 (or a protrusion 65 and the flange portion 63) defining each stagnation space Ss varies so that at least two stagnation spaces Ss have different capacities with a relatively simple structure.

[0080] In the fiber waste recovery device 1 of the present embodiment, each protrusion 65 is shaped not to overlap the inner wall surface 64a when viewed in a direction orthogonal to the inner wall surface 64a in the main body portion 64. With this arrangement, each protrusion 65 is shaped so that the protrusion 65 is formed with a relatively simple mold when the main body portion 64 is formed by mold processing.

[0081] In the flow direction of the stagnation spaces Ss of the fiber waste recovery device 1 of the present embodiment, each two adjacent stagnation spaces Ss are aligned so that the capacity of the upstream stagnation space Ss is equal to or larger than that of the downstream stagnation space Ss. When stagnation spaces Ss with different capacities are provided in the main body portion 64, air easily flows from the cyclone separator 30 into a stagnation space Ss with a large capacity. Therefore, in the flow direction, when a stagnation space Ss with a small capacity is located on the upstream side (the near side) while a stagnation space Ss with a large capacity is located on the downstream side (the far side), air flows from the cyclone separator 30 into the stagnation space Ss with a large capacity on the far side rather than the stagnation space Ss with a small capacity on the near side. In this case, the stagnation space Ss with a small capacity is not effectively utilized. In the present embodiment, the stagnation spaces Ss are aligned in descending order of capacity so that a stagnation space Ss having a larger capacity is provided upstream of a stagnation space Ss having a smaller capacity in the flow direction. With this arrangement, the air flows from the cyclone separator 30 into the nearest (upstream) one of the stagnation spaces Ss at first and then flows into far (other) stagnation spaces Ss in order. Because each stagnation space Ss is effectively utilized, the discharge sound of air is further effectively suppressed.

[0082] The embodiment of the present invention is described hereinabove. However, the specific structure of the present invention shall not be interpreted as to be limited to the above described embodiment. The scope of the present invention is defined not by the above embodiment but by claims set forth below, and shall encompass the equivalents in the meaning of the claims and every modification within the scope of the claims.

[0083] In the embodiment above, each main body

portion 64 extends along one direction (up-down direction) and is cylindrical in shape. However, the disclosure is not limited to this. The cross sectional shape of the main body portion 64 may be polygonal. When the main body portion 64 is cylindrical in shape, each discharge sound suppressor 60 may be provided so that the main body portion 64 extends in a direction other than the up-down direction. The main body portion 64 may be differently arranged as long as it is a hollow, long, and tubular member. That is, the main body portion 64 may be partially or entirely curved. For example, the main body portion 64 may be flexible so that it can be curved and located according to the alignment of devices and facilities.

[0084] In the embodiment above, the passage space Sf is formed in the main body portion 64 so as to extend along the up-down direction. However, the disclosure is not limited to this. When the main body portion 64 is curved, the passage space Sf is also accordingly curved.

[0085] In the embodiment above, each protrusion 65 extends along the circumferential direction of the main body portion 64. However, the disclosure is not limited to this. The protrusion 65 may obliquely extend relative to the circumferential direction.

[0086] In the embodiment above, the protrusion 65 is formed by partially denting the side wall of the main body portion 64. However, the disclosure is not limited to this. For example, the protrusion 65 may be formed by thickening a part of the side wall of the main body portion 64.

[0087] In the embodiment above, the lower surface 65a of the protrusion 65 extends from the inner wall surface 64a toward the downstream side in the flow direction. However, the disclosure is not limited to this. The lower surface 65a may extend from the inner wall surface 64a toward the upstream side in the flow direction, or may extend in a direction orthogonal to the inner wall surface 64a.

[0088] In the embodiment above, the upper surface 65b of the protrusion 65 extends in a direction orthogonal to the inner wall surface 64a. However, the disclosure is not limited to this. The upper surface 65a may extend from the inner wall surface 64a toward the downstream side or the upstream side in the flow direction.

[0089] In the embodiment above, an interval of two protrusions 65 (or a protrusion 65 and the flange portion 63) defining each stagnation space Ss varies so that at least two stagnation spaces Ss have different capacities. However, the disclosure is not limited to this. That is, in a discharge sound suppressor 260 of a modification of FIG. 12, d11, d12, d13, d14, and d15 are equal intervals each of which is formed between two protrusions 265 (or a protrusion 265 and a flange portion 263) defining each stagnation space Ss11, Ss12, Ss13, Ss14, Ss15.

[0090] The inner diameter of a main body portion 264 of the discharge sound suppressor 260 is not constant. In the inner diameter of the main body portion 264, assume that the inner diameter of a part with the stagnation space Ss11 is D1, that of a part with the stagnation space Ss12 is

D2, that of a part with the stagnation space Ss13 is D3, that of a part with the stagnation space Ss14 is D4, and that of a part with the stagnation space Ss15 is D5. In this regard, the relationship between these inner diameters is $D1 \geq D2 \geq D3 \geq D4 \geq D5$. At least two of D1, D2, D3, D4, and D5 are different from each other. That is, the stagnation spaces Ss are provided at parts of the main body portion 264, and the cross-sectional area of the internal space of the main body portion 264 in a direction orthogonal to the flow direction is different among at least two of these parts of the main body portion 264.

[0091] The outer diameter of the main body portion 264 of this modification is constant. That is, at least two parts of the main body portion 264 have different inner diameters, and the thickness of a side wall of the main body portion 264 is different among at least two parts of the main body portion 264. That is, the thickness of the side wall of the main body portion 264 is larger at its part with a small inner diameter than at its part with a large inner diameter. The thickness of the side wall of the main body portion 264 may be constant. In this case, at least two parts of the main body portion 264 have different inner diameters, and the outer diameter of the main body portion 264 is different among at least two parts of the main body portion 264.

[0092] As such, in this modification, the cross-sectional area of the internal space of the main body portion 264 of the discharge sound suppressor 260 in a direction orthogonal to the flow direction is adjusted so that at least two of the stagnation spaces Ss have different capacities. Alternatively, at least two of the stagnation spaces Ss may have different capacities by adjusting both (i) an interval between two protrusions 265 (or a protrusion 265 and the flange portion 263) defining each stagnation space Ss and (ii) the cross-sectional area of the internal space of the main body portion 264 in a direction orthogonal to the flow direction.

[0093] In the embodiment above, each protrusion 65 is shaped not to overlap the inner wall surface 64a when viewed in a direction orthogonal to the inner wall surface 64a in the main body portion 64. However, the disclosure is not limited to this. That is, each protrusion 65 may be shaped to overlap the inner wall surface 64a when viewed in the direction orthogonal to the inner wall surface 64a in the main body portion 64.

[0094] In the embodiment above, the discharge sound suppressor 60 is made of resin and formed by the injection molding. However, the material and manufacturing method of the discharge sound suppressor 60 are not limited to those. For example, the discharge sound suppressor 60 may be made of metal. The discharge sound suppressor 60 may be formed of plural parts made of different materials.

[0095] In the embodiment above, the stagnation spaces Ss are aligned in descending order of capacity so that a stagnation space Ss having a larger capacity is provided upstream of a stagnation space Ss having a smaller capacity in the flow direction. However, the dis-

closure is not limited to this. In this regard, the discharge sound suppressor 60 may be differently arranged as long as it is provided with two stagnation spaces Ss which are aligned in the flow direction and which have different capacities. These two stagnation spaces Ss are preferably aligned so that one stagnation space Ss with a larger capacity is provided upstream of the other stagnation space Ss with a smaller capacity in the flow direction. However, the alignment of these two stagnation spaces Ss is not particularly limited.

[0096] In the embodiment above, the shielding cover 62 is attached to the lower end portion of the attaching portion 61 of the discharge sound suppressor 60. However, the disclosure is not limited to this. In this regard, the shielding cover 62 may be differently arranged as long as it is provided on a passage from the air discharge unit 50 of the cyclone separator 30 to the outside. That is, for example, the shielding cover 62 may be attached to the upper end portion of the attaching portion 61. Alternatively, the shielding cover 62 may be attached to the air discharge unit 50 of the cyclone separator 30.

Claims

1. A fiber waste recovery device (1) comprising: a pipe (11) in which fiber waste flows along with air;

a fiber waste collector (13) configured to collect the fiber waste sent through the pipe (11); and a cyclone separator (30) which is provided between the pipe (11) and the fiber waste collector (13) and which is configured to separate the fiber waste from the air sent through the pipe (11) and to discharge the separated fiber waste into the fiber waste collector (13),

the cyclone separator (30) including an air discharge unit (50) provided with an opening (50a) allowing the air separated from the fiber waste to flow out,

a discharge sound suppressor (60, 260) being provided to suppress discharge sound of the air discharged from the air discharge unit (50),

the discharge sound suppressor (60, 260) including a tubular portion (64, 264) which is a tubular member provided with a passage space (Sf) extending from one end portion to the other end portion of the tubular portion (64, 264) in a flow direction, the one end portion of the tubular portion (64, 264) being connected to the air discharge unit (50),

stagnation spaces (Ss) being formed outside of the passage space (Sf) in a direction orthogonal to the flow direction of the tubular portion (64, 264), and

the stagnation spaces (Ss) including a first stagnation space and a second stagnation space which are aligned in the flow direction and which

have different capacities.

2. The fiber waste recovery device (1) according to claim 1, wherein, the tubular portion (64, 264) includes protrusions (65, 265) which protrude from an inner wall surface (64a) of the tubular portion (64, 264), which extend in a direction intersecting with the flow direction, and which are aligned in the flow direction, each of the stagnation spaces (Ss) is defined by two of the protrusions (65, 265) and a part of the inner wall surface (64a) between these two of the protrusions (65, 265), and these two of the protrusions (65, 265) are adjacent in the flow direction. 5 10 15
3. The fiber waste recovery device (1) according to claim 2, wherein, an upstream surface of each of the protrusions (65) extends from the inner wall surface (64a) toward a downstream side in the flow direction. 20
4. The fiber waste recovery device (1) according to claim 2 or 3, wherein, among the protrusions (65), an interval between two protrusions (65) defining the first stagnation space is different from an interval between two protrusions (65) defining the second stagnation space. 25
5. The fiber waste recovery device (1) according to any one of claims 2 to 4, wherein, the first stagnation space is provided at one part of the tubular portion (264), the second stagnation space is provided at another part of the tubular portion (264), and the cross-sectional area of the internal space of the tubular portion (264) in the direction orthogonal to the flow direction is different among the one part and another part of the tubular portion (264). 30 35
6. The fiber waste recovery device (1) according to any one of claims 2 to 5, wherein, the each of the protrusions (65, 265) is shaped not to overlap the inner wall surface (64a) when viewed in a direction orthogonal to the inner wall surface (64a) in the tubular portion (64, 264). 40 45
7. The fiber waste recovery device (1) according to any one of claims 1 to 6, wherein, the capacity of the first stagnation space is larger than the capacity of the second stagnation space, and the first stagnation space is provided upstream of the second stagnation space in the flow direction. 50
8. The fiber waste recovery device (1) according to claim 7, wherein, in the flow direction, each adjacent two of the stagnation spaces (Ss) are aligned so that the capacity of upstream one of the each adjacent two of the stagnation spaces (Ss) is equal to or larger than the capacity of downstream one of the each 55

adjacent two of the stagnation spaces (Ss).

9. A false-twist texturing machine (101) comprising the fiber waste recovery device (1) according to any one of claims 1 to 8.

FIG.1

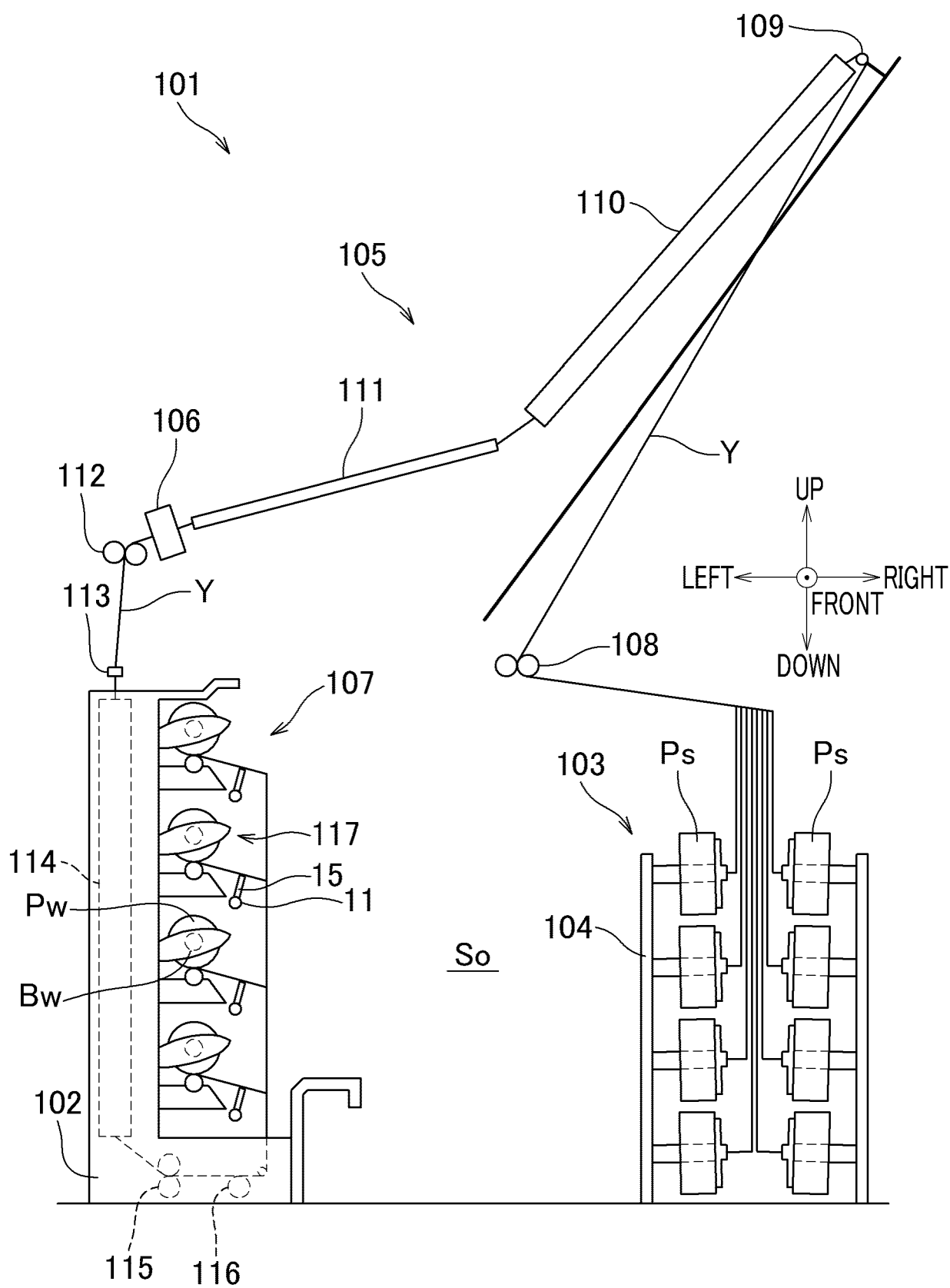


FIG.2

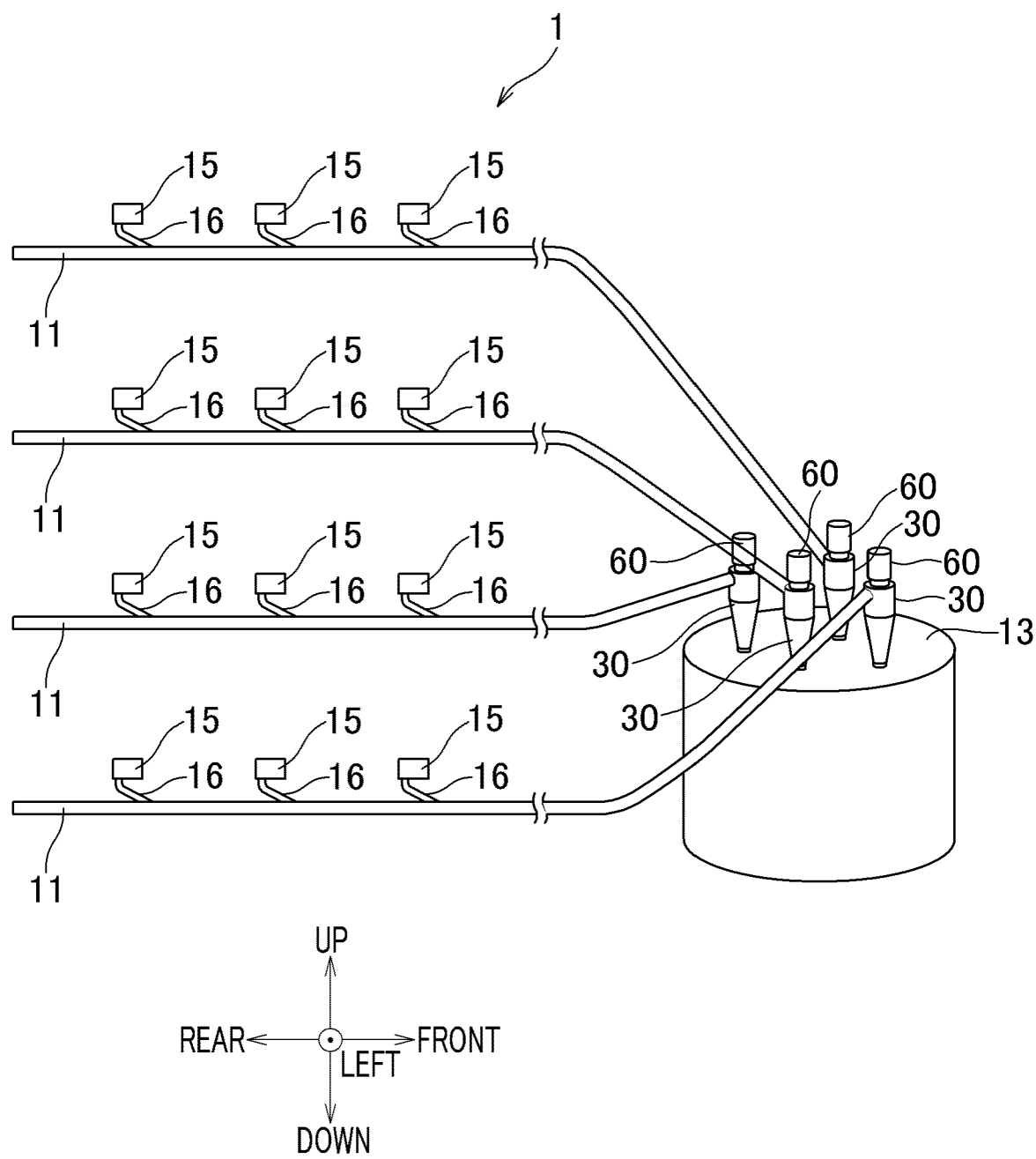


FIG.3

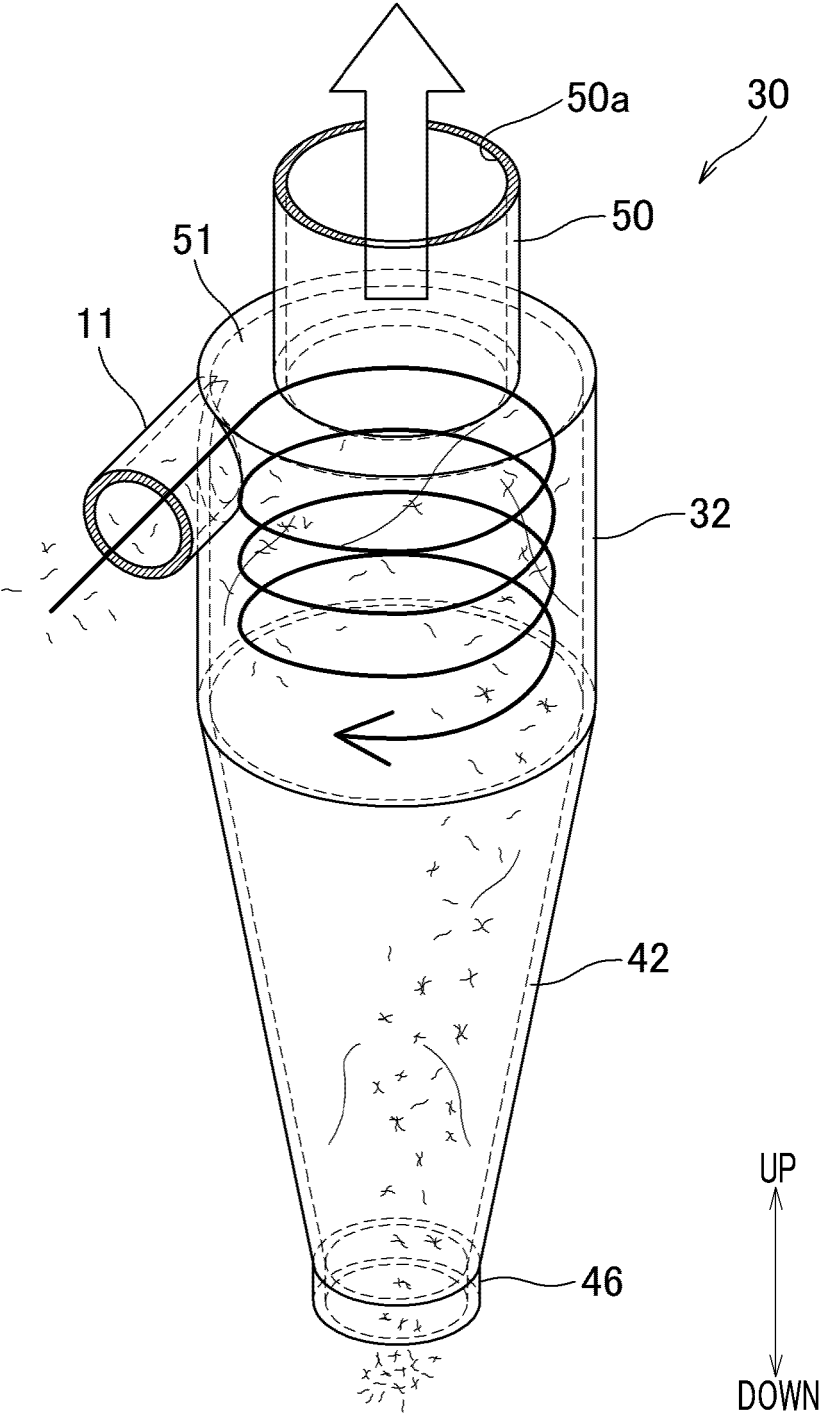


FIG.4

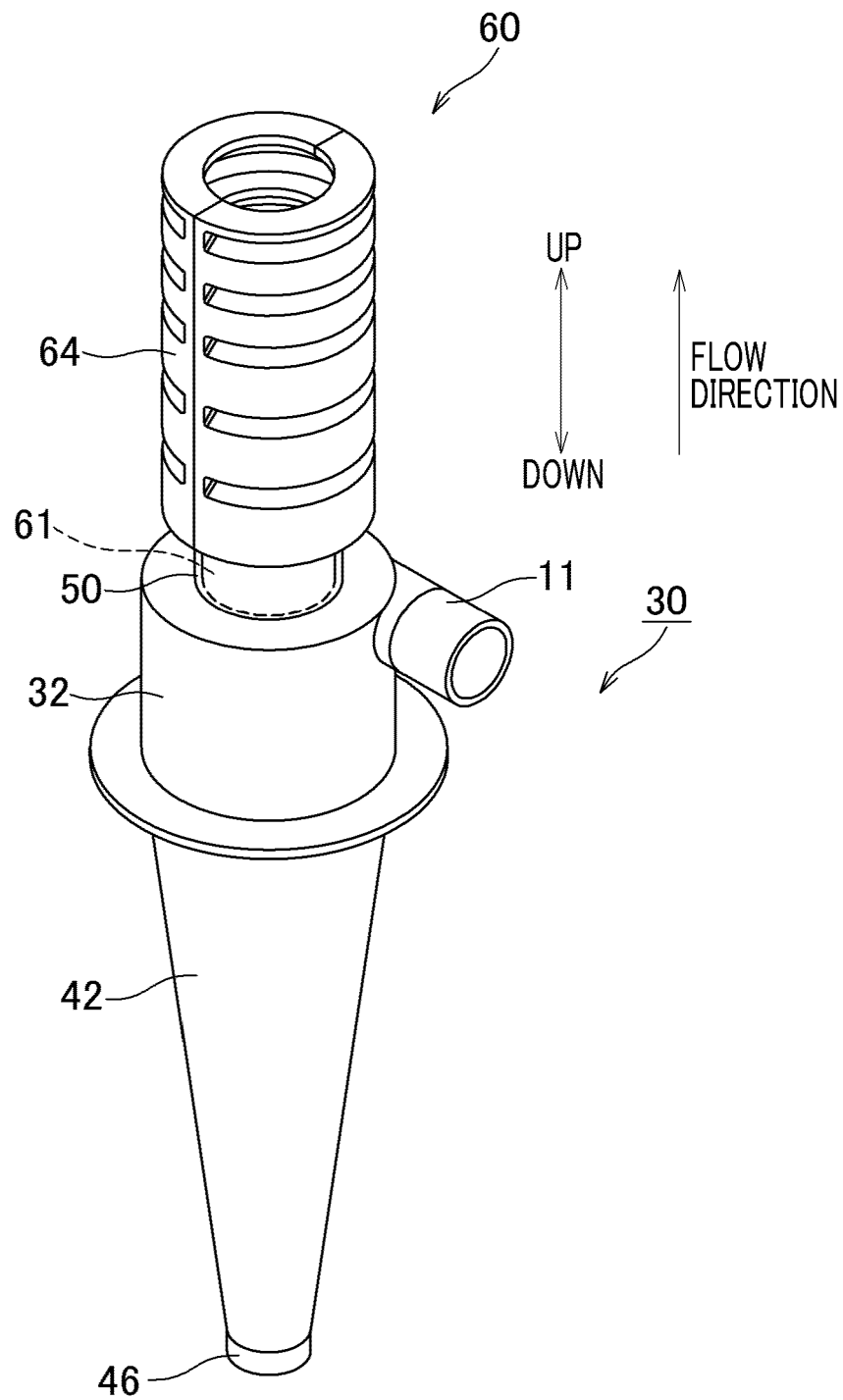


FIG.5

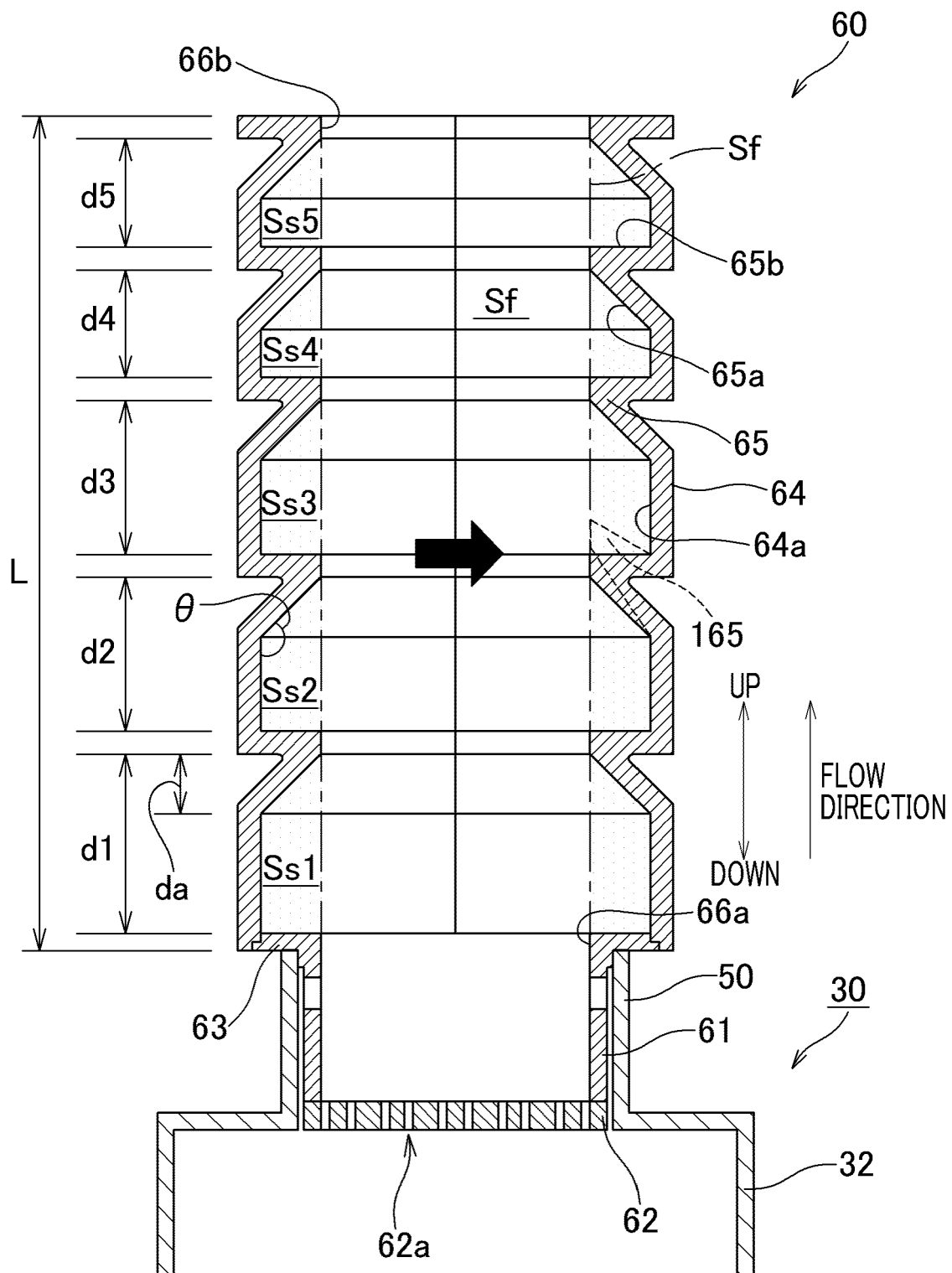


FIG.6

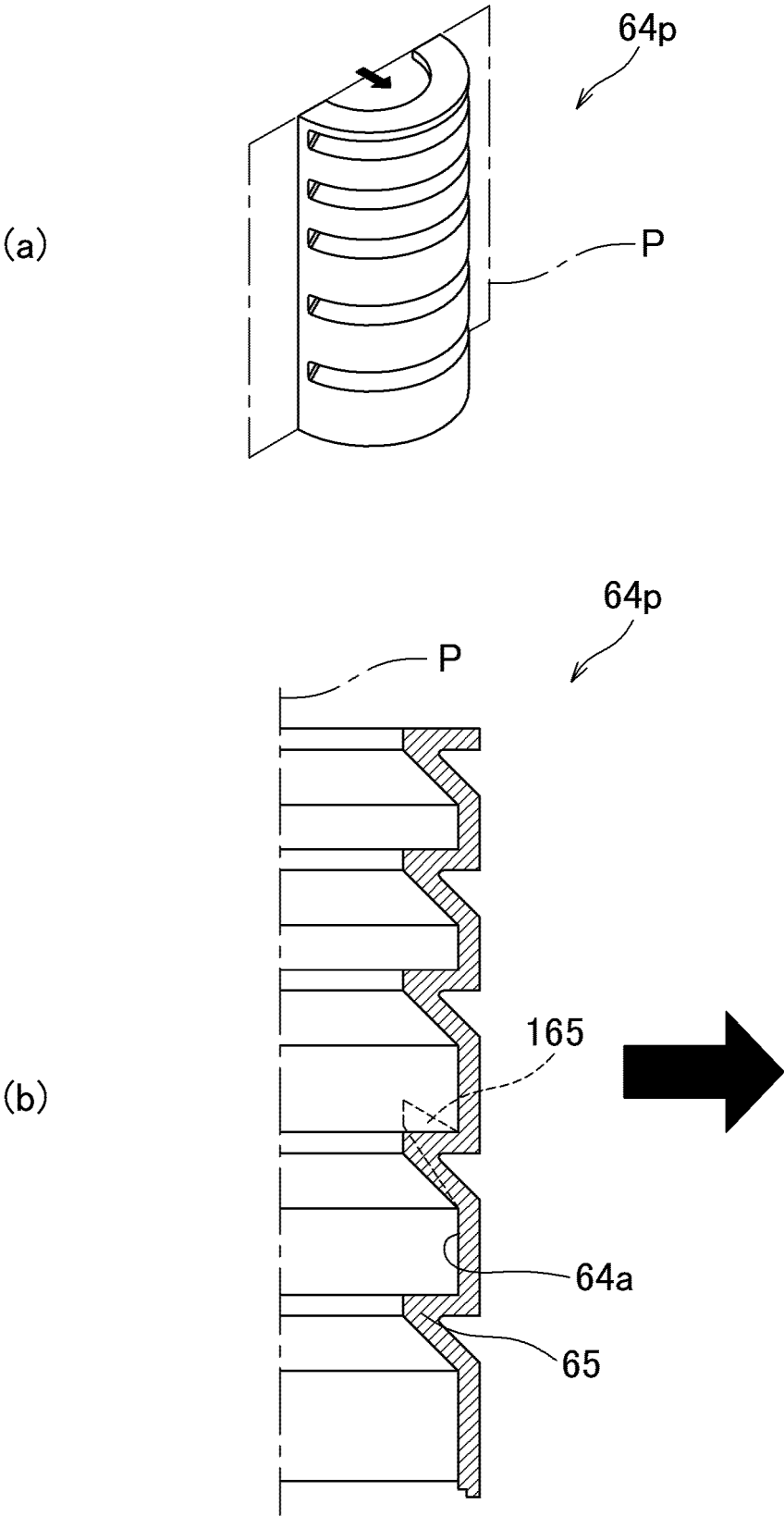


FIG.7

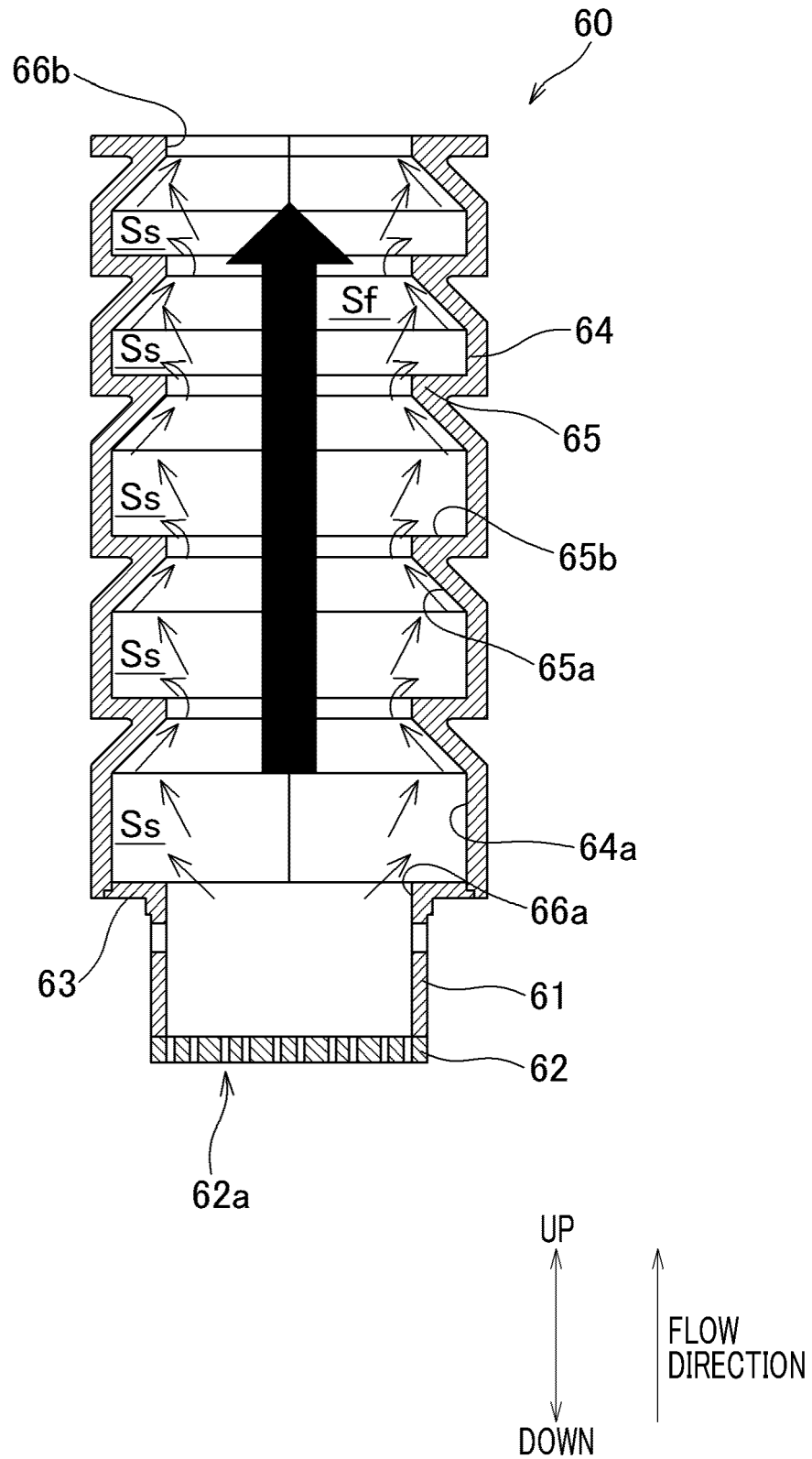


FIG.8

	EXAMPLE1	COMPARATIVE EXAMPLE1	COMPARATIVE EXAMPLE2	COMPARATIVE EXAMPLE3	COMPARATIVE EXAMPLE4	COMPARATIVE EXAMPLE5	COMPARATIVE EXAMPLE6	COMPARATIVE EXAMPLE7	COMPARATIVE EXAMPLE8
d8									14mm
d7							18mm		14mm
d6					22mm		18mm	18mm	14mm
d5	18mm		26mm		22mm	22mm	18mm	18mm	14mm
d4	18mm	30mm	26mm	26mm	22mm	22mm	18mm	18mm	14mm
d3	26mm	30mm	26mm	26mm	22mm	22mm	18mm	18mm	14mm
d2	26mm	30mm	26mm	26mm	22mm	22mm	18mm	18mm	14mm
d1	30mm	30mm	26mm	26mm	22mm	22mm	18mm	18mm	14mm
L	141mm	139mm	153mm	123mm	159mm	133mm	157mm	135mm	147mm

FIG.9

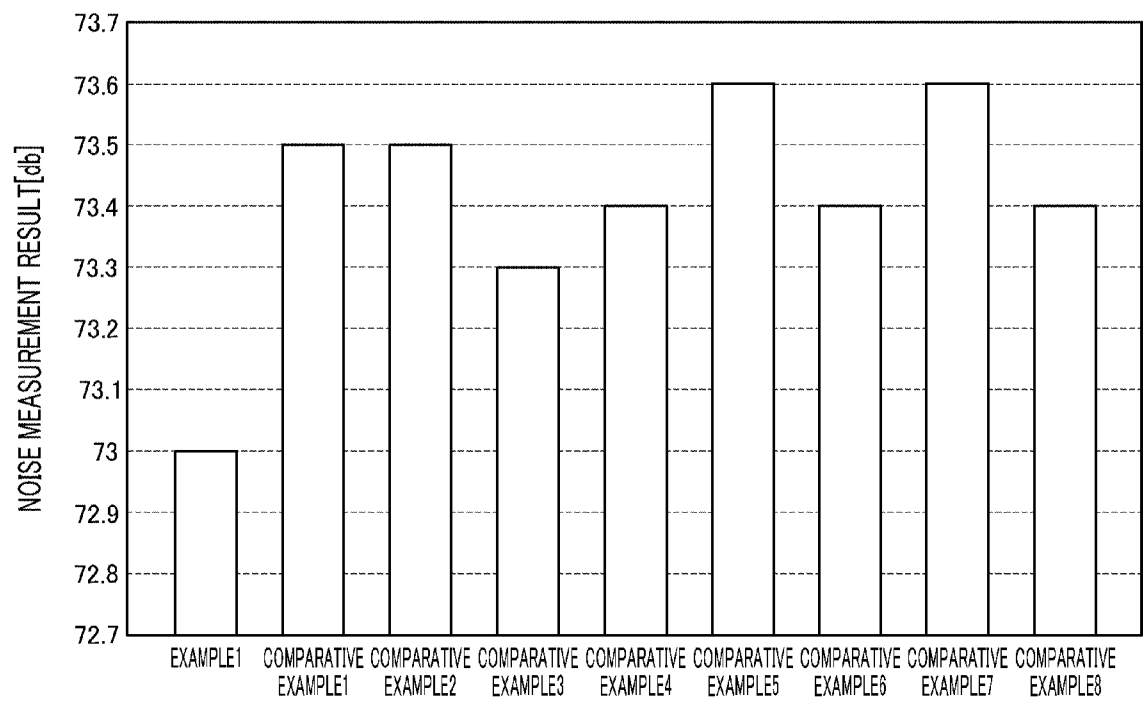


FIG.10

	EXAMPLE1	EXAMPLE2	EXAMPLE3	EXAMPLE4	EXAMPLE5	EXAMPLE6
d5	18mm	18mm	26mm	30mm	26mm	30mm
d4	18mm	18mm	26mm	18mm	26mm	26mm
d3	26mm	30mm	18mm	18mm	30mm	26mm
d2	26mm	26mm	18mm	26mm	18mm	18mm
d1	30mm	26mm	30mm	26mm	18mm	18mm
L	141mm	141mm	141mm	141mm	141mm	141mm

FIG.11

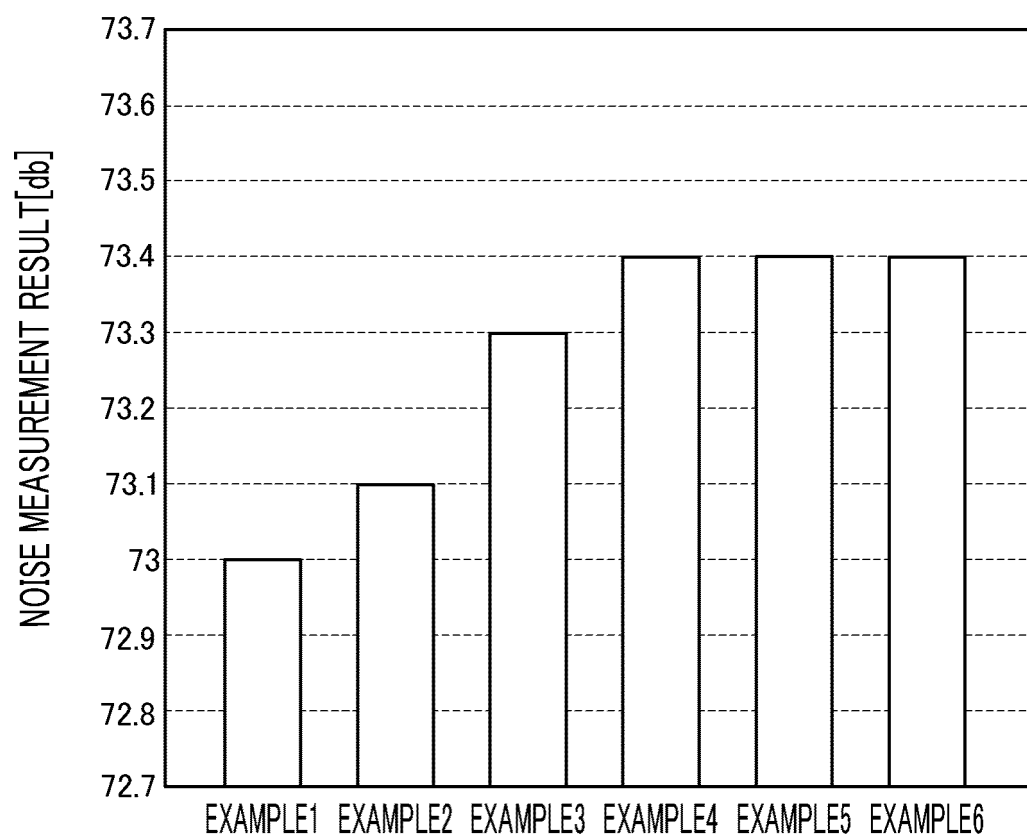
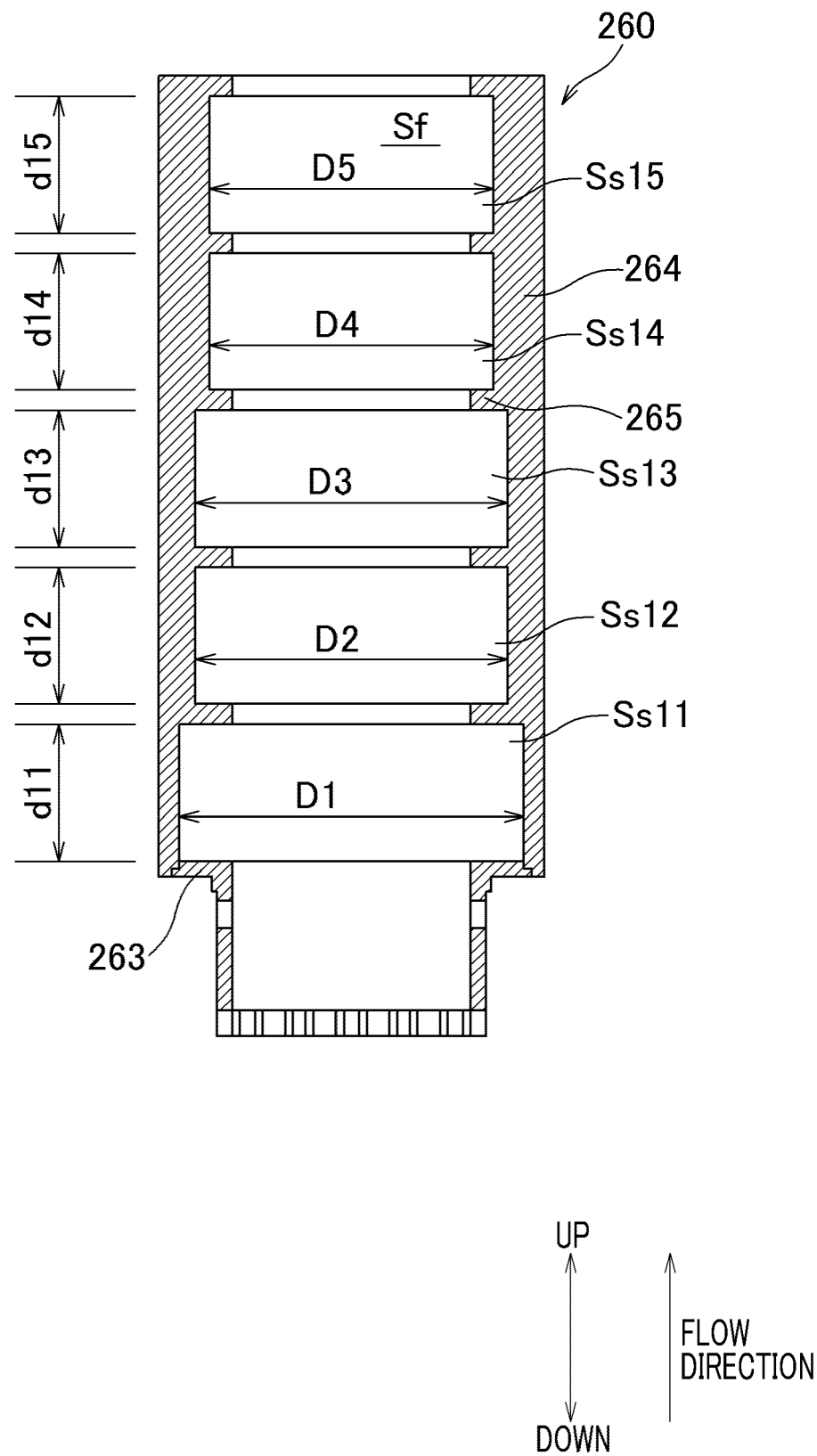


FIG.12





EUROPEAN SEARCH REPORT

Application Number

EP 26 16 2353

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,P	EP 4 556 609 A1 (TMT MACHINERY INC [JP]) 21 May 2025 (2025-05-21) * figures 1,2,4,7,8,9,18,19,20,21 * * paragraph [0001] * * paragraph [0059] - paragraph [0060] * * paragraph [0065] - paragraph [0067] * * paragraph [0073] - paragraph [0078] * * paragraph [0123] - paragraph [0135] * -----	1-9	INV. B65H54/88 B65H54/70
A	EP 4 345 199 A1 (TMT MACHINERY INC [JP]) 3 April 2024 (2024-04-03) * the whole document *	1-9	TECHNICAL FIELDS SEARCHED (IPC) B65H D01H
A,D	& JP 2024 052577 A (TMT MACHINERY INC) 11 April 2024 (2024-04-11) * the whole document *	1-9	
A	WO 2024/166489 A1 (TMT MACHINERY INC [JP]) 15 August 2024 (2024-08-15) * figures 2-8 * * paragraph [0039] - paragraph [0041] * * paragraph [0044] - paragraph [0045] * * paragraph [0050] - paragraph [0051] * -----	1-9	
A	WO 2018/235617 A1 (MURATA MACHINERY LTD [JP]) 27 December 2018 (2018-12-27) * paragraph [0040] * * figures 5-10 * -----	1-9	
A	US 4 667 864 A (KITECK PAUL D [US]) 26 May 1987 (1987-05-26) * figures 2,4,5,8 * * column 1, line 48 - column 1, line 58 * -----	1-9	
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		29 May 2026	Guisan, Thierry
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P24C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 26 16 2353

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

29-05-2026

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 4556609 A1	21-05-2025	CN 120020286 A	20-05-2025
		EP 4556609 A1	21-05-2025
		JP 2025082824 A	29-05-2025
		TW 202521457 A	01-06-2025

EP 4345199 A1	03-04-2024	CN 117802644 A	02-04-2024
		EP 4345199 A1	03-04-2024
		EP 4729673 A2	22-04-2026
		EP 4729674 A2	22-04-2026
		EP 4729675 A2	22-04-2026
		JP 2024052577 A	11-04-2024
		TW 202415821 A	16-04-2024

WO 2024166489 A1	15-08-2024	CN 120530236 A	22-08-2025
		EP 4663824 A1	17-12-2025
		JP WO2024166489 A1	15-08-2024
		TW 202432921 A	16-08-2024
		WO 2024166489 A1	15-08-2024

WO 2018235617 A1	27-12-2018	CN 110431098 A	08-11-2019
		JP 2019006534 A	17-01-2019
		WO 2018235617 A1	27-12-2018

US 4667864 A	26-05-1987	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 2024052577 A [0002]