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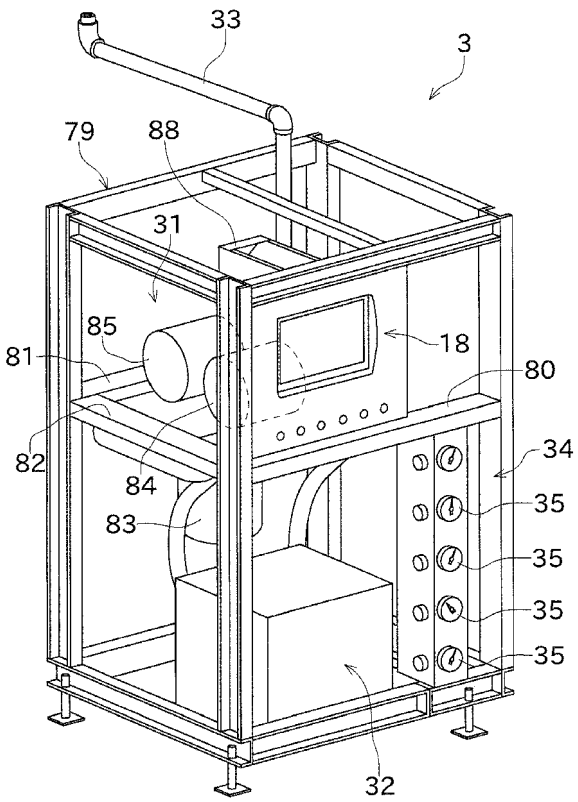
(54) Air-jet spinning machine and manufacturing method of spun yarn

(57) A fine spinning machine includes a machine main body, a plurality of spinning units, 1 a driving section (31), an air supplying section (34), and a drive end box (3). The spinning units are arranged along a longitudinal direction of the machine main body, each spinning unit including a driven bottom roller. The driving section (31) is adapted to collectively drive a front bottom roller and a middle bottom roller of the bottom rollers of each of the spinning units. The air supplying section (34) supplies air to the spinning units. The drive end box (3) is adapted to accommodate the driving section (31) and the air supplying section (34) at one end in a direction in which the spinning units are arranged. The drive end box (3) is adapted to accommodate the driving section (31) in an upper range and the air supplying section (34) in a lower range.

FIG. 5



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Description

1. Field of the Invention

[0001] The present invention relates to a layout of a driving section and an air supplying section in an air-jet spinning machine.

2. Description of the Related Art

[0002] Conventionally, there is known a yarn winding machine (air-jet spinning machine) adapted to wind a yarn to form a package (e.g., Japanese Unexamined Patent Publication No. 2010-77576 (Patent Document 1) and Japanese Unexamined Patent Publication No. 8-246275 (Patent Document 2)). As disclosed in Patent Document 1 and Patent Document 2, this type of spinning machine includes a plurality of spinning units, each of which is adapted to wind the yarn, arranged in line on a machine main body.

[0003] The spinning unit includes various driven members driven for winding the yarn (e.g., a draft roller and the like). Among the driven members arranged in the spinning unit, at least some of the driven members are driven by a common driving section. By driving the driven members of all the spinning units by the common driving section, the yarn can be wound all at once in all the spinning units. The common driving section is accommodated in a motor box arranged at a side of the machine main body.

[0004] The spinning machine realizes various functions by generating an airflow in each section and applying the airflow on the yarn. For example, a whirling airflow can be generated by ejecting compressed air, and twists can be applied to the yarn by the whirling airflow. Yarn dusts can be blown away by ejecting the compressed air. Furthermore, a suction flow can be generated by negative pressure, for example, to suck and catch the yarn or to remove the yarn dusts. The spinning machine includes an air supplying section adapted to supply compressed air to each section, and a negative pressure source adapted to supply negative pressure to each section. The air supplying section and the negative pressure source are collectively accommodated in a blower box provided at a side of the machine main body.

[0005] A driving speed of the driven member (the draft roller or the like), air pressure of the compressed air to be supplied to each section, and the like have different optimum values depending on a winding condition of the yarn. When changing the winding condition of the yarn, setting of the driving section and the air supplying section is required to be changed. In the spinning machine described in Patent Document 1, the motor box accommodating the driving section and the blower box accommodating the air supplying section are arranged at different ends of the machine main body. Therefore, in order to carry out an operation of changing the setting, an operator of the spinning machine is required to go back and forth between the motor box and the blower box, and workload has been caused on the operator.

[0006] Patent Document 2 discloses a spinning machine in which the motor box and the blower box are collectively arranged at one end of the machine main body. When changing the setting, the operator is not required to go back and forth between the both ends of the machine main body. However, the structure of Patent Document 2 merely has the motor box and the blower box collectively arranged on one end side of the machine main body, and does not take into consideration operability in changing the setting. Patent Document 2 does not describe at all about a specific arrangement of the driving section and the air supplying section.

[0007] As described above, in the conventional air-jet spinning machine, the arrangements of the driving section and the air supplying section are not organized. Thus, the operation of changing the setting of the driving section and the air supplying section has been difficult to be performed.

BRIEF SUMMARY OF THE INVENTION

[0008] An object of the present invention is to provide an air-jet spinning machine in which an operability in changing setting of a driving section and an air supplying section is improved.

[0009] According to an aspect of the present invention, an air-jet spinning machine includes a machine main body, a plurality of air-jet spinning units, a driving section, an air supplying section, and an accommodating section. The air-jet spinning units are arranged along a longitudinal direction of the machine main body. Each air-jet spinning unit includes at least one driven member. The driving section is adapted to collectively drive at least one driven member of the air-jet spinning units. The air supplying section is adapted to supply air to the air-jet spinning units. The accommodating section is adapted to accommodate the driving section and the air supplying section at one end in a direction in which the air-jet spinning units are arranged. The accommodating section is adapted to accommodate the driving section and the air supplying section within different ranges in a vertical direction.

[0010] As described above, since the driving section and the air supplying section are accommodated in one accommodating section, the driving section and the air supplying section can be simultaneously accessed, and the operation of changing the setting can be smoothly carried out. With the driving section and the air supplying section arranged in different ranges in the vertical direction of the accommodating section, an organized arrangement is realized in which the driving section and the air supplying section can be easily accessed from a front-back direction or a left-right direction. Therefore, the operability in changing the setting of the driving section and the air supplying section is improved.

[0011] In the above air-jet spinning machine, the accommodating section is preferably adapted to accommo-

date the driving section in an upper range, and the air supplying section in a lower range.

[0012] Accordingly, the driving section and the air supplying section can be arranged in the accommodating section in an organized manner.

[0013] In the above air-jet spinning machine, it is provided that a left-right direction is the direction in which the air-jet spinning units are arranged, and a front-back direction is a direction perpendicular to the left-right direction and a top-bottom direction. When viewing the machine main body from the front-back direction, a front side is a side on which a yarn wound by the air-jet spinning unit is travelling, and a back side is an opposite side with respect to the front side. The accommodating section is formed as a frame that enables the driving section to be accessed from the front side, and at least one of the back side and one of end sides in the left-right direction.

[0014] Accordingly, since the driving section can be easily accessed, change of settings, maintenance, and the like of the driving section can be easily carried out.

[0015] In the above air-jet spinning machine, an operation section is provided at the front side of the accommodating section and adapted to be operable commonly for the air-jet spinning units. The operation section is provided to be openable and closable with respect to the accommodating section.

[0016] As described above, since the operation section is provided at the front side, the operation section can be easily operated. By opening the operation section, an interior of the accommodating section is accessible from the front side. Therefore, the operation of changing the setting and/or the maintenance operation of the driving section and the like accommodated in the accommodating section can also be easily carried out.

[0017] In the above air-jet spinning machine, each of the air-jet spinning units includes a draft device adapted to draft a fiber bundle. The driven member is a draft roller of the draft device. The driving section includes a driving shaft adapted to commonly drive the draft roller of each of the air-jet spinning units, a motor adapted as a drive source of the draft roller, and a pulley adapted to transmit driving between the motor and the driving shaft. The accommodating section includes a space adapted to enable changing of the pulley adapted to transmit driving for at least a high-speed pulley and a low-speed pulley.

[0018] The rotation speed of the draft roller can be changed by changing the pulley. A changing operation of the pulley can be easily carried out by forming a space in the accommodating section.

[0019] In the above air-jet spinning machine, the draft device includes at least a front roller pair, a middle roller pair, and a back roller pair arranged in this order from downstream in a travelling direction of the fiber bundle. The front roller pair includes a driven front bottom roller and a front top roller that is driven by making contact with the front bottom roller. The middle roller pair includes a driven middle bottom roller and a middle top roller that is driven by making contact with the middle bottom roller. The driving section includes a first driving shaft adapted to commonly drive the front bottom roller of each of the air-jet spinning units, a second driving shaft adapted to commonly drive the middle bottom roller of each of the air-j et spinning units, a first motor adapted as a driving source of the front bottom roller, a second motor adapted as a driving source of the middle bottom roller, a plurality of first pulleys adapted to transmit driving between the first motor and the first driving shaft, and a plurality of second pulleys adapted to transmit driving between the second motor and the second driving shaft.

[0020] Accordingly, the front roller pair and the middle roller pair can be commonly driven for the plurality of the air-jet spinning units. By changing the pulley, the rotation speeds of the front roller pair and the middle roller pair can be changed.

[0021] In the above air-jet spinning machine, the driving section includes a driving shaft adapted to commonly drive the draft roller of each of the air-jet spinning units, a motor adapted as a driving source of the draft roller, a plurality of pulleys adapted to transmit driving between the motor and the driving shaft, and a transmission belt adapted to transmit a driving force between the pulleys. At least one of the pulleys is a multistage pulley provided with a high-speed pulley and a low-speed pulley. The accommodating section includes a space adapted to enable changing of the transmission belt set on the multistage pulley.

[0022] Instead of detaching the pulley, the rotation speed of the draft roller can be changed by simply changing the transmission belt.

[0023] In the above air-jet spinning machine, each of the air-jet spinning units includes a spinning section having an air-jet spinning device adapted to produce a spun yarn by spinning the fiber bundle, which has been drafted by the draft device, using a whirling airflow. The spinning section is adapted to hold the air-jet spinning device of different types.

[0024] According to the above air-jet spinning machine, satisfactory operability in changing the setting of the driving section and the air supplying section is achieved. Therefore, when the type of air-jet spinning device is changed, change can be easily made to an appropriate setting according to the type of air-jet spinning device.

[0025] In the above air-jet spinning machine, the different types of the air-jet spinning device that is adapted to be held by the spinning section includes at least a first air-jet spinning device and a second air-jet spinning device. The first air-jet spinning device includes a fiber guiding section adapted to receive the fiber bundle and to guide the fiber bundle to a spinning chamber, a nozzle block including a nozzle adapted to generate a whirling airflow in the spinning chamber, and a hollow guide shaft body adapted as a passage of the fiber bundle twisted by the airflow in the spinning chamber. The second air-jet spinning device includes a first nozzle block including a first nozzle adapted to apply a whirling airflow to the

fiber bundle in a first direction, and a second nozzle block including a second nozzle adapted to apply a whirling airflow to the fiber bundle in a second direction that is opposite to the first direction. The driving section is adapted to drive the draft roller by the high-speed pulley when the spinning section carries out spinning by the first air-j et spinning device. The driving section is adapted to drive the draft roller by the low-speed pulley when the spinning section carries out spinning by the second air-jet spinning device.

[0026] In the driving section of the above air-jet spinning machine, the low-speed pulley and the high-speed pulley can be easily changed. Therefore, the pulley can be easily changed to the appropriate pulley according to the type of the air-jet spinning device.

[0027] The above air-jet spinning machine further includes a molded integrated base body to which at least a portion of the driving section is mounted. The base body is adapted to function as a structure of the accommodating section.

[0028] Since the base body also serves as the structure of the accommodating section, rigidity of the accommodating section can be improved.

[0029] The above air-jet spinning machine further includes an operation cart provided to travel along the direction in which the air-j et spinning units are arranged and adapted to perform an operation with respect to at least one of the air-jet spinning units. The machine main body includes an opened section adapted to enable the operation cart to be installed or removed from the back side.

[0030] As described above, by installing or removing the operation cart to or from the machine main body, the maintenance of the operation cart can be easily carried out.

[0031] According to another aspect of the present invention, a manufacturing method of a spun yarn by the above air-j et spinning machine is provided as below. In the manufacturing method of the spun yarn, the pulley adapted to drive the draft roller is changed to the high-speed pulley when the air-jet spinning device of the spinning section is changed to the first air-jet spinning device. The pulley adapted to drive the draft roller is changed to the low-speed pulley when the air-j et spinning device of the spinning section is changed to the second air-jet spinning device.

[0032] Since the pulley can be changed to the appropriate pulley according to the type of the air-jet spinning device, the spun yarn can be produced by different air-jet spinning devices.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033]

FIG. 1 is a front view illustrating an overall structure of a fine spinning machine according to one embodiment of the present invention;

FIG. 2 is a plan view of the fine spinning machine;

FIG. 3 is a cross-sectional side view of the fine spinning machine;

FIG. 4 is a perspective view of an outer appearance of a drive end box;

FIG. 5 is a perspective view illustrating a state of an interior of the drive end box;

FIG. 6 is a cross-sectional view of a first air-jet spinning device;

FIG. 7 is a cross-sectional view of a second air-jet spinning device;

FIG. 8 is an enlarged perspective view of an upper range of a frame; and

FIG. 9 is a plan view of a draft driving section.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0034] A fine spinning machine (spinning machine) as an air-jet spinning machine according to one embodiment of the present invention will be described with reference to the drawings. As illustrated in FIG. 1 and FIG. 2, a fine spinning machine 1 includes a machine main body 2, a drive end box (accommodating section) 3, a bobbin stocker 4, and a blower box 5.

[0035] The machine main body 2 includes a plurality of spinning units (air-jet spinning units) 6 arranged in line in a longitudinal direction thereof. As illustrated in FIG. 3, each spinning unit 6 includes a draft device 10, a spinning section 11, a yarn accumulating device 12, and a winding section 13, arranged in this order from upstream to downstream. "Upstream" and "downstream" respectively refer to upstream and downstream in a travelling direction of a fiber bundle 14 and a spun yarn 15 at the time of spinning. Each spinning unit 6 is adapted to produce the spun yarn 15 by spinning the fiber bundle 14, which has been fed from the draft device 10, by the spinning section 11, and winds the spun yarn 15 around a winding bobbin 16 with the winding section 13. The winding bobbin 16 wound with the spun yarn 15 is referred to as a package 17.

[0036] In the following description, a direction in which the spinning units 6 are arranged (a direction indicated with arrows of "right" and "left" in FIG. 1 and FIG. 2) may be simply referred to as a "left-right direction". A direction perpendicular to the left-right direction and a top-bottom direction (vertical direction) (a direction indicated with arrows of "front" and "back" in FIG. 1 and FIG. 3) may be simply referred to as a "front-back direction". As illustrated in FIG. 3, when viewed in the left-right direction, a spun yarn 15 produced by the spinning unit 6 travels on one side of the front-back direction of the machine main body 2. A side on which the spun yarn 15 travels when viewed from the machine main body 2 in the front-back direction (a right side of FIG. 3) may be referred to as a front side, and an opposite side with respect to the front side may be referred to as a back side.

[0037] The drive end box 3 is arranged at an end on

one side in the left-right direction of the machine main body 2. As illustrated in FIG. 5, a draft driving section (driving section) 31 and a traverse driving section 32, which are common driving sources of the plurality of spinning units 6, are arranged in the drive end box 3.

[0038] Compressed air is supplied to the drive end box 3 from a compressed air source (not illustrated) through a compressed air supply pipe 33. An air supplying section 34 adapted to appropriately adjust the compressed air and supply the air to each section of the fine spinning machine 1 is arranged in the drive end box 3. The air supplying section 34 includes a regulator 35 or,the like for adjusting the pressure of the compressed air. The compressed air adjusted to an appropriate air pressure by the air supplying section 34 is supplied to each section of the fine spinning machine 1 via a duct, a tube, or the like (not illustrated).

[0039] As illustrated in FIG. 1 and FIG. 4, an operation section 18 is arranged on the front side of the drive end box 3. The operation section 18 includes a display screen capable of displaying information related to each spinning unit 6, a setting operation tool for carrying out various types of settings (an operation button and/or an operation dial), and the like. The operation section 18 can communicate with each spinning unit 6, and collectively manages information related to the plurality of spinning units 6 of the fine spinning machine 1. The operation section 18 can collectively or individually transmit a control signal to the plurality of spinning units 6 of the fine spinning machine 1. Therefore, an operator of the fine spinning machine 1 can collectively operate the spinning units 6 with the operation section 18.

[0040] The bobbin stocker 4 is arranged at an end in the left-right direction of the machine main body 2 that is opposite to the end at which the drive end box 3 is provided. The bobbin stocker 4 can stock a plurality of empty winding bobbins 16.

[0041] As illustrated in FIG. 2, the blower box 5 is arranged on the back side of the bobbin stocker 4. A negative pressure source (not illustrated) is provided in the blower box 5. As illustrated in FIG. 3, the machine main body 2 is provided with negative pressure ducts 19, 20, and 21 along the left-right direction. The negative pressure ducts 19, 20, and 21 are connected to the negative pressure source. An interior of the negative pressure ducts 19, 20, and 21 is maintained at the negative pressure by the negative pressure source. The negative pressure can be supplied to each section of the fine spinning machine 1 via the negative pressure ducts 19, 20, and 21.

[0042] The draft device 10 of each of the spinning units 6 is arranged in proximity to an upper end of the machine main body 2. The draft device 10 drafts a sliver (a material of the fiber bundle) 22 supplied from a sliver case (not illustrated) via a sliver guide (not illustrated) until a predetermined width is obtained.

[0043] The draft device 10 includes a plurality of draft rollers. Two draft rollers as one set form a draft roller pair. The draft device 10 includes four draft roller pairs, i.e., a back roller pair 23 and 27, a third roller pair 24 and 28, a middle roller pair 25 and 29, and a front roller pair 26 and 30, arranged in this order from the upstream. In each draft roller pair, a draft roller on the front side in the front-back direction is referred to as a top roller, and a draft roller on the back side is referred to as a bottom roller. As illustrated in FIG. 3, the top rollers are, in the order from the upstream, a back top roller 23, a third top roller 24, a middle top roller 25 provided with a rubber apron belt, and a front top roller 26. The bottom rollers are, in the order from the upstream, a back bottom roller 27, a third bottom roller 28, a middle bottom roller 29 provided with a rubber apron belt, and a front bottom roller 30.

[0044] Each of the bottom rollers 27, 28, 29, and 30 is a driven member driven with an appropriate driving source. Each spinning unit 6 includes an electric motor (not illustrated) for rotatably driving the back bottom roller 27 and the third bottom roller 28. The back bottom roller 27 and the third bottom roller 28 thus can be rotatably driven for each spinning unit 6.

[0045] The middle bottom roller 29 and the front bottom roller 30 are driven by the draft driving section 31 provided in the drive end box 3 described above. The draft driving section 31 commonly drives the middle bottom roller 29 and the front bottom roller 30 of the plurality of spinning units 6 arranged in the fine spinning machine 1. Specifically, as illustrated in FIG. 1 and FIG. 2, the fine spinning machine 1 includes a first line shaft 36 and a second line shaft 37 arranged along the left-right direction. The front bottom roller 30 of each spinning unit 6 is coaxially fixed to the first line shaft 36. The middle bottom roller 29 of each spinning unit 6 is coaxially fixed to the second line shaft 37. One end of the first line shaft 36 and the second line shaft 37 is respectively connected to the draft driving section 31 in the drive end box 3. The draft driving section 31 rotatably drives the first line shaft 36 and the second line shaft 37 at a prescribed rotation speed. The front bottom roller 30 and the middle bottom roller 29 are driven all at once in all the spinning units 6.

[0046] Each of the top rollers 23, 24, 25, and 26 is rotatably supported via a bearing (not illustrated) and the like with an axial line thereof as a center. Each of the top rollers 23, 24, 25, and 26 is urged towards the respective bottom rollers 27, 28, 29, and 30 by an urging member (not illustrated).

[0047] The draft device 10 can sandwich the sliver 22 between the rotating top rollers 23, 24, 25, and 26 and the bottom rollers 27, 28, 29, and 30, and transport the sliver 22 towards the downstream. In the draft device 10, the rotation speed of the downstream draft roller pair is faster. Therefore, the fiber bundle 14 (or the sliver 22) is stretched (drafted) while being transported between the draft roller pair and the draft roller pair. A degree to which the fiber bundle 14 is drafted can be changed by appropriately setting the rotation speed of each of the bottom rollers 27, 28, 29, and 30. The draft device 10 can draft the fiber bundle 14 into a desired fiber width. The rotation

speed of each roller is appropriately changed according to a type of fibers and/or a spinning condition (a winding condition) such as a thickness of the spun yarn 15.

[0048] The spinning section 11 is arranged immediately downstream of the front roller pair 26 and 30. The fiber bundle 14 drafted by the draft device 10 is supplied to the spinning section 11. The spinning section 11 includes an air-jet spinning device adapted to apply twists to the fiber bundle 14 using a whirling airflow. The air-jet spinning device twists the fiber bundle 14 supplied from the draft device 10 to produce the spun yarn 15.

[0049] In the spinning section 11 of the present embodiment, the air-jet spinning device is detachable and thus can be changed to an air-jet spinning device of a different type. Accordingly, since the air-jet spinning device can be changed to an air-jet spinning device of an appropriate type according to the type of the spun yarn 15 to be produced, the spun yarn 15 having desired quality can be produced. Two types of air-jet spinning devices, i.e., a first air-jet spinning device 41 and a second air-jet spinning device 42 described below, can be selectively mounted to the spinning section 11 of the present embodiment.

[0050] As illustrated in FIG. 6, the first air-jet spinning device 41 includes a nozzle block 43, a hollow guide shaft body 44, and a fiber guiding section 45.

[0051] A spinning chamber 46 is formed between the nozzle block 43 and the hollow guide shaft body 44. The nozzle block 43 is provided with an air ejecting nozzle 47 for ejecting air into the spinning chamber 46. An introducing port 48 for introducing the fiber bundle 14 into the spinning chamber 46 is formed in the fiber guiding section 45. The air ejecting nozzle 47 is adapted to eject the air into the spinning chamber 46 to generate a whirling airflow. The fiber bundle 14 supplied from the draft device 10 is guided into the spinning chamber 46 by the fiber guiding section 45 having the introducing port 48. In the spinning chamber 46, fibers of the fiber bundle 14 are swung around the hollow guide shaft body 44 by the whirling airflow, and twists are applied to the fiber bundle 14. Accordingly, the spun yarn 15 is produced. The twisted spun yarn 15 is passed through a yarn passage 49 formed at an axial center of the hollow guide shaft body 44, and fed to an outside of the first air-jet spinning device 41 from a downstream yarn exit (not illustrated).

[0052] A needle-like guide needle 50 is arranged in the introducing port 48, and a tip of the guide needle 50 is directed towards the spinning chamber 46. The fiber bundle 14 introduced from the yarn introducing port 48 is guided into the spinning chamber 46 via the guide needle 50. Accordingly, a state of the fiber bundle 14 introduced into the spinning chamber 46 can be stabilized. Since the fiber bundle 14 is guided so as to be wound around the guide needle 50, even if twists are applied to the fibers in the spinning chamber 46, the twists are prevented from being propagated to the upstream of the fiber guiding section 45. Accordingly, the twists applied by the spinning section 11 are prevented from influencing the draft device 10. However, the guide needle 50 may be omitted, and a downstream end of the fiber guiding section 45 may function as the guide needle 50.

[0053] As illustrated in FIG. 7, the second air-jet spinning device 42 includes a first nozzle block 51 and a second nozzle block 52. The second nozzle block 52 is arranged downstream of the first nozzle block 51.

[0054] The first nozzle block 51 is provided with a first fiber passing chamber 53 adapted to pass the fiber bundle 14. The second nozzle block 52 is provided with a second fiber passing chamber 54 adapted to pass the fiber bundle 14. The first fiber passing chamber 53 and the second fiber passing chamber 54 are connected to one another. The fiber bundle 14 fed from the draft device 10 can pass through the second air-jet spinning device 42. The first nozzle block 51 is provided with a first air ejection nozzle 55 adapted to eject air into the first fiber passing chamber 53 to generate a whirling airflow. The second nozzle block 52 is provided with a second air ejection nozzle 56 adapted to eject air into the second fiber passing chamber 54 to generate a whirling airflow. The second air ejection nozzle 56 is formed to generate the whirling airflow that whirls in an opposite direction from that of the first air ejection nozzle 55.

[0055] Twists are applied to the fiber bundle 14 passing through the second air-jet spinning device 42 by the whirling airflow generated by the first air ejection nozzle 55 and the second air ejection nozzle 56, and the spun yarn 15 can be produced. Since the first air ejection nozzle 55 and the second air ejection nozzle 56 generate the whirling airflow in opposite directions, the fiber bundle 14 is strongly twisted such that both ends of the fiber bundle 14 between the two nozzles 55 and 56 are twisted in opposite directions. The spun yarn 15 having a high yarn strength thus can be formed.

[0056] The compressed air for generating the whirling airflow in the first air-jet spinning device 41 or the second air-jet spinning device 42 is supplied from the air supplying section 34 arranged in the drive end box 3. The air supplying section 34 includes the regulator 35 for adjusting the air pressure of the compressed air. The compressed air can be appropriately supplied to the air-jet spinning device (the first air-jet spinning device 41 or the second air-jet spinning device 42) by appropriately adjusting the regulator 35 in advance. Therefore, the whirling airflow can be appropriately generated in the relevant air-jet spinning device. The spinning by the spinning section 11 thus can be appropriately carried out.

[0057] The winding section 13 is arranged in a lower range of the machine main body 2 at the downstream of the spinning section 11. The winding section 13 includes a cradle arm 58 and a winding drum 59. The cradle arm 58 is supported to be swingable about a supporting shaft 57. The cradle arm 58 can rotatably support a winding bobbin 16 for winding the spun yarn 15. The winding drum 59 is adapted to be driven while making contact with an outer peripheral surface of the winding bobbin 16 or an outer peripheral surface of the package 17. When the

winding drum 59 is driven by an electric motor (not illustrated), the winding bobbin 16 (or the package 17) making contact with the winding drum 59 is rotated, and the spun yarn 15 can be wound around the winding bobbin 16.

[0058] As illustrated in FIG. 1, the fine spinning machine 1 includes a traverse mechanism 60 in the lower range of the machine main body 2. The traverse mechanism 60 is adapted to traverse the spun yarn 15 to be wound by the winding section 13 of each spinning unit 6. The traverse mechanism 60 includes a plurality of traverse guides 61 and a traverse rod 62.

[0059] Each of the traverse guides 61 is arranged in proximity to the winding section 13 of each spinning unit 6, and is provided to be engaged with the spun yarn 15 wound by the winding section 13. The traverse rod 62 is arranged such that a longitudinal direction thereof is in the left-right direction, and is arranged over all the spinning units 6 of the fine spinning machine 1. Each traverse guide 61 is fixed to the traverse rod 62. One end of the traverse rod 62 is connected to the traverse driving section 32 in the drive end box 3. The traverse driving section 32 reciprocates the traverse rod 62 left and right. Accordingly, the traverse guide 61 can be reciprocated all at once in all the spinning units 6. By rotating the winding bobbin 16 by the winding section 13 while reciprocating the traverse guide 61 engaged with the spun yarn 15, the spun yarn 15 can be wound while being traversed to form the package 17 of an appropriate shape.

[0060] The yarn accumulating device 12 is arranged between the spinning section 11 and the winding section 13. As illustrated in FIG. 3, the yarn accumulating device 12 includes a yarn accumulating roller 63 and an electric motor 64 for rotatably driving the yarn accumulating roller 63.

[0061] The yarn accumulating roller 63 can have a prescribed amount of the spun yarn 15 wound around an outer peripheral surface thereof to temporarily accumulate the spun yarn 15. When the yarn accumulating roller 63 is rotated at a predetermined rotation speed with the spun yarn 15 wound around the outer peripheral surface of the yarn accumulating roller 63, the spun yarn 15 can be pulled out at a predetermined speed from the air-jet spinning device of the spinning section 11 and transported towards the downstream. Since the spun yarn 15 is temporarily accumulated on the outer peripheral surface of the yarn accumulating roller 63, the yarn accumulating device 12 can function as one type of buffer. Accordingly, a drawback (e.g., slackening of the spun yarn 15 or the like) when a spinning speed in the spinning section 11 and a winding speed in the winding section 13 do not match for some reason can be resolved.

[0062] A yarn quality measuring device 65 is arranged at a position between the spinning section 11 and the yarn accumulating device 12. The spun yarn 15 spun by the spinning section 11 is passed through the yarn quality measuring device 65 before being wound by the yarn accumulating device 12. The yarn quality measuring device 65 monitors a thickness of the travelling spun yarn 15 with a capacitance sensor (not illustrated). When a yarn defect (an area where an abnormality is found in thickness or the like of the spun yarn 15) of the spun yarn 15 is detected, the yarn quality measuring device 65 transmits a yarn defect detection signal to a unit controller (not illustrated). The yarn quality measuring device 65 is not limited to the capacitance sensor and may be a light transmissive sensor to monitor a thickness of the spun yarn 15. The yarn quality measuring device 65 may detect a foreign substance contained in the spun yarn 15 as a yarn defect.

[0063] A cutter (not illustrated) is arranged in proximity to the yarn quality measuring device 65, and immediately cuts the spun yarn 15 when the yarn defect of the spun yarn 15 is detected. Instead of using the cutter, the spinning unit 6 may stop the supply of the air to the spinning section 11 and cut the spun yarn 15 by interrupting the production of the spun yarn 15.

[0064] The fine spinning machine 1 includes a yarn joining cart (an operation cart) 66 and a doffing cart 67. A yarn joining cart travelling rail 68 is laid along the left-right direction in the machine main body 2. The yarn joining cart travelling rail 68 is located on the back side of the yarn path of the spun yarn 15. The yarn joining cart 66 can travel along the yarn joining cart travelling rail 68.

[0065] The yarn joining cart 66 includes a yarn joining device 69, a suction pipe 70, and a suction mouth 71. When the spun yarn 15 between the spinning section 11 and the winding section 13 is disconnected due to a yarn breakage or a yarn cut in a spinning unit 6, the yarn joining cart 66 travels on the yarn joining cart travelling rail 68 to the relevant spinning unit 6 and stops. The suction pipe 70 sucks and catches the yarn end from the spinning section 11 while swinging vertically with a shaft as a center and guides the yarn end to the yarn joining device 69. The suction mouth 71 sucks and catches the yarn end from the package 17 supported by the winding section 13 while swinging vertically with a shaft as a center and guides the yarn end to the yarn joining device 69. A negative pressure for causing the suction pipe 70 and the suction mouth 71 to generate the suction flow is supplied by the negative pressure source in the blower box 5. The yarn joining device 69 performs a yarn joining operation by twisting the guided yarn ends by the whirling airflow generated by the compressed air. The spun yarn 15 between the spinning section 11 and the winding section 13 is thereby connected, and the winding of the spun yarn 15 into the package 17 can be resumed. The compressed air for the yarn joining device 69 to generate the whirling airflow is supplied from the air supplying section 34.

[0066] As described above, since the yarn joining cart travelling rail 68 is laid on the back side of the yarn path, the yarn joining cart 66 travels on the back side of the yarn path and performs the yarn joining operation from a position on the back side. Since the yarn joining cart 66 is located on the back side of the yarn path (i.e., a receded position in the machine main body 2), mainte-

nance is difficult to be carried out on the yarn joining cart 66. In the fine spinning machine 1 of the present embodiment, the yarn joining cart 66 can be taken out from the back surface of the machine main body 2. More specifically, as illustrated in FIG. 3, the negative pressure ducts 19, 20, and 21 adapted to supply the negative pressure are arranged at positions higher or lower than the yarn joining cart 66, and are not arranged on the back side of the yarn joining cart 66. An opened section 110 communicating with a space where the yarn joining cart 66 performs the yarn joining operation is formed at a portion in the back side of the machine main body 2. The yarn joining cart 66 thus can be installed or removed from the machine main body 2 through the opened section 110. Therefore, the yarn joining cart 66 can be taken out from the back side of the machine main body 2 to carry out the maintenance.

[0067] When carrying out maintenance on the yarn joining cart 66, if access can be made to the back side of the yarn joining cart 66, sufficient maintenance may be carried out. In such a case, the maintenance operation can be carried out through the opened section 110 with the yarn joining cart 66 installed in the machine main body 2. Therefore, an opened area of the opened section 110 may not be formed to a size to a degree which enables the yarn joining cart 66 to be taken out, and the opened area is sufficient to be formed to a degree enabling the operator to carry out the maintenance.

[0068] A doffing cart travelling rail 39 is laid along the left-right direction on the front side of the machine main body 2. The doffing cart 67 can travel along the doffing cart travelling rail 39.

[0069] The doffing cart 67 performs at least one of a doffing operation of the fully-wound package 17, or a bobbin setting operation for supplying an empty winding bobbin 16 to each spinning unit 6. The doffing cart 67 includes an empty bobbin accommodating section 38, a cradle operation arm 72, a yarn pull-out arm 73, and an empty bobbin supplying arm 74. The empty bobbin accommodating section 38 can accommodate a plurality of empty winding bobbins 16. The yarn pull-out arm 73 can be extended or contracted by an air cylinder mechanism (not illustrated) . A catching section (not illustrated) adapted to suck and catch the spun yarn 15 by a suction airflow is arranged at the distal end of the yarn pull-out arm 73.

[0070] Next, a structure of the drive end box 3 will be more specifically described.

[0071] As illustrated in FIG. 4, the drive end box 3 has the front side and a side surface side (and a back side although illustration is omitted) covered with a panel 78. The panel 78 is mounted or removed with respect to a frame 79 of the drive end box 3 (see FIG. 5).

[0072] As illustrated in FIG. 5, the frame 79 of the drive end box 3 is configured by combining elongate frame materials. The frame material is not particularly limited, and a shaped steel such as a groove steel, steel tube, or the like may be used, and a sheet metal may also be used as long as it has a necessary strength. The draft driving section 31, the traverse driving section 32, and the air supplying section 34 are arranged at an inner side of the frame 79. The frame 79 includes reinforcement frame members 80, 81, and 82 arranged substantially horizontally at an intermediate portion in the top-bottom direction.

[0073] The traverse driving section 32 is arranged lower than the reinforcement frame members 80, 81, and 82. The traverse driving section 32 includes a cam box (not illustrated) incorporating a cam mechanism for reciprocating the traverse rod 62 in the left-right direction, and a traverse driving motor (not illustrated) which is a driving source of the cam box. The traverse rod 62 can be reciprocated to the left and the right at a prescribed speed by rotating the traverse driving motor at a prescribed rotation speed.

[0074] The air supplying section 34 is arranged lower than the reinforcement frame members 80, 81, and 82. The air supplying section 34 includes air equipment adapted to appropriately supply the compressed air to each section of the fine spinning machine 1. Specifically, the air supplying section 34 includes a filter 83 adapted to remove moisture in the compressed air supplied through the compressed air supply pipe 33. The air supplying section 34 includes a regulator 35 for appropriately adjusting the air pressure of the compressed air.

[0075] In the fine spinning machine 1, the compressed air is used for the whirling airflow in the air-jet spinning device, the whirling airflow in the yarn joining device 69 of the yarn joining cart 66, cleaning air for blowing away the yarn dusts, or the like, wherein an appropriate air pressure differs in each case. The air supplying section 34 includes the regulator 35 for each supplying destination of the compressed air. Thus, the air pressure of the compressed air can be appropriately adjusted for each supplying destination of the compressed air. As illustrated in FIG. 5, a plurality of regulators 35 is collectively arranged on the front side of the drive end box 3. Therefore, the operator of the fine spinning machine 1 can detach the panel 78 on the front side of the drive end box 3 to expose the regulator 35 towards the front side. The operator thus can easily adjust the regulator 35.

[0076] The draft driving section 31 is arranged higher than the reinforcement frame members 80, 81, and 82. As illustrated in FIG. 5, the draft driving section 31 includes a first motor 84 adapted to drive the first line shaft 36, and a second motor 85 adapted to drive the second line shaft 37. As illustrated in FIG. 8, the draft driving section 31 includes a first driving shaft 86 and a second driving shaft 87. The first driving shaft 86 is coupled to the first line shaft 36. The second driving shaft 87 is coupled to the second line shaft 37. In FIG. 8, the illustration of a state in which the first line shaft 36 is coupled to the first driving shaft 86 and a state in which the second line shaft 37 is coupled to the second driving shaft 87 is omitted.

[0077] As illustrated in FIG. 9, the first motor 84 and the first driving shaft 86 are connected by a plurality of

pulleys and a transmission belt. The first line shaft 36 is thus driven by a driving force of the first motor 84, and the front bottom rollers 30 of all the spinning units 6 are collectively driven. The second motor 85 and the second driving shaft 87 are also connected by a plurality of pulleys and a transmission belt. The second line shaft 37 is thus driven by a driving force of the second motor 85, and the middle bottom rollers 29 of all the spinning units 6 are collectively driven.

[0078] The draft driving section 31 includes a base body 88 adapted to support a rotation shaft of the pulleys. The base body 88 is formed as a molded integrated structure. As illustrated in FIG. 9, the base body 88 includes a first supporting section 89 and a second supporting section 90 adapted to rotatably support a shaft of each pulley. The first supporting section 89 and the second supporting section 90 are respectively formed along the front-back direction and are arranged to face each other in the left-right direction. The base body 88 is arranged to be set over the reinforcement frame member 80 on the front side of the frame 79 and the reinforcement frame member 81 on the back side, and is fixed to the reinforcement frame members 81 and 82 by screw-fitting. The base body 88 itself thus serves as a structure of the frame 79, and rigidity of the frame 79 is improved.

[0079] Next, a drive transmission path from the first motor 84 to the first driving shaft 86 will be more specifically described.

[0080] As illustrated in FIG. 9, a first drive output pulley 91 is fixed to an end of an output shaft 84a of the first motor 84. A first drive input pulley 92 is mounted to an end of the first driving shaft 86 in a relatively non-rotatable manner. One end of the output shaft 84a of the first motor 84 is supported by the first supporting section 89 of the base body 88. One end of the first driving shaft 86 is supported by the second supporting section 90 of the base body 88. The first drive output pulley 91 and the first drive input pulley 92 are arranged between the first supporting section 89 and the second supporting section 90. A first transmission belt 93 is set on the first drive output pulley 91 and the first drive input pulley 92. The rotation output of the first motor 84 can be output from the first driving shaft 86.

[0081] The output of the first motor 84 is appropriately reduced and output from the first driving shaft 86 by appropriately setting a ratio of a diameter of the first drive output pulley 91 and the first drive input pulley 92. In the present embodiment, the first drive output pulley 91 is a two-stage pulley. The first drive output pulley 91 has a structure in which a high-speed pulley 91a (a pulley having a larger diameter) and a low-speed pulley 91b (a pulley having a smaller diameter) are arranged next to one another in an axial line direction on the output shaft 84a of the first motor 84. The first transmission belt 93 is set over the first drive input pulley 92 and one of the high-speed pulley 91a and the low-speed pulley 91b. Depending on which one of the high-speed pulley 91a and the low-speed pulley 91b is set with the first transmission belt 93, a reduction ratio of the output of the first motor 84 can be changed. By resetting the first transmission belt 93, the rotation speed of the front bottom roller 30 can be easily changed.

[0082] The first drive input pulley 92 and the first driving shaft 86 are coupled by a slip key and a key groove. The first drive input pulley 92 and the first driving shaft 86 are relatively non-rotatable, and the first drive input pulley 92 can be moved in an axial direction of the first driving shaft 86. Thus, the first drive input pulley 92 can be moved between a position corresponding to the high-speed pulley 91a (a position illustrated with a solid line in FIG. 9) and a position corresponding to the low-speed pulley 91b (a position illustrated with a chain double-dashed line in FIG. 9). Therefore, regardless of whether the driving force is transmitted by either the high-speed pulley 91a or the low-speed pulley 91b, the first transmission belt 93 can be appropriately set on the first drive output pulley 91 and the first drive input pulley 92. A structure of coupling the first drive input pulley 92 and the first driving shaft 86 is not limited to a key groove, and may be a spline fitting, for example.

[0083] The diameter differs between the high-speed pulley 91a and the low-speed pulley 91b. Between a case of using the high-speed pulley 91a and a case of using the low-speed pulley 91b, a necessary length of the first transmission belt 93 differs. Therefore, between the case of using the high-speed pulley 91a and the case of using the low-speed pulley 91b, the first transmission belt 93 is required to be changed. In the present embodiment, the first transmission belt 93 can be easily changed.

[0084] Since one end of the output shaft 84a to which the first drive output pulley 91 is fixed is supported by the first supporting section 89 of the base body 88, the first transmission belt 93 can be removed from the other end of the output shaft 84a. Since one end of the first driving shaft 86 to which the first drive input pulley 92 is mounted is supported by the second supporting section 90 of the base body 88, the first transmission belt 93 can be removed from the other end of the first driving shaft 86. The first transmission belt 93 thus can be changed.

[0085] In the fine spinning machine 1 of the present embodiment, in order to enable the transmission belt 93 to be more easily changed, a space for changing the transmission belt 93 is formed in the drive end box 3. More specifically, a space 95 is formed between a distal end of the output shaft 84a of the first motor 84 and the second supporting section 90 of the base body 88. A space 96 is formed between a distal end of the first driving shaft 86 and the first supporting section 89 of the base body 88. In order to form the space 96, the first supporting section 89 is provided with a recess 97 at a position facing the distal end of the first driving shaft 86.

[0086] By forming the spaces 95 and 96, the first transmission belt 93 can be easily changed, and the operation of changing the setting of the rotation speed of the front bottom roller 30 can be easily carried out.

[0087] Next, a drive transmission path from the second

motor 85 to the second driving shaft 87 will be specifically described.

[0088] A second drive output pulley 98 is fixed to an end of an output shaft 85a of the second motor 85. A second drive input pulley 99 is mounted to the end of the second driving shaft 87 in a relatively non-rotatable manner. The draft driving section 31 includes an intermediate shaft 100. A first intermediate pulley 101 is mounted to one end of the intermediate shaft 100 in a relatively non-rotatable manner. A second intermediate pulley 102 is mounted to the other end of the intermediate shaft 100 in a relatively non-rotatable manner. The output shaft 85a of the second motor 85, the second driving shaft 87, and the intermediate shaft 100 are supported so as to be set over the first supporting section 89 and the second supporting section 90 of the base body 88.

[0089] The second drive output pulley 98 and the first intermediate pulley 101 are arranged opposite to the first supporting section 89 with the second supporting section 90 therebetween. The second intermediate pulley 102 and the second drive input pulley 99 are arranged opposite to the second supporting section 90 with the first supporting section 89 therebetween. The pulleys 98, 99, 101, and 102 are arranged at an outer side with respect to the first supporting section 89 and the second supporting section 90. A second transmission belt 103 is set on the second drive output pulley 98 and the first intermediate pulley 101. A third transmission belt 104 is set on the second intermediate pulley 102 and the second drive input pulley 99. The rotation output of the second motor 85 thus can be output from the second driving shaft 87.

[0090] By appropriately setting a ratio of a diameter of the pulleys 98, 99, 101, and 102, the output of the second motor 85 is appropriately reduced and output from the second driving shaft 87. In the present embodiment, the first intermediate pulley 101 and the second drive input pulley 99 can be changed. Specifically, the first intermediate pulley 101 can be removed from the end of the intermediate shaft 100. The first intermediate pulley 101 thus can be changed to a pulley of a different diameter. The second drive input pulley 99 can be removed from the end of the second driving shaft 87. The second drive input pulley 99 thus can be changed to a pulley having a different diameter. By changing the diameter of the first intermediate pulley 101 and the second drive input pulley 99, the reduction ratio of the output of the second motor 85 can be changed. By changing the first intermediate pulley 101 and the second drive input pulley 99, the rotation speed of the middle bottom roller 29 can be easily changed.

[0091] In the present embodiment, in order to easily change the first intermediate pulley 101 and the second drive input pulley 99, a space for changing the pulleys 101 and 99 is formed in the drive end box 3. Since the first intermediate pulley 101 is arranged opposite to the first supporting section 89 with the second supporting section 90 therebetween, the first supporting section 89 is not provided beyond the distal end of the intermediate shaft 100 located at the first intermediate pulley 101 side. Therefore, a space 105 for changing the first intermediate pulley 101 is formed beyond the distal end of the intermediate shaft 100 located at the first intermediate pulley 101 side. Since the second drive input pulley 99 is arranged opposite to the second supporting section 90 with the first supporting section 89 therebetween, the second supporting section 90 is not provided beyond the distal end of the second driving shaft 87. Therefore, a space 106 for changing the second drive input pulley 99 is formed beyond the distal end of the second driving shaft 87.

[0092] Since the space 105 and the space 106 are formed, the first intermediate pulley 101 and the second drive input pulley 99 can be easily changed. As a result, the operation of changing the setting of the rotation speed of the middle bottom roller 29 can be easily carried out.

[0093] In the present embodiment, the frame 79 of the drive end box 3 is structured by combining elongate frame members (shaped steel such as groove steel, or a steel tube). Therefore, by inserting a hand from between the frame members, the draft driving section 31 arranged in the frame 79 can be easily accessed. The transmission belt and/or the pulley thus can be easily changed.

[0094] The panel 78 covering the front side, the side surface side (an end side in the left-right direction of the fine spinning machine 1), and the back side of the frame 79 is removably mounted. Therefore, in the fine spinning machine 1 of the present embodiment, by detaching the panel 78, access can be made from three sides, i.e., the front side, the side end, and the back side with respect to the draft driving section 31 in the frame 79. The transmission belt and/or the pulley thus can be more easily changed. Therefore, in the fine spinning machine 1 of the present embodiment, the setting of the rotation speed of the front bottom roller 30 and the middle bottom roller 29 can be easily changed.

[0095] The operation section 18 is arranged on the front side of the drive end box 3. As illustrated in FIG. 5, the operation section 18 is located on the front side of the draft driving section 31. Therefore, in this state, the operation section 18 becomes a hindrance and access cannot be easily made to the draft driving section 31. The operation section 18 is connected with a power supply cable for supplying power to the operation section 18, a communication cable for communicating with each spinning unit 6, and the like. Thus, in order to completely detach the operation section 18 from the frame 79, the cables are required to be detached, and a work load is caused. In the fine spinning machine 1 of the present embodiment, the operation section 18 is mounted to the frame 79 via a hinge section (not illustrated), and the cables are wired to pass near the hinge section. As illustrated in FIG. 8, the operation section 18 can be swung with the hinge section as a center. Thus, the operation section 18 can be opened to open the front side of the draft driving section 31. The draft driving section 31 thus can be easily accessed from the front side.

[0096] Next, characteristics of a layout in the fine spinning machine 1 of the present embodiment will be described.

[0097] In the yarn winding machine such as the fine spinning machine, when the winding condition of the yarn is changed, the setting of each section is required to be changed. For example, in the case of the fine spinning machine 1 as in the present embodiment, when the spinning condition such as the type of fibers and/or a yarn count (the thickness) of the spun yarn 15 to be produced is changed, the rotation speed of the draft roller, the air pressure of the compressed air to be supplied to the air-jet spinning device, and the like are required to be changed. When the spinning condition is changed, the operator of the fine spinning machine 1 changes the pulley and the transmission belt arranged in the draft driving section 31, and adjusts the regulator 35 arranged in the air supplying section 34.

[0098] In the conventional fine spinning machine, since the draft driving section is arranged in the motor box and the air supplying section is arranged in the blower box, every time the spinning condition is changed, the operator has been required to move between the motor box and the blower box. Thus, the operation of changing the setting cannot be smoothly carried out, and a work load has been caused on the operator.

[0099] In the fine spinning machine 1 of the present embodiment, the draft driving section 31 and the air supplying section 34 are arranged in the drive end box 3. By collectively arranging the draft driving section 31 and the air supplying section 34, the operation of changing the setting can be carried out just at the drive end box 3. As a result, the operation of changing the setting can be smoothly carried out, and the work load on the operator can also be reduced.

[0100] In the present embodiment, the air supplying section 34 is arranged lower than, and the draft driving section 31 is arranged higher than the reinforcement frame members 80, 81, and 82. The air supplying section 34 and the draft driving section 31 are arranged separately in different ranges in a vertical direction in the drive end box 3. By separately arranging the draft driving section 31 and the air supplying section 34 in the upper and lower ranges, the arrangement in the drive end box 3 becomes organized. For example, compared to a case where the draft driving section 31 and the air supplying section 34 are arranged in a mixed manner, access can be easily made to the draft driving section 31 and the air supplying section 34. By arranging the air supplying section 34 and the draft driving section 31 in different ranges in the vertical direction in the drive end box 3, the air supplying section 34 and the draft driving section 31 do not become adjacent in the front-back direction or the left-right direction. Thus, the air supplying section 34 and the draft driving section 31 can be easily accessed from the front-back direction and the left-right direction.

[0101] Since the air supplying section 34 is not arranged in the upper range in the frame 79, the draft driving section 31 can be easily arranged in the space at the upper range of the frame 79. Thus, the spaces 95, 96, 105, and 106 for changing the pulley and/or the transmission belt can be easily formed sufficiently. The setting of the draft driving section 31 can be more easily changed.

[0102] For example, as described in Patent Document 2, in order to carry out maintenance on the yarn joining cart (the operation cart) in the conventional fine spinning machine, the operation cart is taken out from the side of the machine main body. Therefore, when the structure of arranging the drive end box 3 at the side end of the machine main body 2 as in the present embodiment is applied to the fine spinning machine of Patent Document 2, the drive end box 3 is required to be arranged avoiding the passage of the operation cart to be taken out from the side of the machine main body 2. Thus, the space in the drive end box 3 becomes narrow, and the space for changing the pulley and/or the transmission belt becomes difficult to be ensured. Since the space in the drive end box 3 becomes narrow, arranging the air supplying section 34 in the drive end box 3 becomes difficult. In the conventional spinning machine as in Patent Document 2, arranging the draft driving section 31 and the air supplying section 34 in the drive end box 3 in an organized manner has been difficult.

[0103] In the fine spinning machine 1 of the present embodiment, the yarn joining cart 66 can be taken out from the back side of the machine main body 2 to carry out maintenance. Therefore, the yarn joining cart 66 is not required to be taken out from the side of the machine main body 2. The fine spinning machine 1 of the present embodiment does not have a restriction that the drive end box 3 must be arranged avoiding the passage of the yarn joining cart 66. According to the present embodiment, there is a margin in the space in the drive end box 3, and the space for changing the pulley and/or the transmission belt can be sufficiently ensured. Furthermore, since the space can be ensured in the drive end box 3, the air supplying section arranged in the blower box in the conventional fine spinning machine can be moved to the drive end box 3. Thus, the draft driving section 31 and the air supplying section 34 can be arranged in the drive end box 3 in an organized manner.

[0104] In the fine spinning machine of Patent Document 2, since the motor box is arranged to be sandwiched by the machine main body and the blower box, the draft driving section in the motor box cannot be accessed from the side. In the fine spinning machine 1 of the present embodiment, the drive end box 3 is arranged at the end in the left-right direction of the fine spinning machine 1, and other structures are not arranged on one side in the left-right direction of the drive end box 3. Therefore, the draft driving section 31 in the drive end box 3 can be easily accessed from one of left or right side. Since other structures are not arranged on the back side of the drive end box 3, the draft driving section 31 also can be freely accessed from the back side.

[0105] A manufacturing method of the spun yarn 15 by the fine spinning machine 1 of the present embodiment will be described.

[0106] As described above, in the fine spinning machine 1 of the present embodiment, when the spinning condition is changed, the setting of the draft driving section 31 is changed, and the rotation speed of the front bottom roller 30 and the middle bottom roller 29 is changed. When slightly changing the rotation speed of the front bottom roller 30 and the middle bottom roller 29, this can be achieved by simply controlling to change the rotation speed of the output shaft of each of the first motor 84 and the second motor 85. However, when greatly changing the rotation speed of the front bottom roller 30 and the middle bottom roller 29, this cannot be appropriately achieved by simply controlling to change the rotation speed of the output shaft of each of the first motor 84 and the second motor 85. In such a case, the pulley and the transmission belt of the draft driving section 31 are required to be changed.

[0107] An example of case in which the rotation speed of the front bottom roller 30 and the middle bottom roller 29 is required to be greatly changed is a case in which the type of the air-jet spinning device of the spinning section 11 is changed. When the type of the air-jet spinning device is changed, the setting of the rotation speed of the front bottom roller 30 and the middle bottom roller 29 is required to be changed according to the spinning speed of the spinning section 11. Since the method of producing the spun yarn 15 differs between the first air-jet spinning device 41 and the second air-jet spinning device 42, the spinning speed of the spun yarn 15 greatly differs. Therefore, when the type of air-jet spinning device is changed, the rotation speed of the front bottom roller 30 and the middle bottom roller 29 is required to be greatly changed.

[0108] When producing the spun yarn 15 using the first air-jet spinning device 41, the front bottom roller 30 and the middle bottom roller 29 are rotatably driven at high speed. This is because the first air-jet spinning device 41 can perform high-speed spinning. When producing the spun yarn 15 using the second air-jet spinning device 42, the front bottom roller 30 and the middle bottom roller 29 are rotatably driven at low speed as compared to the case of using the first air-jet spinning device 41.

[0109] The manufacturing of the spun yarn 15 by the fine spinning machine 1 of the present embodiment is carried out in the following manner.

[0110] In the spinning section 11, when performing the spinning by the first air-jet spinning device 41, the setting of the draft driving section 31 is changed such that the draft roller is driven with a high-speed pulley in the draft driving section 31. More specifically, in the first drive output pulley 91 configured as a two-stage pulley, the first transmission belt 93 is set on the high-speed pulley 91a side. The front bottom roller 30 thus can be rotatably driven at high speed. The first intermediate pulley 101 and the second drive input pulley 99 are changed to the high-speed pulley (the pulley having a relatively small diameter). The middle bottom roller 29 thus can be rotatably driven at high speed.

[0111] In the spinning section 11, when performing the spinning by the second air-jet spinning device 42, the setting of the draft driving section 31 is changed to drive the draft roller with a low-speed pulley in the draft driving section 31. More specifically, in the first drive output pulley 91 configured as a two-stage pulley, the first transmission belt 93 is set on the low-speed pulley 91b side. The front bottom roller 30 thus can be rotatably driven at low speed. The first intermediate pulley 101 and the second drive input pulley 99 are changed to the low-speed pulley (the pulley having a relatively large diameter) . The middle bottom roller 29 thus can be rotatably driven at low speed.

[0112] By changing to the low-speed pulley or the high-speed pulley according to the type of air-jet spinning device, the draft roller can be rotatably driven at an appropriate speed according to properties of the air-jet spinning device.

[0113] The fine spinning machine 1 of the present embodiment includes the machine main body 2, a plurality of the spinning units 6, the draft driving section 31, the air supplying section 34, and the drive end box 3. The spinning units 6 include the bottom rollers to be driven, and are lined along the longitudinal direction of the machine main body 2. The draft driving section 31 is adapted to commonly drive the front bottom roller 30 and the middle bottom roller 29 of the bottom rollers arranged in each of the spinning units 6. The air supplying section 34 is adapted to supply air to the spinning units 6. The drive end box 3 is adapted to accommodate the draft driving section 31 and the air supplying section 34 at one end in a direction in which the spinning units 6 are arranged. The drive end box 3 is adapted to accommodate the draft driving section 31 in the upper range and the air supplying section 34 in the lower range.

[0114] By accommodating the draft driving section 31 and the air supplying section 34 in one drive end box 3, the draft driving section 31 and the air supplying section 34 can be simultaneously accessed, and the operation of changing the setting can be smoothly carried out. With the draft driving section 31 and the air supplying section 34 arranged separately in the upper and lower ranges of the drive end box 3, the organized arrangement can be realized in which access can be easily made to the draft driving section 31 and the air supplying section 34 from the front-back direction or the left-right direction. Therefore, the operability in changing the setting of the draft driving section 31 and the air supplying section 34 is improved.

[0115] In the fine spinning machine 1 of the present embodiment, a left-right direction is the direction in which the spinning units 6 are arranged, a front-back direction is a direction perpendicular to the left-right direction and a top-bottom direction. When viewing the machine main body 2 from the front-back direction, a front side is a side on which the spun yarn 15 wound by the spinning unit 6

is travelling, and a back side is an opposite side with respect to the front side. The drive end box 3 has the frame 79 that enables an access to the draft driving section 31 from one of the end sides in the left-right direction, the back side, and the front side.

[0116] The draft driving section 31 thus can be easily accessed, and change in setting, maintenance, and the like of the draft driving section 31 can be easily carried out.

[0117] In the fine spinning machine 1 of the present embodiment, the operation section 18 adapted to be operable commonly for the plurality of the spinning units 6 is provided at the front side of the drive end box 3. The operation section 18 is provided to be openable and closable with respect to the drive end box 3.

[0118] Since the operation section 18 is arranged at the front side, the operation section 18 can be operated easily. The interior of the drive end box 3 can be accessed from the front side by opening the operation section 18. Therefore, the setting changing operation and/or maintenance operation of the draft driving section 31 accommodated in the drive end box 3 can also be carried out easily.

[0119] In the fine spinning machine 1 of the present embodiment, the draft driving section 31 includes the driving shafts 86 and 87 respectively adapted to commonly drive the bottom rollers 29 and 30 of the plurality of the spinning units 6, motors 84 and 85, which are driving sources of the bottom rollers 29 and 30, and a plurality of pulleys adapted to transmit driving respectively between the motors 84, 85 and the driving shaft 86, 87. The drive end box 3 includes the spaces 95, 96, 105, and 106 adapted to enable changing of the pulley for transmitting the driving for at least the high-speed pulley and the low-speed pulley.

[0120] The rotation speed of the draft roller can be changed by changing the pulley. The changing operation of the pulley can be easily carried out by forming the space in the drive end box 3.

[0121] In the fine spinning machine 1 of the present embodiment, the draft device 10 includes at least a front roller pair, a middle roller pair, and a back roller pair in this order from the downstream in the travelling direction of the fiber bundle 14. The front roller pair includes a driven front bottom roller 30, and a front top roller 26 that is driven by making contact with the front bottom roller 30. The middle roller pair includes a driven middle bottom roller 29, and a middle top roller 25 that is driven by making contact with the middle bottom roller 29. The draft driving section 31 includes the first driving shaft 86 adapted to commonly drive the front bottom roller 30 of each of the plurality of the spinning units 6, the second driving shaft 87 adapted to commonly drive the middle bottom roller 29 of each of the plurality of spinning units 6, the first motor 84 adapted as a driving source of the front bottom rollers 30, the second motor 85 adapted as a driving source of the middle bottom rollers 29, a plurality of pulleys adapted to transmit driving between the first motor 84 and the first driving shaft 86, and a plurality of pulleys adapted to transmit driving between the second motor 85 and the second driving shaft 87.

[0122] The front roller pair and the middle roller pair thus can be commonly driven in the plurality of the spinning units 6. By changing the pulley, the rotation speed of the front roller pair and the middle roller pair can be changed.

[0123] In the fine spinning machine 1 of the present embodiment, the draft driving section 31 includes the first driving shaft 86 adapted to commonly drive the front bottom roller 30 of each of the plurality of spinning units 6, the first motor 84 adapted as a driving source of the front bottom roller 30, the first drive output pulley 91 and the first drive input pulley 92 adapted to transmit driving between the first motor 84 and the first driving shaft 86, and the first transmission belt 93 adapted to transmit a driving force between the pulleys 91 and 92. The first drive output pulley 91 is a two-stage pulley in which the high-speed pulley 91a and the low-speed pulley 91b are arranged next to one another. The drive end box 3 includes the spaces 95 and 96 adapted to enable the changing of the first transmission belt 93 set on the two-stage pulley.

[0124] The rotation speed of the front bottom roller 30 can be changed by simply changing the first transmission belt 93 without detaching the pulley.

[0125] In the fine spinning machine 1 of the present embodiment, each of the spinning units 6 includes the spinning section 11 having the air-jet spinning device adapted to produce the spun yarn 15 by spinning the fiber bundle 14, which has been drafted by the draft device 10, using a whirling airflow. The spinning section 11 is adapted to hold the air-jet spinning device of different types.

[0126] In the fine spinning machine 1 of the present embodiment, satisfactory operability in changing the setting of the draft driving section 31 and the air supplying section 34 is achieved. Therefore, when the type of the air-jet spinning device is changed, change can be easily made to an appropriate setting according to the type of the air-jet spinning device.

[0127] In the fine spinning machine 1 of the present embodiment, the different types of the air-jet spinning device that is adapted to be held by the spinning section 11 includes at least the first air-jet spinning device 41 and the second air-jet spinning device 42. The first air-jet spinning device 41 includes the fiber guiding section 45 adapted to receive the fiber bundle 14 and to guide the fiber bundle 14 to the spinning chamber 46, the nozzle block 43 including the air ejecting nozzle 47 adapted to generate a whirling airflow in the spinning chamber 46, and the hollow guide shaft body 44 adapted as the passage of the fiber bundle 14 twisted by the whirling airflow in the spinning chamber 46. The second air-jet spinning device 42 includes the first nozzle block 51 including the first air ejection nozzle 55 adapted to apply a whirling airflow in the first direction to the fiber bundle 14, and the second nozzle block 52 including the second air ejection

nozzle 56 adapted to apply a whirling airflow to the fiber bundle 14 in the second direction that is opposite to the first direction. When the spinning section 11 carries out spinning by the first air-jet spinning device 41, the draft driving section 31 is adapted to drive the draft roller by the high-speed pulley. When the spinning section 11 carries out spinning by the second air-jet spinning device 42, the draft driving section 31 is adapted to drive the draft roller by the low-speed pulley.

[0128] Since the draft driving section 31 of the fine spinning machine 1 can easily change the low-speed pulley and the high-speed pulley, change to an appropriate pulley according to the type of the air-jet spinning device can be easily carried out.

[0129] The fine spinning machine 1 of the present embodiment further includes the molded integrated base body 88 to which at least a portion of the draft driving section 31 is mounted. The base body 88 is adapted to function as a structure of the drive end box 3. Since the base body 88 also serves as a structure of the drive end box 3, the rigidity of the drive end box 3 can be improved.

[0130] The fine spinning machine 1 of the present embodiment further includes the yarn joining cart 66 provided to travel along the direction in which the spinning units 6 are arranged and adapted to perform an operation with respect to the spinning units 6. The machine main body 2 includes the opened section 110 adapted to enable the yarn joining cart 66 to be installed or removed from the back side. Thus, by installing or removing the yarn joining cart 66 from the machine main body 2, the maintenance of the yarn joining cart 66 can be easily carried out.

[0131] In the manufacturing method of the spun yarn 15 by the fine spinning machine 1 of the present embodiment, when the air-jet spinning device of the spinning section 11 is changed to the first air-jet spinning device 41, the pulley for driving the draft roller is changed to the high-speed pulley. When the air-jet spinning device of the spinning section 11 is changed to the second air-jet spinning device 42, the pulley for driving the draft roller is changed to the low-speed pulley.

[0132] Preferred embodiments and alternative embodiments of the present invention have been described above, but the above-described structure may be modified as below.

[0133] In the fine spinning machine 1 of the embodiment described above, since the draft device 10 is arranged in the upper range of the machine main body 2, the draft driving section 31, which is the driving source of the draft roller, is arranged in the upper range of the drive end box 3. In place of such a structure, the draft device 10 may be arranged in the lower range of the machine main body 2. In this case, the draft driving section 31 is suitably arranged in the lower range of the drive end box 3, and the air supplying section 34 is suitably arranged in the upper range.

[0134] In the embodiments described above, the yarn accumulating roller 63 of the yarn accumulating device 12 is rotated to pull out the spun yarn 15 from the spinning section 11. For example, as described in Japanese Unexamined Patent Publication No. 2005-220484, a yarn feeding device which sandwiches the spun yarn with a delivery roller and a nip roller and rotates to pull out the spun yarn from the spinning device may be arranged.

[0135] In the embodiments described above, the draft driving section 31 in the drive end box 3 can be accessed from three sides, i.e., the front side, the end side, and the back side. Access is to be made at least from the front side, and it is suitable if access can be made from one of the end side and the back side in addition to the front side.

[0136] In the embodiments described above, the driven member to be driven by the driving section of the drive end box 3 is the draft roller. The structure of the present invention can be applied even to the arrangement of the driving section adapted to drive the driven member other than the draft roller. Furthermore, in the embodiments described above, the entire air supplying section 34 is arranged in the lower range of the drive end box 3. However, one portion of the air supplying section 34 may be arranged in other areas, for example, the upper range of the drive end box 3.

[0137] In the embodiments described above, the spinning section 11 can be mounted with any of the two types of the air-jet spinning device. Another type of an air-jet spinning device may be mounted on the spinning section 11. In the embodiments described above, the pulley adapted to reduce the output of the motor can be changed with the high-speed pulley and the low-speed pulley. The type of the changeable pulley is not limited to two types, and may be three or more types.

[0138] In FIG. 1, the winding section 13 is illustrated to form a conical (tapered) package 17, but may form a cheese-shaped (cylindrical) package.

[0139] The spinning device is not limited to the air-jet spinning device, and the structure of the present embodiments can be applied to spinning machines provided with other types of spinning devices.

Claims

1. An air-jet spinning machine comprising:

a machine main body (2),
a plurality of air-jet spinning units (6) arranged along a longitudinal direction of the machine main body (2), each air-jet spinning unit (6) including at least one driven member (29, 30),
a driving section (31) adapted to collectively drive at least one driven member (30) of the air-jet spinning units (6),
an air supplying section (34) adapted to supply air to the air-jet spinning units (6),
an accommodating section (3) adapted to accommodate the driving section (31) and the air supplying section (34) at one end in a direction

in which the air-jet spinning units (6) are arranged, the accommodating section (3) being adapted to accommodate the driving section (31) and the air supplying section (34) within different ranges in a vertical direction.

2. The air-jet spinning machine according to claim 1, wherein the accommodating section (3) is adapted to accommodate the driving section (31) in an upper range, and the air supplying section (34) in a lower range.

3. The air-jet spinning machine according to claim 1 or claim 2, wherein provided that a left-right direction is the direction in which the air-jet spinning units (6) are arranged, a front-back direction is a direction perpendicular to the left-right direction and a top-bottom direction, and when viewing the machine main body (2) from the front-back direction, a front side is a side on which a yarn (15) wound by the air-jet spinning unit (6) is travelling, and a back side is an opposite side with respect to the front side,
the accommodating section (3) is formed as a frame (79) adapted to enable access to the driving section (31) from the front side, and at least one of the back side and one of end sides in the left-right direction.

4. The air-jet spinning machine according to claim 3, further comprising an operation section (18) provided at the front side of the accommodating section (3) and adapted to be operable commonly for the air-jet spinning units (6), the operation section (18) being provided to be openable and closable with respect to the accommodating section (3).

5. The air-jet spinning machine according to any one of claim 1 through claim 4, wherein each of the air-jet spinning units (6) includes a draft device (10) adapted to draft a fiber bundle (14),
the driven member is a draft roller (30) of the draft device (10),
the driving section (31) includes:

a driving shaft (86) adapted to commonly drive the draft roller (30) of each of the air-jet spinning units (6),
a motor (84) adapted as a drive source of the draft roller (30), and
a pulley (91, 92) adapted to transmit driving between the motor (84) and the driving shaft (86), and

the accommodating section (3) includes a space adapted to enable changing of the pulley (91, 92) for at least a high-speed pulley (91a) and a low-speed pulley (91b).

6. The air-jet spinning machine according to claim 5, wherein the draft device (10) includes at least a front roller pair (26, 30), a middle roller pair (25, 29), and a back roller pair (24, 28) arranged in this order from downstream in a travelling direction of the fiber bundle (14),
the front roller pair (26, 30) including a driven front bottom roller (30) and a front top roller (26) that is driven by making contact with the front bottom roller (30), and the middle roller pair (25, 29) including a driven middle bottom roller (29) and a middle top roller (25) that is driven by making contact with the middle bottom roller (29), and
the driving section (31) includes:

a first driving shaft (86) adapted to commonly drive the front bottom roller (30) of each of the air-jet spinning units (6),
a second driving shaft (87) adapted to commonly drive the middle bottom roller (29) of each of the air-jet spinning units (6),
a first motor (84) adapted as a driving source of the front bottom roller (30),
a second motor (85) adapted as a driving source of the middle bottom roller (29),
a plurality of first pulleys adapted to transmit driving between the first motor (84) and the first driving shaft (86), and
a plurality of second pulleys adapted to transmit driving between the second motor (85) and the second driving shaft (87).

7. The air-jet spinning machine according to any one of claim 1 through claim 4, wherein each of the air-jet spinning units (6) includes a draft device (10) adapted to draft the fiber bundle (14),
the driven member is a draft roller (30) of the draft device (10),
the driving section (31) includes:

a driving shaft (86) adapted to commonly drive the draft roller (30) of each of the air-jet spinning units (2),
a motor (84) adapted as a drive source of the draft roller (30), and
a plurality of pulleys (91, 92) adapted to transmit driving between the motor (84) and the driving shaft (86), at least one of the pulleys (91, 92) being a multistage pulley (91) provided with a high-speed pulley (91a) and a low-speed pulley (91b), and
a transmission belt (93) adapted to transmit driving force between the pulleys (91, 92),

wherein the accommodating section (3) includes a space adapted to enable changing of the transmission belt (93) set on the multistage pulley (91).

8. The air-jet spinning machine according to any one

of claim 5 through claim 7, wherein each of the air-jet spinning units (6) includes a spinning section (11) having an air-jet spinning device adapted to produce a spun yarn (16) by spinning the fiber bundle (14), which has been drafted by the draft device (10), by a whirling airflow, the spinning section (11) being adapted to hold the air-jet spinning device of different types.

9. The air-jet spinning machine according to claim 8, wherein the different types of the air-jet spinning device that is adapted to be held by the spinning section (11) includes at least:

a first air-jet spinning device (41) including a fiber guiding section (45) adapted to receive the fiber bundle (14) and to guide the fiber bundle (14) to a spinning chamber (46), a nozzle block (43) including a nozzle (47) adapted to generate a whirling airflow in the spinning chamber (46), and a hollow guide shaft body (44) adapted as a passage of the fiber bundle (14) twisted by the whirling airflow in the spinning chamber (46), and

a second air-jet spinning device (42) including a first nozzle block (51) including a first nozzle (55) adapted to apply a whirling airflow in a first direction to the fiber bundle (14), and a second nozzle block (52) including a second nozzle (56) adapted to apply a whirling airflow in a second direction that is opposite to the first direction,

wherein the driving section (31) is adapted to drive the draft roller (30) by the high-speed pulley (91a) when the spinning section (11) carries out spinning by the first air-jet spinning device (41), and

the driving section (31) is adapted to drive the draft roller (30) by the low-speed pulley (91b) when the spinning section (11) carries out spinning by the second air-jet spinning device (42).

10. The air-jet spinning machine according to any one of claim 1 through claim 9, further comprising a molded integrated base body (88) to which at least a portion of the driving section (31) is mounted, the base body (88) being adapted to function as a structure of the accommodating section (3).

11. The air-jet spinning machine according to any one of claim 1 through claim 10, further comprising an operation cart (66) provided to travel along the direction in which the air-jet spinning units (6) are arranged and adapted to perform an operation with respect to at least one of the air-jet spinning units (6), wherein provided that a left-right direction is the direction in which the air-jet spinning units (6) are arranged, a front-back direction is a direction perpendicular to the left-right direction and a top-bottom direction, and when viewing the machine main body (2) from the front-back direction, a front side is a side on which a yarn (15) wound by the air-jet spinning unit (6) is travelling, and a back side is an opposite side with respect to the front side,

the machine main body (2) includes an opened section (110) adapted to enable the operation cart (66) to be installed or removed from the back side.

12. A manufacturing method of a spun yarn by the air-jet spinning machine according to claim 8, wherein the different types of the air-jet spinning device that is adapted to be held by the spinning section (11) includes at least:

a first air-jet spinning device (41) including a fiber guiding section (45) adapted to receive the fiber bundle (14) and to guide the fiber bundle (14) to a spinning chamber (46), a nozzle block (43) including a nozzle (47) adapted to generate a whirling airflow in the spinning chamber (46), and a hollow guide shaft body (44) adapted as a passage of the fiber bundle (14) twisted by the whirling airflow in the spinning chamber (46), and

a second air-jet spinning device (42) including a first nozzle block (51) including a first nozzle (55) adapted to apply a whirling airflow in a first direction to the fiber bundle (14), and a second nozzle block (52) including a second nozzle (56) adapted to apply a whirling airflow in a second direction that is opposite to the first direction,

the manufacturing method including:

changing the pulley adapted to drive the draft roller (30) to the high-speed pulley (91a) when the air-jet spinning device of the spinning section (11) is changed to the first air-jet spinning device (41), and

changing the pulley adapted to drive the draft roller (30) to the low-speed pulley (91b) when the air-jet spinning device of the spinning section (11) is changed to the second air-jet spinning device (42).

FIG. 1

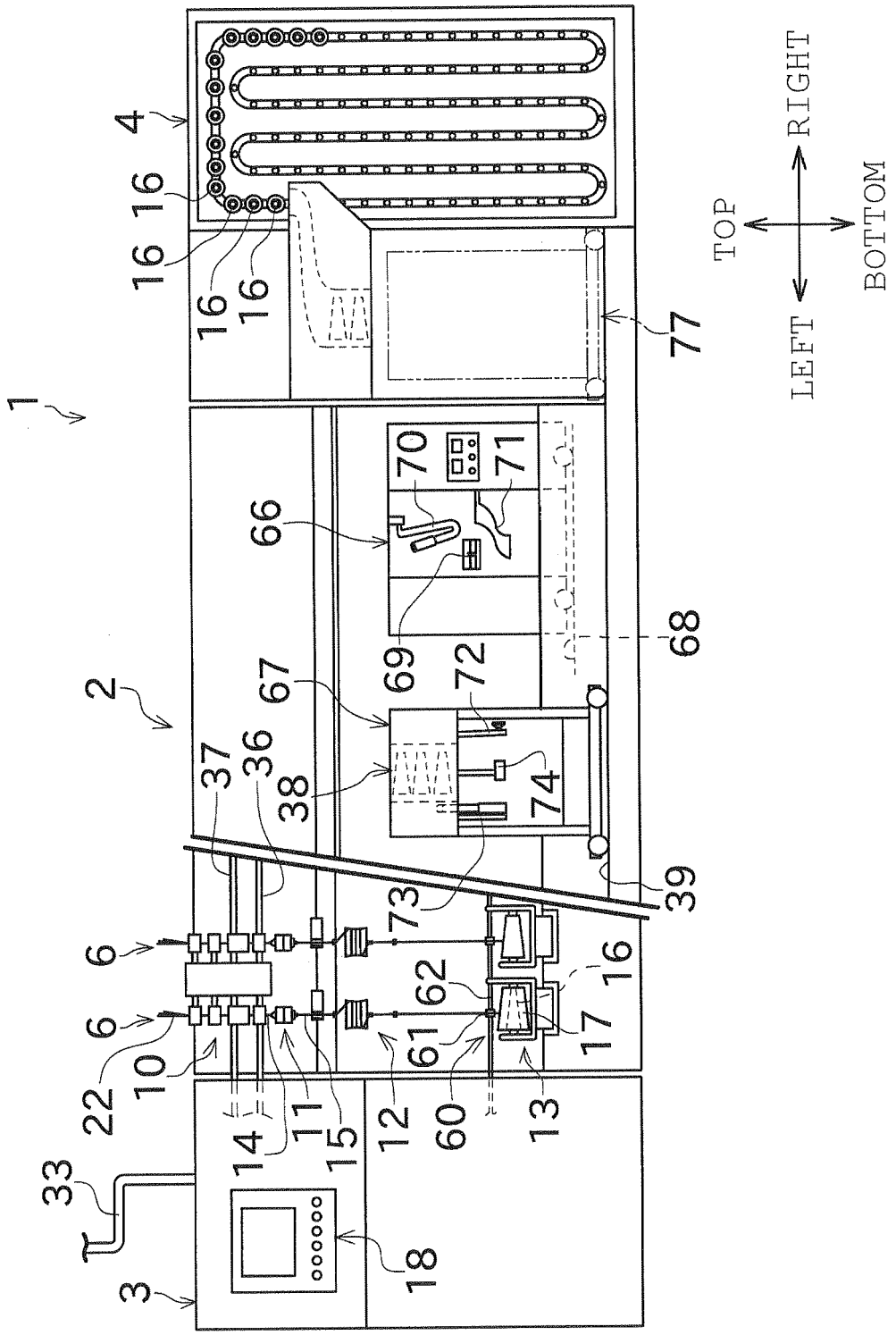
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FIG. 2

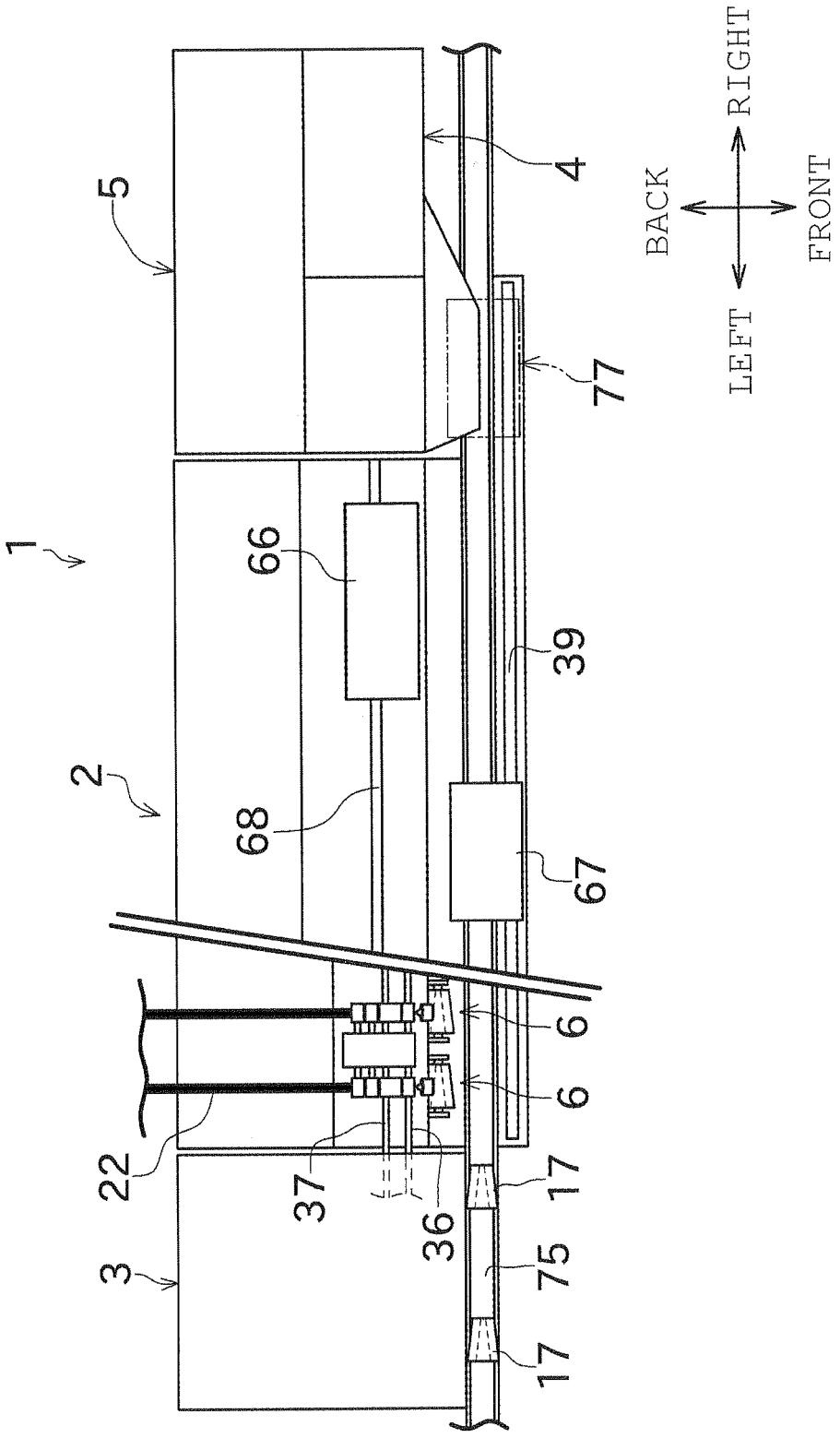

FIG. 3

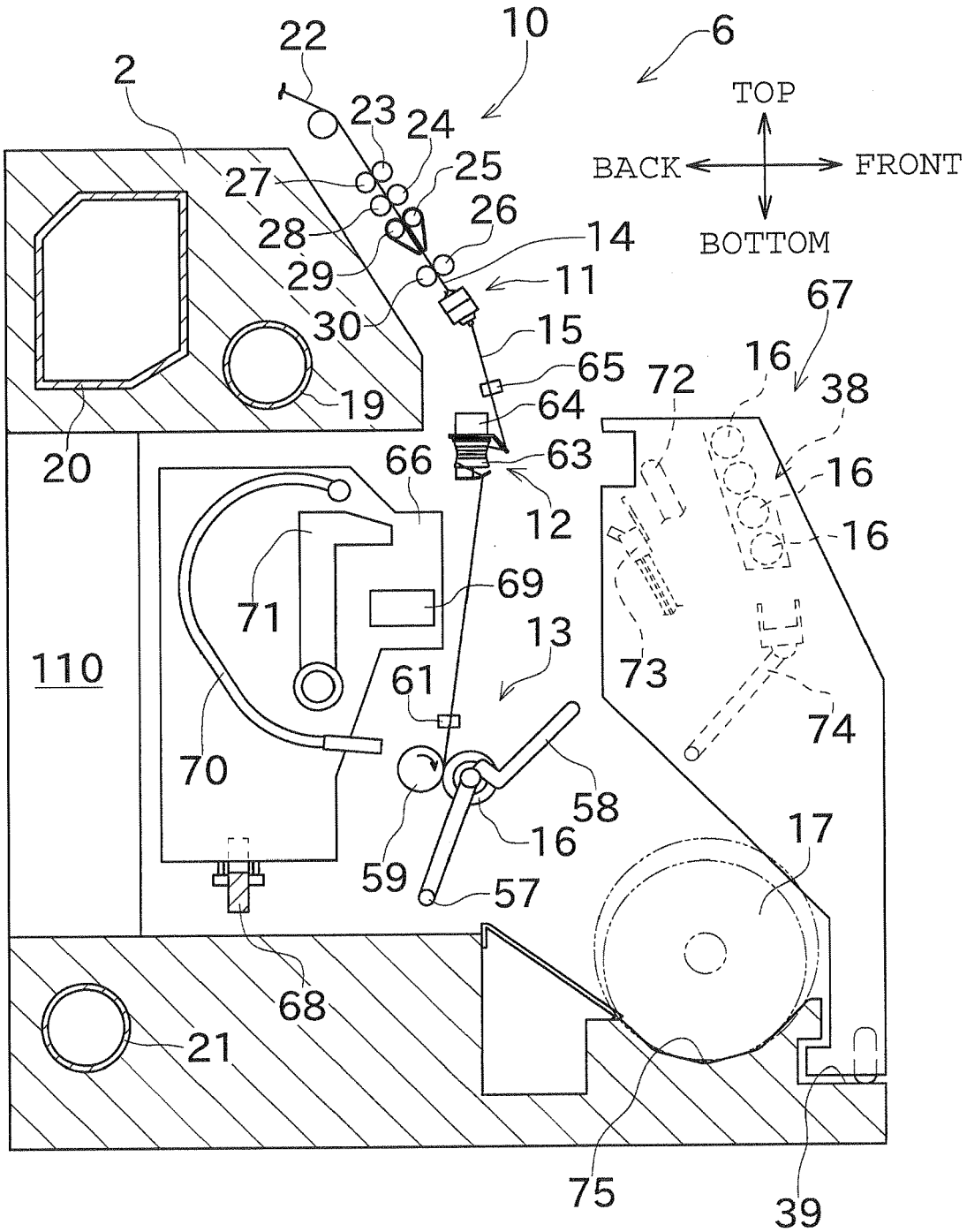
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FIG. 4

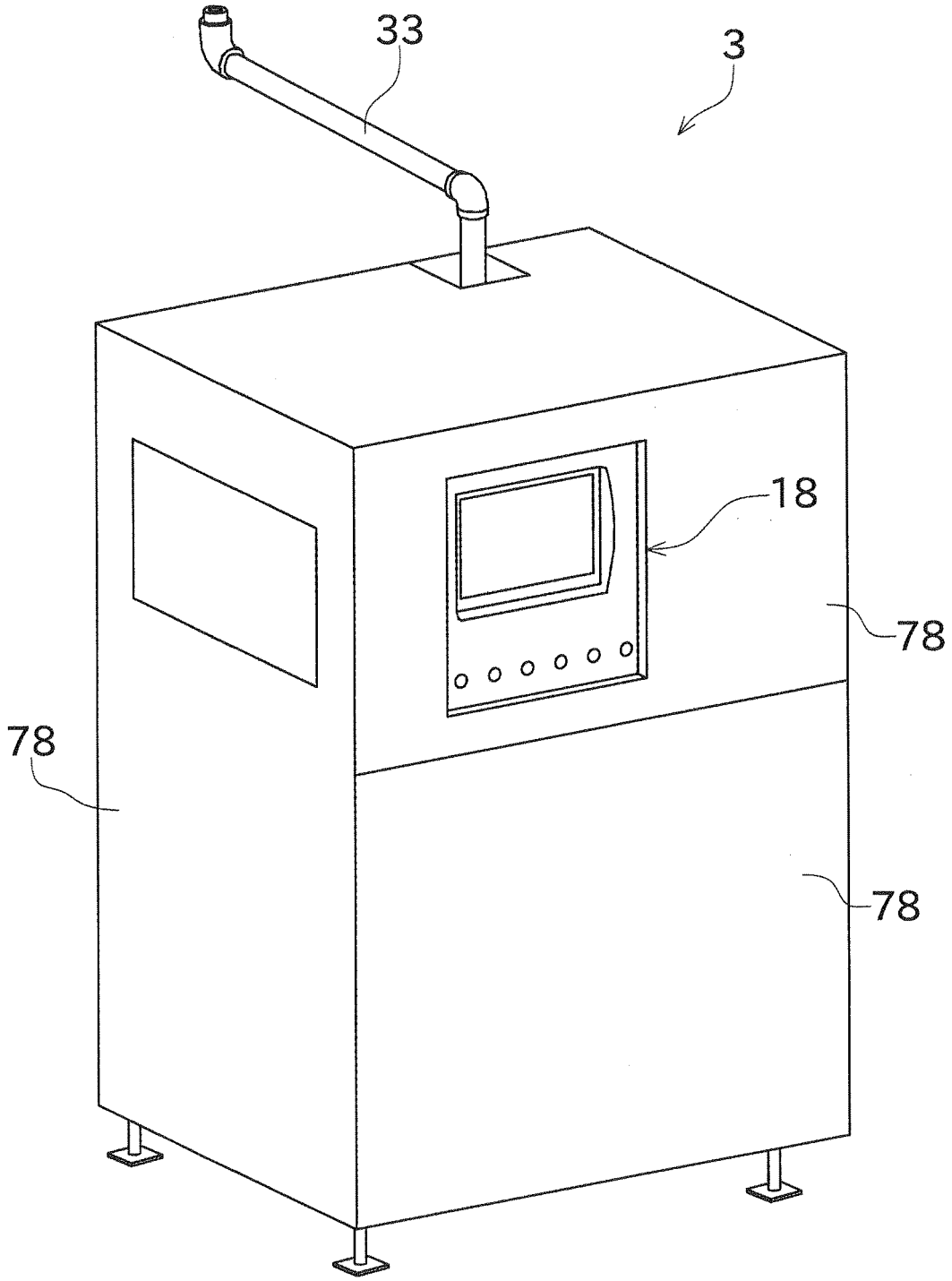


FIG. 5

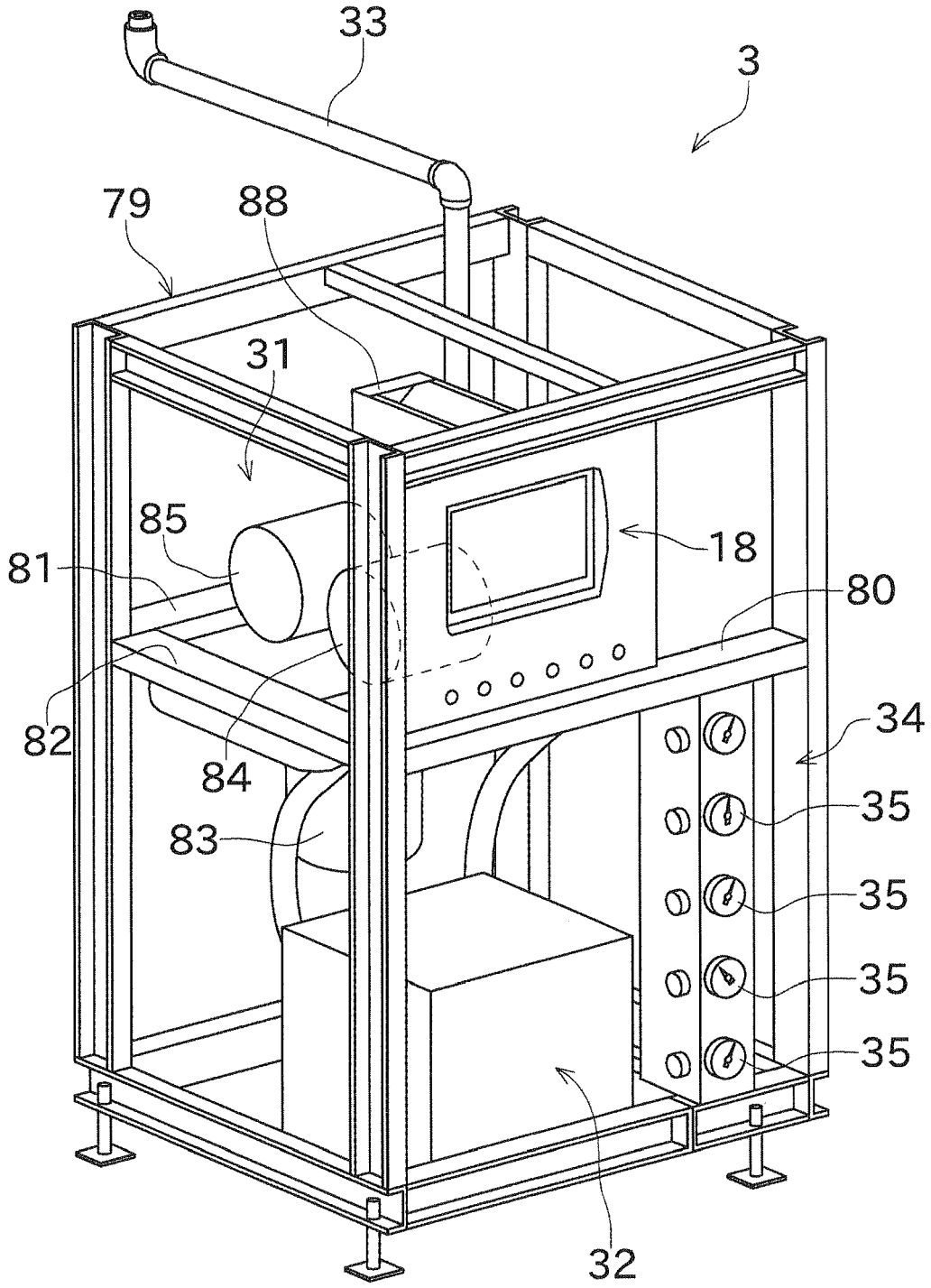


FIG. 6

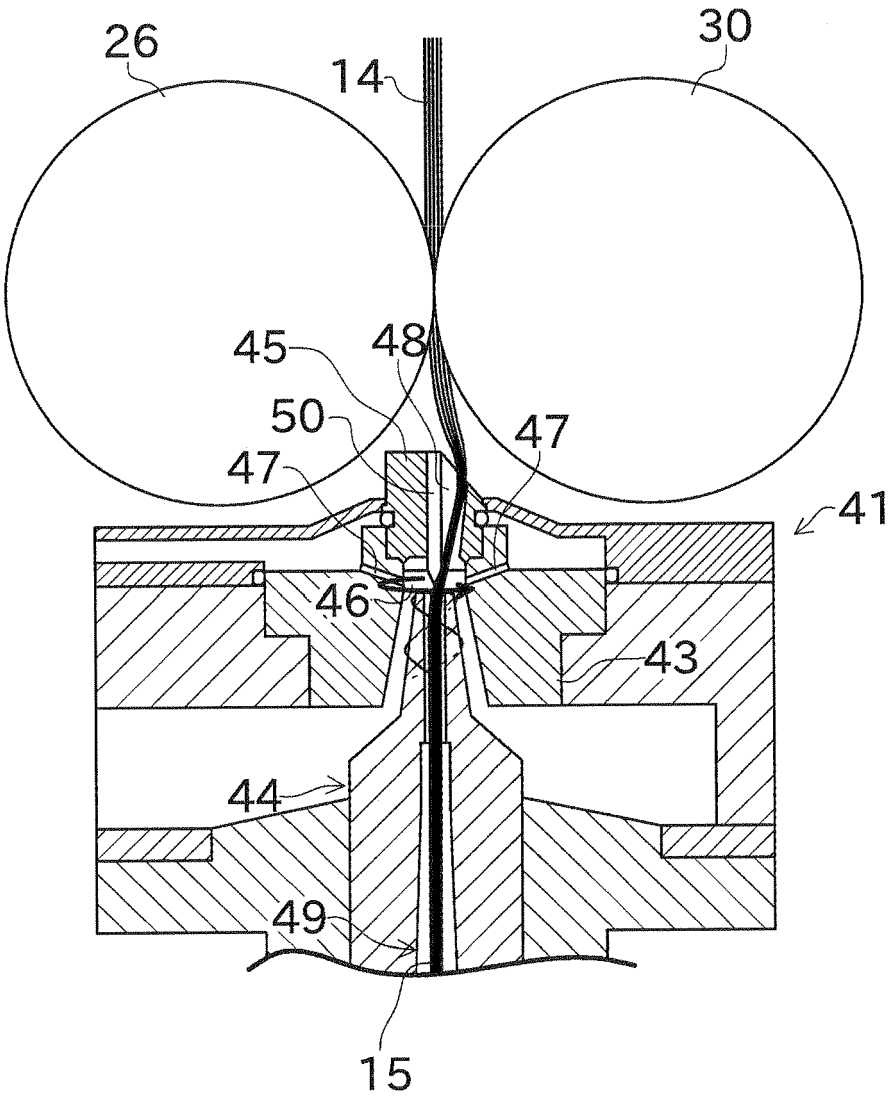


FIG. 7

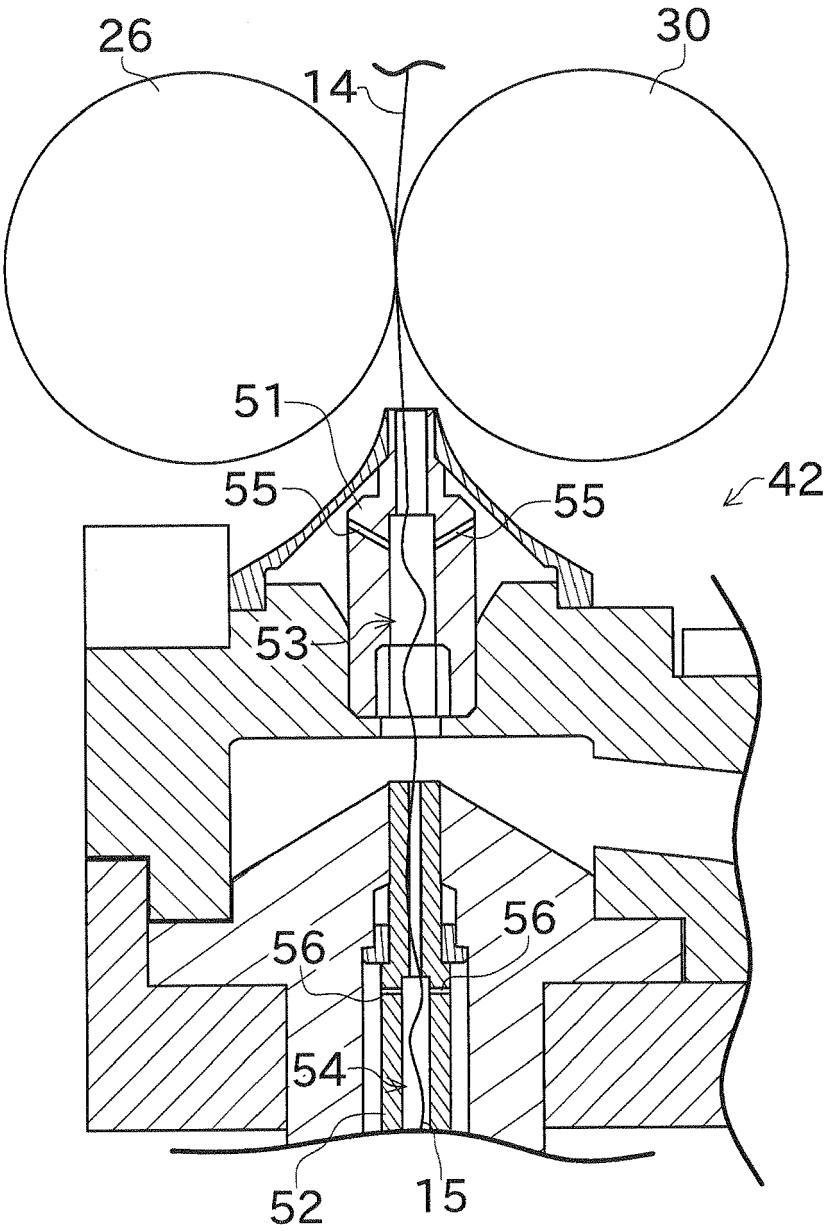


FIG. 8

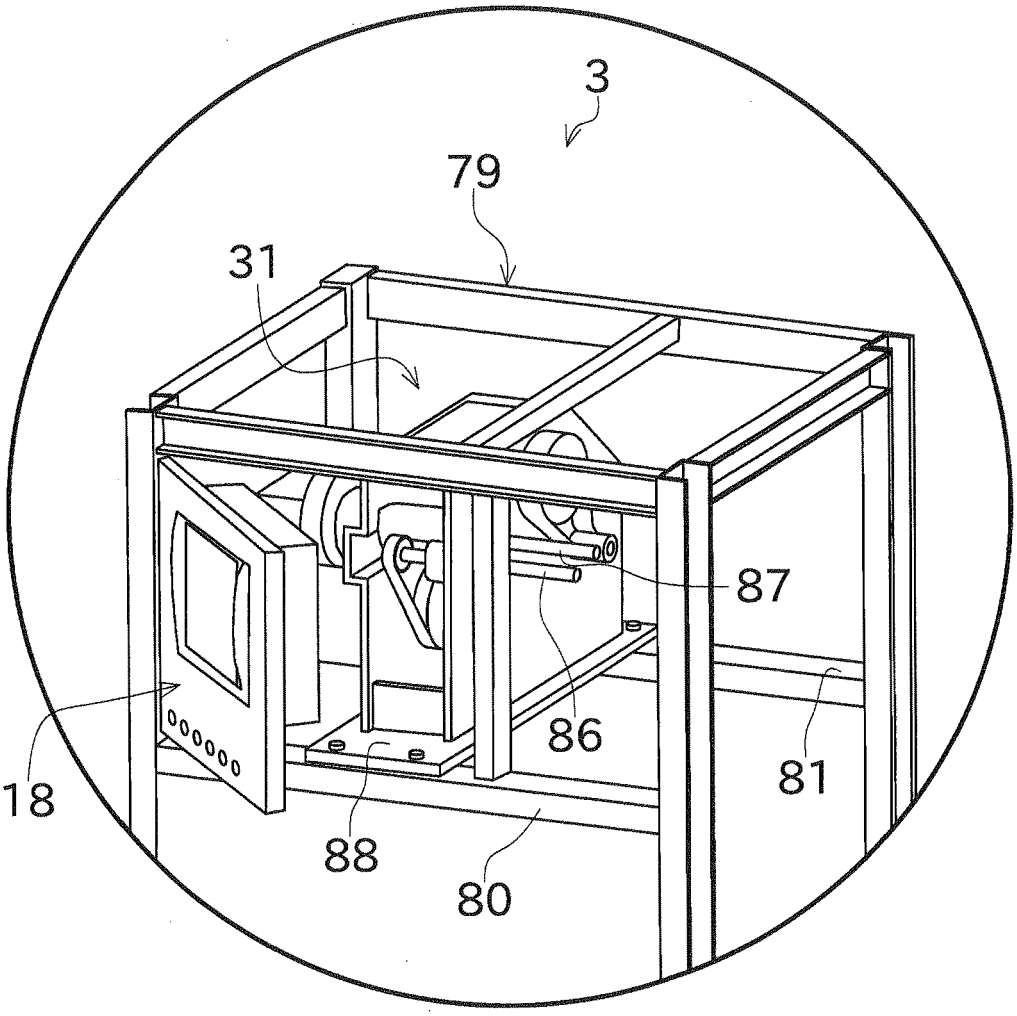
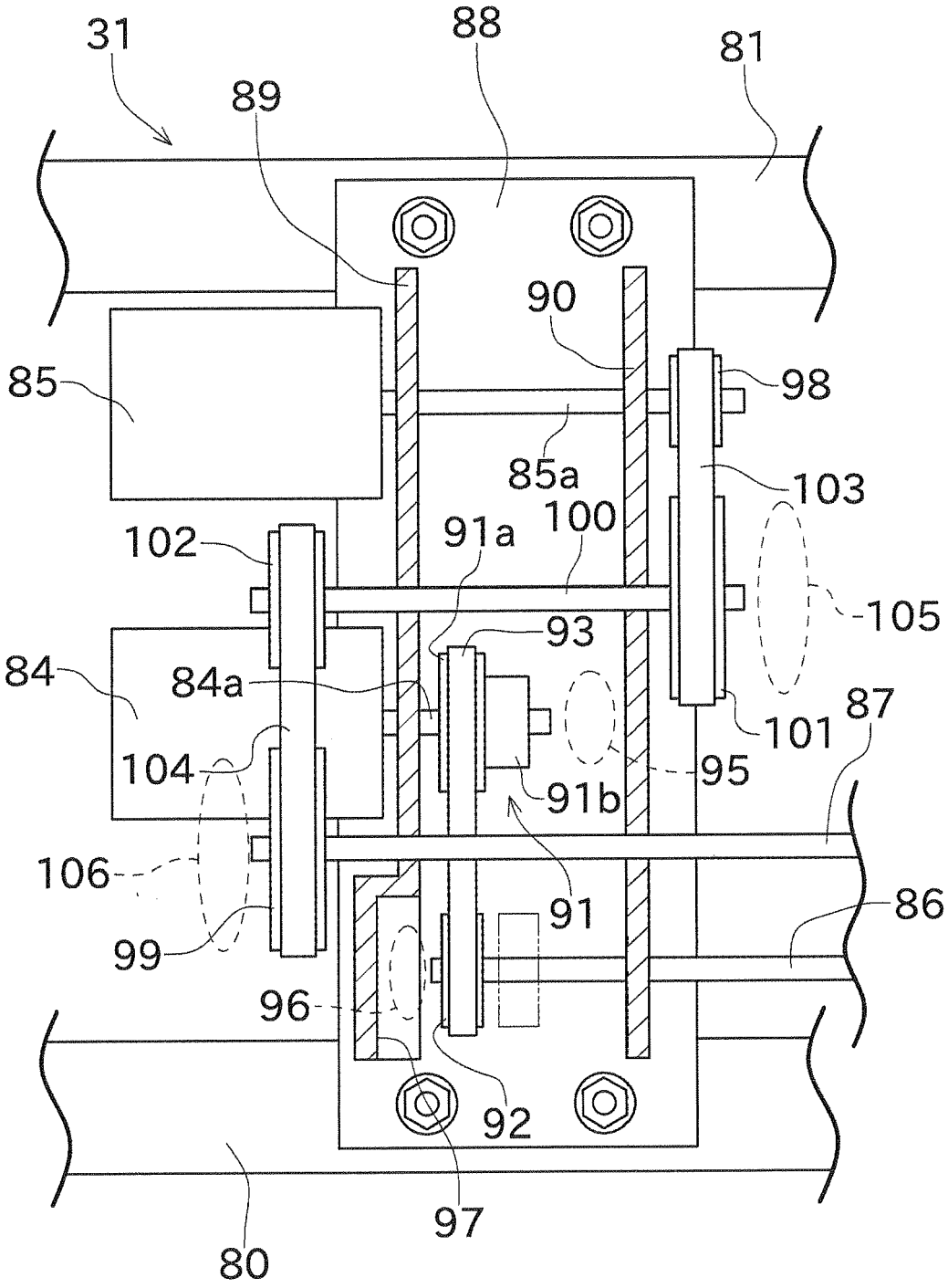


FIG. 9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