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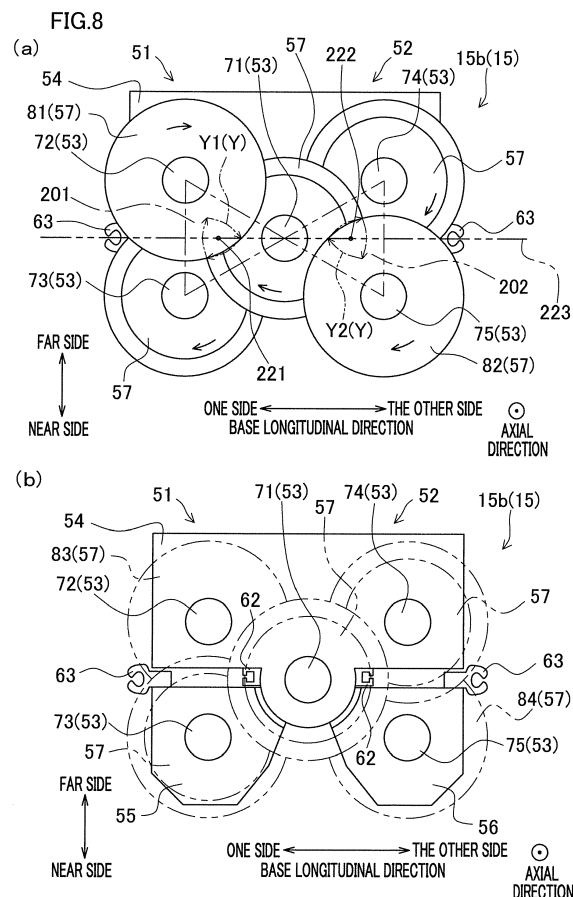
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(54) **DRAW TEXTURING MACHINE**

(57) An object of the present invention is, in a draw texturing machine in which five-axial false-twisting devices are aligned in a base longitudinal direction, to suppress difference of yarn quality between a first yarn and a second yarn. Each five-axial false-twisting device 15 includes: a first false-twisting unit 51 which includes two first independent rotational shafts 72 and 73 and a common rotational shaft 71 which virtually form apexes of a first triangle 201 when viewed in the axial direction, the first false-twisting unit 51 applying twisting to a yarn Y1; and a second false twisting unit 52 which includes two second independent rotational shafts 74 and 75 and the common rotational shaft 71 which virtually form apexes of a second triangle 202 when viewed in the axial direction, the second false-twisting unit 52 applying the twisting to a yarn Y2. The first independent rotational shafts 72 and 73 oppose the second independent rotational shafts 74 and 75 over the common rotational shaft 71 in the base longitudinal direction. A straight line 223 passes through a centroid 221 of the first triangle 201 and a centroid 222 of the second triangle 202 when viewed in the axial direction, and the straight line 223 extends along the base longitudinal direction.



Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a draw texturing machine.

[0002] A draw texturing machine recited in Patent Literature 1 (Japanese Laid-Open Patent Publication No. 2016-141912) performs false twisting of a yarn made of synthetic fibers. The draw texturing machine includes false-twisting devices which are aligned in a predetermined base longitudinal direction and twist running yarns. As the false-twisting devices, for example, a false-twisting device (triaxial false-twisting device) which includes a triaxial friction system recited in Patent Literature 2 (Japanese Laid-Open Patent Publication No. S62-199826) is often used. The triaxial false-twisting device includes three rotational shafts which extend in a predetermined axial direction substantially orthogonal to a base longitudinal direction, and friction discs (circular plate members) which are provided at the respective rotational shafts. Axial centers of the three rotational shafts form apexes of a virtual triangle when viewed in an axial direction. As the circular plate members are rotated in predetermined direction, a yarn which runs inside of the triangle while making a contact with the circular plate members is twisted.

[0003] In this stage, to suppress increase in size of the draw texturing machine and to process more yarns, a five-axial false-twisting device (as shown in Patent Literature 3 (Japanese Laid-Open Patent Publication No. S53-2656)) which includes five rotational shafts and twists two yarns at the same time may be provided instead of the triaxial false-twisting device. In the five-axial false-twisting device, a first false-twisting unit which twists a first yarn and a second false-twisting unit which twists a second yarn are provided. These false-twisting units share one of the five rotational shafts as a common rotational shaft. In the five-axial false-twisting device, two virtual triangles which have the common rotational axis as a common apex are formed when viewed in the axial direction, and two yarns which run inside of these triangles, respectively, are twisted. The five-axial false-twisting device reduces the number of the rotational shafts as compared with a structure in which the two triaxial false-twisting devices are provided, so that increase in size is suppressed and more yarns are processed.

SUMMARY OF THE INVENTION

[0004] In Patent Literature 3, a direction of the five-axial false-twisting device (e.g., positional relationship between the first false-twisting unit and the second false-twisting unit) is not described specifically, and the five-axial false-twisting device is shown to be tilted to the sheet in a plan view (as shown in FIG. 2 in Patent Literature 3). If the five-axial false-twisting device is placed to be tilted as described above, positions of the first false-

twisting unit and the second false-twisting unit are different from each other when the draw texturing machine is viewed in the base longitudinal direction. As a result, for example, a bending angle of the first yarn and length of a yarn path of the first yarn are different from a bending angle of the second yarn and length of a yarn path of the second yarn. Because of this, a way of twisting of the first yarn and a way of twisting of the second yarn may be different from each other, with the result that yarn quality may be different between the first yarn and the second yarn. Therefore, for example, in dyeing the first yarn and the second yarn, a problem such as difference of color therebetween may occur.

[0005] An object of the present invention is to suppress difference of yarn quality between a first yarn and a second yarn in a draw texturing machine in which five-axial false-twisting devices are aligned in a base longitudinal direction.

[0006] A draw texturing machine according to a first aspect of the invention includes: five-axial false-twisting devices aligned in a base longitudinal direction, each of the five-axial false-twisting devices being able to apply twisting to two yarns at the same time by circular plate members, the circular plate members being provided at five rotational shafts, the five rotational shafts extending in an axial direction orthogonal to the base longitudinal direction, and each of the five-axial false-twisting devices includes: a first false-twisting unit which includes, among the five rotational shafts, two first independent rotational shafts and a common rotational shaft which virtually form apexes of a first triangle when viewed in the axial direction, the first false-twisting unit applying the twisting to a first yarn running inside of the first triangle; and a second false twisting unit which includes, among the five-rotational shafts, two second independent rotational shafts and the common rotational shaft which virtually form apexes of a second triangle when viewed in the axial direction, the second false-twisting unit applying the twisting to a second yarn running inside of the second triangle, the two first independent rotational shafts opposing the two second independent rotational shafts over the common rotational shaft in the base longitudinal direction, a straight line passing through a centroid of the first triangle and a centroid of the second triangle when viewed in the axial direction, and the straight line extending along the base longitudinal direction.

[0007] In the five-axial false-twisting device of the present invention, the first false-twisting unit and the second false-twisting unit are provided. These units share the common rotational shaft. In the first false-twisting unit, the first yarn which runs inside of the first triangle is twisted. In the second false-twisting unit, the second yarn which runs inside of the second triangle is twisted. Because of this, increase of an installation space of the draw texturing machine can be suppressed, and many yarns can be twisted.

[0008] In the present invention, the straight line passing through the centroid of the first triangle and the cen-

troid of the second triangle extends along the base longitudinal direction. Because of this, the yarn path of the first yarn running through the first false-twisting unit is arranged to substantially overlap the yarn path of the second yarn running through the second false-twisting unit when viewed in the base longitudinal direction. Therefore, the bending angle of the first yarn and length of the yarn path of the first yarn are arranged to be substantially identical to the bending angle of the second yarn and length of the yarn path of the second yarn. Therefore, in the draw texturing machine in which the five-axial false-twisting devices are aligned in the base longitudinal direction, the difference in yarn quality can be suppressed between the first yarn and the second yarn.

[0009] A draw texturing machine according to a second aspect of the invention includes: five-axial false-twisting devices aligned in a base longitudinal direction, each of the five-axial false-twisting devices being able to apply twisting to two yarns at the same time by circular plate members, the circular plate members being provided at five rotational shafts, the five rotational shafts extending in an axial direction orthogonal to the base longitudinal direction, and each of the five-axial false-twisting devices includes: a first false-twisting unit which includes, among the five rotational shafts, two first independent rotational shafts and a common rotational shaft which virtually form apexes of a first triangle when viewed in the axial direction, the first false-twisting unit applying the twisting to a first yarn running inside of the first triangle; and a second-false twisting unit which includes, among the five-rotational shafts, two second independent rotational shafts and the common rotational shaft which virtually form apexes of a second triangle when viewed in the axial direction, the second false-twisting unit applying the twisting to a second yarn running inside of the second triangle, the two first independent rotational shafts opposing the two second independent rotational shafts over the common rotational shaft in the base longitudinal direction, in the two first independent rotational shafts and the common rotational shaft, an intersection between an outer edge of one circular plate member of the circular plate members and an outer edge of another circular plate member of the circular plate members being a first intersection, the first intersection being formed inside of the first triangle when viewed in the axial direction, the one circular plate member being on the most leading end side in the axial direction among the circular plate members, and the another circular plate member being on the second most leading end side in the axial direction, in the second independent rotational shafts and the common rotational shaft, an intersection between an outer edge of one circular plate member of the circular plate members and the outer edge of the another circular plate member of the circular plate members being a second intersection, the second intersection being formed inside of the second triangle when viewed in the axial direction, the one circular plate member being on the most leading

end side in the axial direction among the circular plate members, and the another circular plate member being on the second most leading end side in the axial direction, and a straight line passing through the first intersection and the second intersection extending along the base longitudinal direction, when viewed in the axial direction.

[0010] In the present invention, at least a part of the first yarn is arranged to substantially overlap a part of the second yarn in the yarn running direction which yarns run, when viewed in the base longitudinal direction. The part of the first yarn is placed upstream of the first intersection, and the part of the second yarn is placed upstream of the second intersection. In other words, it is possible to arrange yarn paths of two yarns to be substantially identical to each other in the upstream of the yarn running direction of the circular plate member placed on the most leading end side in the axial direction. Therefore, in the draw texturing machine in which the five-axial false-twisting devices are aligned in the base longitudinal direction, the difference in yarn quality can be suppressed between the first yarn and the second yarn.

[0011] A third aspect of the invention, in the draw texturing machine of the first or second aspect, the first false-twisting unit further includes, a first yarn guide placed upstream of a circular plate member which is the most upstream circular plate member in a first yarn running direction in which the first yarn runs, among the circular plate members, the second false-twisting unit further includes, a second yarn guide placed upstream of a circular plate member which is the most upstream circular plate member in a second yarn running direction in which the second yarn runs, among the circular plate members, and at least one of the first yarn guide and the second yarn guide is a movable yarn guide which is able to be adjusted in position relative to the other.

[0012] Generally, at each false-twisting unit, the circular plate members are placed to form a spiral. In this regard, a yarn path of the first yarn guided by the first yarn guide and a yarn path of the second yarn guided by the second yarn guide may change depending on a rotational shaft which is provided with the most upstream circular plate member placed in the yarn running direction. In this case, when the yarn path of the first yarn and the yarn path of the second yarn are significantly different, twisting of the first yarn and twisting of the second yarn may be different from each other because of difference in, e.g., bending angles between the yarns. As a result, yarn quality of the first yarn and yarn quality of the second yarn may be different from each other.

[0013] In the present invention, the positions of the movable yarn guides are adjusted so that difference can be suppressed to be small between the yarn path of the first yarn guided by the first yarn guide and the yarn path of the second yarn guided by the second yarn guide. Therefore, the difference in quality can be suppressed between the first yarn and the second yarn.

[0014] According to a fourth aspect of the invention, in the draw texturing machine of the third aspect, the first

yarn guide and the second yarn guide are aligned in the base longitudinal direction, and the movable yarn guide is movable in a direction crossing the base longitudinal direction when viewed in the axial direction.

[0015] For example, in a structure in which one of the first yarn guide and the second yarn guide is moved along the base longitudinal direction, movable areas may be narrow in order to avoid interference between the one of the first yarn guide and the second yarn guide and the other of the first yarn guide and the second yarn guide. In the present invention, the movable area of the movable yarn guide can be widened while interference between the two yarn guides is suppressed, so that the yarn path is effectively adjusted.

[0016] According to a fifth aspect of the invention, in the draw texturing machine of any one of the first to fourth aspects, each of the five-axial false-twisting devices further includes a common driving source for driving the five rotational shafts together, and among the five rotational shafts, at a rotational shaft which is not used for processing the yarns, a weight is provided instead of at least one of the circular plate members.

[0017] In the five-axial false-twisting device, two yarns may be twisted at the same time by both of the first false-twisting unit and the second false-twisting unit, or only one yarn may be twisted by one of the first false-twisting unit and the second false-twisting unit. From the perspective of cost reduction, when only one yarn is twisted, preferably, unnecessary circular plate members are detached from a rotational shaft which is not used for processing yarns. However, if the circular plate members are simply detached from some rotational shafts in one five-axial false-twisting device, a load on a common driving source of the one five-axial false-twisting device becomes smaller than a load on each of common driving sources of other five-axial false-twisting devices. Because of this, in the five-axial false-twisting device which some of the circular plate members are detached, five rotational shafts rotate unintentionally at high speed. As a result, yarn quality of yarns which are processed at the five-axial false-twisting device may be greatly different from yarn quality of yarns which are processed at other five-axial false-twisting devices.

[0018] In the present invention, because the weights are provided in place of the unnecessary circular plate members, the rotational shafts are prevented from unintentionally rotating at high speed, thanks to these weights functioning as loads. Therefore, by using members which are more inexpensive than the circular plate members as the weights, the difference in yarn quality is suppressed between the five-axial false-twisting devices while increase in cost is suppressed.

[0019] According to a sixth aspect of the invention, in the draw texturing machine of any one of the first to fifth aspects, a first five-axial false-twisting device which is one of the five-axial false-twisting devices is able to perform Z-twisting on a yarn, a second five-axial false-twisting device which is placed to be adjacent to the first five-

axial false-twisting device in the base longitudinal direction is able to perform S-twisting on a yarn, and the draw texturing machine further includes a combining unit which combines the yarn Z-twisted by the first false-twisting unit of the first five-axial false-twisting device with the yarn S-twisted by the second false-twisting unit of the second five-axial false-twisting device.

[0020] As described above, the five-axial false-twisting device includes the common rotational shaft so that the first and second yarns are always twisted in the same direction. In other words, in one five-axial false-twisting device, both of two yarns can be Z-twisted, or S-twisted. In this regard, for example, to form one yarn by combining one Z-twisted yarn with one S-twisted yarn, the following way may be used. Z-twisting is performed in one (first five-axial false-twisting device) of two adjacent five-axial false-twisting devices, and S-twisting is performed in the other (second five-axial false-twisting device) of the two adjacent five-axial false-twisting devices. Subsequently, the Z-twisted yarn is combined with the S-twisted yarn. Because of this, one yarn can be formed. As a result, a non-torque yarn in which torque of the Z-twisted yarn and torque of the S-twisted yarn cancel each other out can be formed. However, in a case in which yarn quality of the Z-twisted yarn and yarn quality of the S-twisted yarn are greatly different from each other, the torque of the Z-twisted yarn and the torque of the S-twisted yarn cannot cancel each other out completely, with the result that a deficient non-torque yarn may be formed.

[0021] In the present invention, the difference in yarn quality can be suppressed between the first yarn and the second yarn as described above. This is applicable to two adjacent five-axial false-twisting devices. Therefore, the torque of the Z-twisted yarn and the torque of the S-twisted yarn can cancel each other out completely, with the result that a high-quality non-torque yarn can be formed.

[0022] According to a seventh aspect of the invention, in the draw texturing machine of any one of the first to sixth aspects, further includes winding devices each of which forms a wound package by winding a running yarn to at least one winding bobbin, and each of the winding devices includes: a single cradle which is able to support the at least one winding bobbin to be rotatable; and a traverse unit to which traverse guides for traversing yarns (Y) are attachable, and an operational mode of the winding devices being switchable between a first mode in which a yarn is wound to one of the at least one winding bobbin and a second mode in which yarns are wound to the respective winding bobbins at the same time.

[0023] In the present invention, as described above, by the five-axial false-twisting device, many yarns can be twisted while increase of the installation space of the draw texturing machine is suppressed. However, in a case in which each winding device can support only one winding bobbin, the number of the necessary winding devices is different between the following cases: a case in which two yarns are combined with each other, and

then wound; and a case in which each yarn is simply wound. If the number of the winding devices needs to be increased in order to wind each yarn while each yarn is not combined, size of the draw texturing machine is disadvantageously increased.

[0024] In the present invention, the winding device can switch the operational mode between the first mode and the second mode. Because of this, one of the following modes can be selected while increase (i.e., increase in size of the draw texturing machine) of the number of the winding devices is avoided: a mode in which two yarns are combined with each other, and then wound; and a mode in which each yarn is simply wound. In the present invention, because the difference in yarn quality can be suppressed between the first yarn and the second yarn as described above, packages in which the difference in quality is small can be produced in quantity in a space which is small in size of the device.

[0025] According to eighth aspect of the invention, in the draw texturing machine of any one of the first to seventh aspects, further includes a cooler which cools the first yarn and the second yarn, the cooler being placed upstream of the five-axial false-twisting devices in a yarn running direction in which a yarn runs, and the cooler includes: a first guide member which forms a first running space communicating with an external space in which the first yarn runs; a second guide member which forms a second running space communicating with the external space in which the second yarn runs; a common duct in which an internal space communicating with both of the first running space and the second running space is formed, the internal space extending in the base longitudinal direction, the common duct sucking air by a sucking power source, and the air flowing in the internal space.

[0026] The cooler of the present invention generates negative pressure in the internal space by sucking air of the internal space of the common duct, and causes outside air to flow into the first running space and the second running space. As a result, the cooler of the present invention can cool yarns by the airflow. Because of this, cooling efficiency is increased as compared with a structure in which yarns are cooled by a contact with, e.g., a plate. As a result, the yarn paths can be shortened and decrease in size of the cooler is achieved. In addition to that, contact parts, making a contact with the yarns, of components forming the cooler can be decreased so that running resistance (power which resists running of the yarns by the components making a contact with the yarns) of the yarns can be reduced. As a result, running speed of the yarns can be increased. The cooler has the common duct so that the first running space overlaps the second running space when viewed in the base longitudinal direction. In other words, the yarn path of the first yarn and the yarn path of the second yarn overlap each other in the cooler. Therefore, the bending angle of the first yarn and length of the yarn path of the first yarn are arranged to be substantially identical to the bending angle of the second yarn and length of the yarn path of the

second yarn.

[0027] However, in a case in which the first yarn and the second yarn are twisted by the five-axial false-twisting device and the yarn path of the first yarn and the yarn path of the second yarn are different from each other, the above-described cooler cannot be used. In this regard, in the present invention, the bending angle of the first yarn and length of the yarn path of the first yarn which is twisted by the five-axial false-twisting device are arranged to be substantially identical to the bending angle of the second yarn and length of the yarn path of the second yarn as described above, so that the cooler can be used. Therefore, it is possible to achieve, e.g., the decrease in size of the cooler as described above.

[0028] According to a ninth aspect of the invention, in the draw texturing machine of any one of the first to eighth aspects, a circular plate member placed at the most upstream in the first yarn running direction in which the first yarn runs in the first false-twisting unit and a circular plate member placed at the most upstream in the second yarn running direction in which the second yarn runs in the second false-twisting unit are placed in a same first plane which is orthogonal to the axial direction, and a circular plate member placed at the most downstream in the first yarn running direction in the first false-twisting unit and a circular plate member placed at the most downstream in the second yarn running direction in the second false-twisting unit are placed in a same second plane which is orthogonal to the axial direction.

[0029] In a structure in which the most upstream circular plate member placed in the first yarn running direction and the most upstream circular plate member placed in the second yarn running direction are placed to be different in position from each other in the axial direction, at least some of the rotational shafts need to be elongated. As a result, firstly, the yarn path of the first yarn and the yarn path of the second yarn may change. When the yarn path of the first yarn and the yarn path of the second yarn are greatly different, twisting of the first yarn and twisting of the second yarn may be different from each other because of difference in, e.g., bending angles between the yarns. As a result, yarn quality of the first yarn and yarn quality of the second yarn may be different from each other. Secondly, the device may be increased in size in the axial direction. In positional relationship between the most downstream circular plate member placed in the first yarn running direction and the most downstream circular plate member placed in the second yarn running direction, the problems described above also occur. In the present invention, the circular plate members can be small in size in the axial direction in a state in which the yarn path of the first yarn and the yarn path of the second yarn are substantially the same. Therefore, the increase in size of the device can be suppressed in the axial direction. In addition to that, in the present invention, form of the yarn path of the first yarn and form of the yarn path of the second yarn can be moved closer to substantially the same when viewed in the base lon-

gitudinal direction.

[0030] According to the tenth aspect of the invention, in the draw texturing machine of any one of the first to ninth aspects, the yarn made of nylon is false-twisted.

[0031] Typically, because yarns made of nylon (polyamide fibers) have a higher running resistance described above as compared to yarns made of polyester, it is disadvantageous in that production rates of yarns are difficult to be improved. For example, the running resistance becomes high as the bending angles of the yarns are increased. For example, when the bending angle is greatly different between the first yarn and the second yarn, the maximal speed in which the yarns can run may be greatly different between the first yarn and the second yarn. Generally, among the running speed of the first yarn and the running speed of the second yarn, the faster one is adjusted to be as slow as the slower one in order to keep the production rates of these the same. Therefore, when the maximal speed of the first yarn and the maximal speed of the second yarn are greatly different from each other, an improvement in the production efficiency of yarns is disadvantageously obstructed.

[0032] In the present invention, the bending angle, etc. of the first yarn is arranged to be substantially identical to the bending angle, etc. of the second yarn as described above. Because of this, the running resistance of the first yarn is arranged to be substantially identical to the running resistance of the second yarn. Therefore, the running speed of the first yarn can be as fast as the running speed of the second yarn, with the result that the production efficiency can be improved. The improvement in the production efficiency described above is especially effective in a case of processing yarns which are made of nylon and have the higher running resistance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033]

FIG. 1 is a profile of a draw texturing machine related to an embodiment.

FIG. 2 is a schematic diagram of the draw texturing machine, expanded along paths of yarns.

FIG. 3 is a view of a winding unit, viewed along an arrow III in FIG. 1.

FIG. 4 is a cross section of a cooler.

FIG. 5 is a perspective view of a five-axial false-twisting device.

FIG. 6 shows the five-axial false-twisting device viewed in a direction orthogonal to both of a base longitudinal direction and an axial direction.

FIGs. 7(a) and 7(b) are views of a five-axial false-twisting device viewed in the axial direction, which applies S-twisting to yarns.

FIGs. 8(a) and 8(b) are views of a five-axial false-twisting device viewed in the axial direction, which applies S-twisting to yarns.

FIG. 9(a) is a reference drawing which shows ar-

rangement of the five-axial false-twisting devices, and FIG. 9(b) is a reference drawing which shows yarn paths.

FIG. 10 shows the yarn paths in the present embodiment.

FIG. 11(a) shows a guide supporter, and FIGs. 11(b) and 11(c) show yarn paths.

FIGs. 12(a) and 12(b) show a five-axial false-twisting device related to a modification.

FIG. 13(a) shows an arrangement of a five-axial false-twisting device in another modification, and FIG. 13(b) shows yarn paths in the another modification.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0034] The following will describe an embodiment of the present invention. A vertical direction to the sheet of FIG. 1 is defined as a base longitudinal direction, and a left-right direction to the sheet is defined as a base width direction. A direction orthogonal to the base longitudinal direction and the base width direction is defined as the up-down direction (vertical direction) in which the gravity acts.

(Overall Structure of Draw Texturing Machine)

[0035] To begin with, the following will describe an overall structure of a draw texturing machine with reference to FIG. 1 to FIG. 3. FIG. 1 is a profile of a draw texturing machine 1 of the present embodiment. FIG. 2 is a schematic diagram of the draw texturing machine 1, expanded along paths of yarns Y (yarn paths). FIG. 3 is a view of a winding unit, viewed along an arrow III in FIG. 1.

[0036] The draw texturing machine 1 can perform false twisting of a yarn Y made of synthetic fibers such as nylon (polyamide fibers). The draw texturing machine 1 includes a yarn supplying unit 2 for supplying the yarns Y, a processing unit 3 which performs the false twisting of the yarns Y supplied from the supplying unit 2, and a winding unit 4 which winds the yarns Y processed by the processing unit 3 onto a winding bobbins Bw. Component of the yarn supplying unit 2, the processing unit 3, and the winding unit 4 are aligned to form plural lines (as shown in FIG. 2) in the base longitudinal direction orthogonal to a yarn running surface (sheet of FIG. 1) on which yarn paths from the yarn supplying unit 2 to the winding unit 4 through the processing unit 3 are provided.

[0037] The yarn supplying unit 2 includes a creel stand 7 retaining yarn supply packages Ps, and supplies the yarns Y to the processing unit 3. In the processing unit 3, the following members are placed in this order from the upstream in a yarn running direction: first feed rollers 11; twist-stopping guides 12; first heaters 13; coolers 14; five-axial false-twisting devices 15; second feed rollers 16; combining units 17; third feed rollers 18; a second heater 19; and fourth feed rollers 20. The winding unit 4

winds the yarns Y for which the false winding has been performed at the processing unit 3 onto the winding bobbins Bw by winding devices 21, and forms wound packages Pw.

[0038] The draw texturing machine 1 includes a main base 8 and a winding base 9 which are placed to be spaced apart from each other in the base width direction. The main base 8 and the winding base 9 are provided to extend in a substantially same length in the base longitudinal direction, and placed to oppose each other. An upper part of the main base 8 is connected to an upper part of the winding base 9 by a supporting frame 10. Each device forming the processing unit 3 is mainly attached to the main base 8 or the supporting frame 10. The main base 8, the winding base 9, and the supporting frame 10 form a working space 22 in which an operator performs an operation such as the yarn threading to each device. The yarn paths are formed so that the yarns Y mainly run around the working space 22.

[0039] The draw texturing machine 1 includes units which are termed spans each of which includes a pair of the main base 8 and the winding base 9 placed to oppose each other. In one span, each device is placed so that the yarns Y running while being aligned in the base longitudinal direction can be false-twisted at the same time. For example, twelve winding devices 21 are provided for one winding base 9 (as shown in FIG. 3). In addition to that, one winding device 21 can wind a yarn Y or two yarns Y at the same time as described below. In other words, in the present embodiment, twenty four yarns Y can be simultaneously wound at maximum in one span. In the draw texturing machine 1, the spans are placed in a left-right symmetrical manner to the sheet, with a center line C of the base width direction of the main base 8 as a symmetry axis (main base 8 is shared between the left span and the right span), and the spans are aligned in the base longitudinal direction.

(Processing Unit)

[0040] The structure of the processing unit 3 will be described with reference to FIG. 1 and FIG. 2.

[0041] Each first feed roller 11 sends the yarns Y supplied from the yarn supplying unit 2 to the first heater 13. The first feed rollers 11 are placed above the winding base 9 (as shown in FIG. 1). The first feed rollers 11 are aligned in the base longitudinal direction. For example, as shown in FIG. 2, each first feed roller 11 can send the two yarns Y to the first heater 13. However, the disclosure is not limited to this.

[0042] Each twist-stopping guide 12 prevents twisting which has been applied to the yarn Y at the five-axial false-twisting device 15 from being propagated to the upstream of each twist-stopping guide 12 in the yarn running direction. The twist-stopping guides 12 are placed downstream of the first feed rollers 11 in the yarn running direction, and placed upstream of the first heater 13 in the yarn running direction. The twist-stopping guides 12 are,

for example, provided for the yarns Y supplied from the yarn supplying unit 2, respectively, and aligned in the base longitudinal direction.

[0043] Each first heater 13 heats the yarns Y sent from the first feed rollers 11, and are placed at the supporting frame 10 (as shown in FIG. 1). The first heaters 13 are provided for the yarns Y supplied from the yarn supplying unit 2, and aligned in the base longitudinal direction. For example, as shown in FIG. 2, each first heater 13 can heat four yarns Y. However, the disclosure is not limited to this.

[0044] Each cooler 14 cools the yarns Y heated at each first heater 13. The coolers 14 are placed downstream of each first heater 13 in the yarn running direction, and placed upstream of the five-axial false-twisting devices 15 in the yarn running direction. For example, as recited in Japanese Laid-Open Patent Publication No. 2011-47074, the coolers 14 can cool the yarns Y by air-flow. The coolers 14 are provided for the yarns Y supplied by the yarn supplying unit 2, and aligned in the base longitudinal direction. For example, as shown in FIG. 2, each cooler 14 can cool four yarns Y. However, the disclosure is not limited to this.

[0045] The specific structure of the cooler 14 will be described with reference to FIG. 4. FIG. 4 shows the cooler 14 viewed in the base width direction. In FIG. 4, in the cooler 14, only a part cooling two yarns Y (yarn Y1 and yarn Y2) is shown, for convenience of explanation.

[0046] As shown in FIG. 4, the cooler 14 includes a first cooling unit 23a for cooling the yarn Y1, a second cooling unit 23b for cooling the yarn Y2, and a common duct 24 connected to both of the first cooling unit 23a and the second cooling unit 23b. The first cooling unit 23a and the second cooling unit 23b are aligned in the base longitudinal direction. The first cooling unit 23a includes two guide members 25a and 26a (first guide members of the present invention) extending in a direction substantially orthogonal to the base longitudinal direction for guiding the yarn Y1. The guide members 25a and 26a may be, for example, flat and plate-shaped. However, the disclosure is not limited to this. The guide member 25a opposes the guide member 26a in the base longitudinal direction. Because of this, a first running space 27a through which the yarn Y1 runs is formed between the guide members 25a and 26a. The first running space 27a communicates with a working space 22 (external space of the present invention). Likewise, the second cooling unit 23b includes two guide members 25b and 26b (second guide members of the present invention) for guiding the yarn Y2. These guide members extend in the direction substantially orthogonal to the base longitudinal direction, and the guide member 25b opposes the guide member 26b in the base longitudinal direction. A second running space 27b through which the yarn Y2 runs is formed between the guide members 25b and 26b. The second running space 27b communicates with the working space 22.

[0047] The common duct 24 extends along the base

longitudinal direction, and for example, is placed above the first cooling unit 23a and the second cooling unit 23b. As described above, the common duct 24 is connected to the first cooling unit 23a and the second cooling unit 23b, and an internal space 28 of the common duct 24 communicates with the first running space 27a and the second running space 27b. The common duct 24 is connected to a sucking power source 29. The sucking power source 29 is, e.g., a known blower. However, the disclosure is not limited to this. When the sucking power source 29 is in operation, air is sucked (see an arrow in FIG. 4) by the sucking power source 29 in the internal space 28 of the common duct 24, with the result that negative pressure is generated in the first running space 27a and the second running space 27b which communicate with the internal space 28. Because of this, outside air flows into the first running space 27a and the second running space 27b from the working space 22, with the result that the yarns Y1 and Y2 are cooled by airflow. Therefore, in the cooler 14, cooling efficiency is increased as compared with a structure in which yarns Y are cooled by a contact with, e.g., a plate. As a result, the yarn paths can be shortened and decrease in size of the device is achieved. In addition to that, contact parts, making a contact with the yarns Y, of components forming the cooler 14 can be decreased so that running resistance (power which resists running of the yarns Y by the components making a contact with the yarns Y) of the yarns Y can be reduced. As a result, running speed of the yarns Y can be increased. The first running space 27a and the second running space 27b overlap each other when viewed in the base longitudinal direction because the cooler 14 includes the common duct 24 and the first cooling unit 23a and the second cooling unit 23b are aligned in the base longitudinal direction. In other words, a yarn path of the yarn Y1 and a yarn path of the yarn Y2 overlap each other in the cooler 14.

[0048] The five-axial false-twisting device 15 will be described with reference to FIG. 1 and FIG. 2. The five-axial false-twisting devices 15 are a kind of a false-twisting device having a disc-friction system, and each five-axial false-twisting device 15 simultaneously twists two yarns Y, i.e., a yarn Y1 (first yarn of the present invention) and a yarn Y2 (second yarn of the present invention) in the same direction. The five-axial false-twisting devices 15 are placed directly downstream of the coolers 14 in the yarn running direction. The five-axial false-twisting devices 15 are aligned in the base longitudinal direction. In this regard, to the five-axial false-twisting device 15 which is placed at an end portion in the base longitudinal direction, only one yarn Y is threaded (see the five-axial false-twisting device 15 at the left end portion of the sheet of FIG. 2). For example, thirteen five-axial false-twisting devices 15 are provided in one span (not shown in the figure). The specific details of the five-axial false-twisting devices 15 will be given later.

[0049] Each second feed roller 16 sends the yarns Y processed at the five-axial false-twisting devices 15 to

the combining unit 17. The second feed rollers 16 are placed above the upper part of the main frame 8 (as shown in FIG. 1). The second feed rollers 16 are aligned in the base longitudinal direction. For example, as shown in FIG. 2, each second feed roller 16 can send two yarns Y to the combining unit 17. However, the disclosure is not limited to this. In this regard, the second feed rollers 16 convey the yarns Y at a higher conveyance speed than the first feed rollers 11, and the yarns Y are drawn between the first feed rollers 11 and the second feed rollers 16.

[0050] Each combining unit 17 can combine the yarn Y1 and the yarn Y2. In the present embodiment, each combining unit 17 can combine the following yarns Y: a yarn Y1 which is processed at one five-axial false-twisting device 15; and a yarn Y2 which is processed at another five-axial false-twisting device 15 placed adjacent to the five-axial false-twisting device 15 in the base longitudinal direction. However, the disclosure is not limited to this. The combining units 17 are placed below the second feed rollers 16 (as shown in FIG. 1). Each combining unit 17 includes two interlace nozzles 31 and 32 (as shown in FIG. 2). Each combining unit 17 blows air onto the yarn Y1 and the yarn Y2 (as shown at the left part of the sheet of FIG. 2) which are, for example, passing the inside of the interlace nozzle 31, and each combining unit 17 combines the yarn Y1 and the yarn Y2 by air-interlace which the yarn Y1 is interlaced with the yarn Y2 by airflow. In this regard, each combining unit 17 can guide the two yarns Y to downstream in the yarn running direction, without combining the yarn Y1 and the yarn Y2. In this case, the yarn Y1 passes the inside of the interlace nozzle 31, and the yarn Y2 passes the inside of the interlace nozzle 32 (as shown on the right part of the sheet of FIG. 2).

[0051] Each third feed roller 18 sends the yarns Y running downstream of each combining unit 17 in the yarn running direction to the second heater 19. The third feed rollers 18 are placed below the combining units 17 (as shown in FIG. 1). The third feed rollers 18 are aligned in the base longitudinal direction. For example, as shown in FIG. 2, each third feed roller 18 can send two yarns Y to the second heater 19. However, the disclosure is not limited to this. In this regard, the second feed rollers 18 convey the yarns Y at a slower conveyance speed than the second feed rollers 16, and the yarns Y are relaxed between the second feed rollers 16 and the third feed rollers 18.

[0052] The second heater 19 heats the yarns Y supplied from the third feed rollers 18. The second heater 19 is placed below the third feed rollers 18 (as shown in FIG. 1). The second heater 19 extends along the vertical direction, and one second heater 19 is provided in one span.

[0053] Each fourth feed roller 20 sends the yarns Y heated by the second heater 19 to the winding device 21, and are placed at the lower part of the working space 22 (as shown in FIG. 1). The fourth feed rollers 20 are aligned in the base longitudinal direction. For example,

as shown in FIG. 2, each fourth feed roller 20 can send two yarns Y to the winding device 21. However, the disclosure is not limited to this. The fourth feed rollers 20 convey the yarns Y at a slower conveyance speed than the third feed rollers 18, and the yarns Y are relaxed between the third feed rollers 18 and the fourth feed rollers 20.

[0054] In the processing unit 3 described above, two yarns Y which have been drawn between the first feed rollers 11 and the second feed rollers 16 are twisted at each five-axial false-twisting device 15. The twisting formed by the five-axial false-twisting devices 15 propagates to the twist-stopping guides 12 but does not propagate to the upstream of the twist-stopping guides 12 in the yarn running direction. The yarn Y which is twisted and drawn is heated at each first heater 13 and thermally set. After that, the yarn Y is cooled at each cooler 14. The yarn Y is untwisted at the downstream of each five-axial false-twisting device 15. However, each filament is maintained to be wavy in shape on account of the thermal setting described above. Subsequently, after the two yarns Y (yarn Y1 and yarn Y2) false-twisted by each five-axial false-twisting device 15 are combined by the combining unit 17 while being relaxed between the second feed rollers 16 and the third feed rollers 18, the two yarns Y are guided to the downstream side in the yarn running direction. Alternatively, the two false-twisted yarns Y are guided to the downstream side in the yarn running direction without being combined. Furthermore, the yarn Y is thermally set at the second heater 19 while being relaxed between the third feed roller 18 and the fourth feed roller 20. Finally, the yarn Y sent from each fourth feed roller 20 is wound by each winding device 21, and forms each package Pw.

(Winding Unit)

[0055] The structure of the winding unit 4 will be described with reference to FIG. 2 and FIG. 4. The winding unit 4 includes the winding devices 21 which wind the yarns Y onto the winding bobbins Bw. For example, as recited in Japanese Laid-Open Patent Publication No. 2009-74219, each winding device 21 can wind the yarn Y or the yarns Y onto the winding bobbin Bw or two winding bobbins Bw. Each winding device 21 includes fulcrum guides 41 which are fulcrums when the yarns Y are traversed, a traverse unit 42 which traverses the yarns Y, a single cradle 43 which supports the winding bobbins Bw to be rotatable, and a controller 44 (as shown in FIG. 3).

[0056] As described above, each fulcrum guide 41 is a guide which is a fulcrum when the yarn Y is traversed. Three fulcrum guides 41 are provided at each winding device 21 to be aligned along, for example, the base longitudinal direction (as shown in FIG. 2). For example, when the yarn Y formed by yarn combination at the combining unit 17 is guided, the yarn Y is threaded to the central one among the three fulcrum guides 41 (as shown

at the left part of the sheet of FIG. 2). When two yarns Y which are sent without being combined are guided, the two yarns Y are threaded to two fulcrum guides 41 at both ends among the three fulcrum guides 41, respectively (as shown at the right part of the sheet of FIG. 2).

[0057] For example, the traverse unit 42 can traverse the yarns Y by traverse guides 45 which are attached to an endless belt driven in a reciprocating manner by a motor. The number of the traverse guides 45 which are attached to the endless belt can be changed depending on the number of the yarns Y which are traversed. For example, one traverse guide 45 is provided for the traverse unit 42 which traverses the yarn Y formed by yarn combination at one combining unit 17 (as shown at the left part of the sheet of FIG. 2). Meanwhile, two traverse guides 45 are provided for the traverse unit 42 which traverses the yarns Y which are sent without being combined (as shown at the right part of the sheet of FIG. 2). A traveling range of the traverse guides 45 can be changed depending on the number of the yarns Y to be traversed. Information related to settings such as the number of the yarns Y which are traversed or the traveling range of the traverse guides 45 is stored in, for example, the controller 44.

[0058] The cradle 43 can support one or more (one or two) winding bobbin Bw (wound package Pw) to be rotatable. In other words, the cradle 43 can be switched between a state of supporting one winding bobbin Bw and a state of supporting two winding bobbins Bw. The cradle 43 is provided at each winding device 21. A contact roller 46 which makes a contact with surfaces of the wound packages Pw is placed directly upstream of the wound packages Pw in the yarn running direction. The winding bobbins Bw which are supported by the cradle 43 are rotationally driven, for example, by an unillustrated motor. In the structure described above, the contact roller 46 in contact with the surfaces of the wound packages Pw applies a contact pressure onto the wound packages Pw while being rotationally driven by friction. Alternatively, instead of rotationally driving the winding bobbins Bw by a motor, the contact roller 46 may be rotationally driven by an unillustrated motor. In the structure described above, the wound packages Pw in contact with the contact roller 46 are rotationally driven by the friction.

[0059] The controller 44 controls an operation of the traverse unit 42 and an operation of the motor which rotationally drives the winding bobbins Bw. In addition to that, the controller 44 can change the setting related to the number of the yarns Y which are wound onto one winding device 21. In this regard, the controller 44 can switch an operational mode between a first mode in which one yarn Y is wound onto one winding bobbin Bw (as shown at the left part of the sheet of FIG. 2) and a second mode in which two yarns Y are wound onto two winding bobbins Bw (as shown at the right part of the sheet of FIG. 2).

[0060] In the winding unit 4 structured as above, the yarn Y which is sent from the fourth feed roller 20 de-

scribed above is wound onto the winding bobbin Bw by each winding device 21, and forms each wound package Pw. When two yarns Y are combined by one combining unit 17, the operational mode of the corresponding winding device 21 is set in the first mode. In addition to that, when the two yarns Y are guided to the downstream side in the yarn running direction without being combined, the operational mode of the corresponding winding device 21 is set in the second mode.

(Structure of False-Twisting Device)

[0061] The structure of the five-axial false-twisting device 15 will be described with reference to FIG. 5 to FIG. 8(b). FIG. 5 is a perspective view of the five-axial false-twisting device 15. FIG. 6 shows the five-axial false-twisting device 15 viewed in a direction orthogonal to both of a base longitudinal direction and an axial direction of a rotational shaft 53 described below (hereinafter, this direction will be simply referred to as an axial direction). FIGs. 7(a) and 7(b) show the five-axial false-twisting device 15 viewed in the axial direction, which applies Z-twisting to yarns Y. FIGs. 8(a) and 8(b) show the five-axial false-twisting device 15 viewed in the axial direction, which applies S-twisting to yarns Y. In FIG. 7(b) and FIG. 8(b), circular plate members 57 described below are indicated by two-dot chain lines so that supporting tables 54 to 56 described below are shown. One side and the other side in the base longitudinal direction are defined as shown in FIG. 5 to FIG. 8(b). In the five-axial false-twisting device 15, the side which is close to the working space 22 (as shown in FIG. 1) is defined as the near side (as shown in FIG. 1, FIG. 5, FIGs. 7(a) and 7(b), and FIGs. 8(a) and 8(b)), and the side which is distant from the working space 22 is defined as the far side (as shown in FIG. 5, FIGs. 7(a) and 7(b), and FIG. 8(a) and 8(b)). A yarn guide 61 described below is not shown in FIG. 7(a) to FIG. 8(b).

[0062] Each five-axial false-twisting device 15 can twist (perform the Z-twisting or S-twisting on) two yarns Y (yarn Y1 and yarn Y2) in the same direction at the same time. In other words, as shown in FIG. 5 to FIG. 8(b), a first false-twisting unit 51 which applies twisting to the yarn Y1 and a second false-twisting unit 52 which applies the twisting to the yarn Y2 are provided at the five-axial false-twisting device 15. The five-axial false-twisting devices 15 are aligned in the base longitudinal direction (as shown in FIG. 2).

[0063] As shown in FIG. 5 to FIG. 8(b), the five-axial false-twisting device 15 includes five rotational shafts 53, the supporting tables 54, 55, and 56, the circular plate members 57, a driving mechanism 58, and the yarn guides 61, 62, and 63, as components which form the first false-twisting unit 51 and the second false-twisting unit 52. The five rotational shafts 53 (common rotational shaft 71, first independent rotational shafts 72 and 73, second independent rotational shafts 74 and 75) are axial members which extend in the axial direction substantially

orthogonal to the base longitudinal direction. In this regard, the axial direction may not necessarily be substantially orthogonal to the base longitudinal direction. Among the five rotational shafts 53, the first false-twisting unit 51 includes the common rotational shaft 71 which is placed at the center in the base longitudinal direction and two first independent rotational shafts 72 and 73 which are placed on the one side in the base longitudinal direction of the common rotational shaft 71. The second false-twisting unit 52 includes the common rotational shaft 71 and two second independent rotational shafts 74 and 75 which are placed on the other side in the base longitudinal direction of the common rotational shaft 71. In other words, the common rotational shaft 71 is shared between the first false-twisting unit 51 and the second false-twisting unit 52. As shown in FIG. 7(a) and FIG. 8(a), the rotational shafts 53 are placed so that the axial centers of these shafts form apexes of two virtual equilateral triangles (first triangle 201 and second triangle 202) when viewed in the axial direction. The common rotational shaft 71 and the first independent rotational shafts 72 and 73 form the apexes of the first triangle 201. The common rotational shaft 71 and the second independent rotational shafts 74 and 75 form the apexes of the second triangle 202. The first independent rotational shafts 72 and 73 oppose the second independent rotational shafts 74 and 75 over the common rotational shaft 71 in the base longitudinal direction.

[0064] The supporting tables 54, 55, and 56 are tables supporting the rotational shafts 53 to be rotatable via unillustrated bearings. The supporting table 54 cantilevers, in a rotatable manner, the common rotational shaft 71, the first independent rotational shaft 72 which is placed on the far side among the first independent rotational shafts 72 and 73, and the second independent rotational shaft 74 which is placed on the far side among the second independent rotational shafts 74 and 75. The supporting table 55 is attached to the supporting table 54 and placed on the near side of the supporting table 54, and cantilevers the first independent rotational shaft 73 on the near side, in a rotatable manner. The supporting table 56 is attached to the supporting table 54 and placed on the near side of the supporting table 54, and cantilevers the second independent rotational shaft 75 of the near side, in a rotatable manner. The upper side of the sheet in FIG. 5 and FIG. 6 is a leading end side in the axial direction, and the lower side of the sheet is a base end side in the axial direction. The yarns Y run from the leading end side in the axial direction of the rotational shaft 53 to the base end side. In other words, the leading end side in the axial direction is the upstream side in the yarn running direction. The base end side in the axial direction is the downstream side in the yarn running direction. A running direction of a yarn Y1 is defined as a first yarn running direction, and a running direction of a yarn Y2 is defined as a second yarn running direction (as shown in FIG. 6). The Base end parts of the supporting tables 54, 55, and 56 in the axial direction are covers 54a, 55a, and 56a

covering part of the driving mechanism 58, respectively (as shown in FIG. 5 and FIG. 6).

[0065] The circular plate members 57 are members which are attached to each of the rotational shafts 53 and apply the twisting to yarns Y by making a contact with the yarns Y. The present embodiment assumes that the circular plate members 57 are attached to all rotational shafts 53 of all five-axial false-twisting devices 15, in order to simplify the description. Furthermore, in the present embodiment, three or four circular plate members 57 are attached to each of the rotational shafts 53 (as shown in, e.g., FIG. 5). However, the disclosure is not limited to this.

[0066] To begin with, among the circular plate members 57, circular plate members 57 which are attached to the common rotational shaft 71 and the first independent rotational shafts 72 and 73 are provided at the first false-twisting unit 51, and placed to form a spiral extending in the axial direction. A direction of the spiral which the circular plate members 57 form is defined by a direction of a twist performed on the yarn Y. In other words, the circular plate members 57 of the first false-twisting unit 51 are placed to form a spiral in a counterclockwise direction when a five-axial false-twisting device 15 which performs the Z-twisting on the yarns Y (five-axial false-twisting device 15a; as shown in FIGs. 7(a) and 7(b)) is viewed from the leading end side in the axial direction. On the other hand, the circular plate members 57 of the first false-twisting unit 51 are placed to form a spiral in a clockwise direction when a five-axial false-twisting device 15 which performs the S-twisting on the yarns Y (five-axial false-twisting device 15b; as shown in FIGs. 8(a) and 8(b)) is viewed from the leading end side in the axial direction. The five-axial false-twisting device 15a is equivalent to a first five-axial false-twisting device of the present invention. The five-axial false-twisting device 15b is equivalent to a second five-axial false-twisting device of the present invention.

[0067] Circular plate members 57 which are attached to the common rotational shaft 71 and the second independent rotational shafts 74 and 75 are provided at the second false-twisting unit 52, and placed to form a spiral extending in the axial direction. The direction of the spiral formed by the circular plate members 57 provided at the second false-twisting unit 52 is identical with the direction of the spiral formed by the circular plate members 57 provided at the first false-twisting unit 51.

[0068] As shown in FIG. 6, the following members are placed in a first plane 203 orthogonal to the axial direction: a circular plate member 57 which is placed at the most upstream in the first yarn running direction of the first false-twisting unit 51 (circular plate member 81); and a circular plate member 57 which is placed at the most upstream in the second yarn running direction of the second false-twisting unit 52 (circular plate member 82). In other words, the position of the circular plate member 81 in the axial direction and the position of the circular plate member 82 in the axial direction are substantially the

same. In addition to that, the following members are placed in a second plane 204 orthogonal to the axial direction: a circular plate member 57 which is placed at the most downstream in the first yarn running direction of the first false-twisting unit 51 (circular plate member 83); and a circular plate member 57 which is placed at the most downstream in the second yarn running direction of the second false-twisting unit 52 (circular plate member 84). In other words, the position of the circular plate member 83 in the axial direction and the position of the circular plate member 84 in the axial direction are substantially the same. Because of this, increase in length of each of the rotational shafts 53 is suppressed as compared with cases in which the positions of the circular plate member 81 and the circular plate member 82 are different in the axial direction or the positions of the circular plate member 83 and the circular plate member 84 are different in the axial direction.

[0069] The circular plate members 57 of the first false-twisting unit 51 and the circular plate members 57 of the second false-twisting unit 52 are placed point-symmetrical about the common rotational shaft 71 as a symmetrical axis, when viewed in the axial direction. For a specific example, in the five-axial false-twisting device 15a (as shown in FIGs. 7(a) and 7(b)), the circular plate member 81 of the first false-twisting unit 51 is attached to the first independent rotational shaft 73 on the near side. In addition to that, the circular plate member 82 of the second false-twisting unit 52 is attached to the second independent rotational shaft 74 on the far side.

[0070] Contact parts where the circular plate members 57 makes a contact with the yarn Y are made of, for example, polyurethane. In the present embodiment, at least one circular plate member 57 which includes the contact part in contact with the yarn Y is made of polyurethane is attached to each of the rotational shafts 53. Meanwhile, circular plate members 57 (circular plate members 81 and 82) with which the running yarn Y makes a contact at first and circular plate members 57 (circular plate members 83 and 84) with which the running yarn Y makes a contact at last are easily worn away. Therefore, the contact parts of the circular plate members 81, 82, 83, and 84 in contact with the yarn Y are made of, for example, ceramic which has a higher abrasion resistance than polyurethane. Because of this, the circular plate members 81, 82, 83, and 84 are suppressed from being worn away. However, the disclosure is not limited to this. All contact parts of all circular plate members 57 in contact with the yarn Y may be made of polyurethane.

[0071] The driving mechanism 58 is a mechanism which rotationally drives five rotational shafts 53 in the same direction. The driving mechanism 58 includes a motor 85 (as shown in FIG. 5; a common drive source of the present invention), and for example, belts 86, 87, 88, and 89 for transmitting the power of the motor 85 to each of the rotational shafts (as shown in FIG. 6). A driving mechanism 58 of the five-axial false-twisting device 15 (five-axial false-twisting device 15a) which performs the

Z-twisting on the yarn Y rotationally drives the rotational shafts 53 counterclockwise (indicated by arrows in FIGs. 7) and 7(b)), when viewed from the leading end side in the axial direction. A driving mechanism 58 of the five-axial false-twisting device 15 (five-axial false-twisting device 15b) which performs the S-twisting on the yarn Y rotationally drives the rotational shafts 53 clockwise (indicated by arrows in FIGs. 8(a) and 8(b)), when viewed from the leading end side in the axial direction.

[0072] Two yarn guides 61, two yarn guides 62, and two yarn guides 63 are provided to correspond to the first false-twisting unit 51 and the second false-twisting unit 52, as shown in FIG. 6. To begin with, the yarn guide 61 of the first false-twisting unit 51 (yarn guide 61a; a first yarn guide of the present invention) is placed directly upstream of the circular plate member 81 in the first yarn running direction. The yarn guide 62 (yarn guide 62a) of the first false-twisting unit 51 is placed directly downstream of the circular plate member 83 in the first yarn running direction. The yarn guide 63 (yarn guide 63a) of the first false-twisting unit 51 is placed directly downstream of the yarn guide 62a in the first yarn running direction, and provided at one end portion of the supporting table 55 in the base longitudinal direction. In addition to that, the yarn guide 61 of the second false-twisting unit 52 (yarn guide 61b; a second yarn guide of the present invention) is placed directly upstream of the circular plate member 82 in the second yarn running direction. The yarn guide 62 (yarn guide 62b) of the second false-twisting unit 52 is placed directly downstream of the circular plate member 84 in the second yarn running direction. The yarn guide 63 (yarn guide 63b) of the first false-twisting unit 52 is placed directly downstream of the yarn guide 62b in the second yarn running direction, and provided at the other end portion of the supporting table 56 in the base longitudinal direction.

[0073] In the five-axial false-twisting device 15 structured as described above, the yarns Y are placed to form paths (yarn paths) described below. As shown in FIG. 6, to begin with, a yarn Y1 is placed to form a spiral while making a contact with the circular plate members 57 of the first false-twisting unit 51 via the yarn guide 61a. The yarn Y1 in contact with the circular plate members 57 is placed to be inside the first triangle 201 (as shown in FIG. 7(a)) and runs through the inside of the first triangle 201, when viewed in the axial direction. Subsequently, the yarn Y1 runs toward the downstream side in the first yarn running direction via the yarn guides 62a and 63a. A yarn Y2 is placed to form a spiral while making a contact with the circular plate members 57 of the second false-twisting unit 52 via the yarn guide 61b. The yarn Y2 in contact with the circular plate members 57 is placed to be inside the second triangle 202 (as shown in FIG. 7(a)) and runs through the inside of the second triangle 202, when viewed in the axial direction. Subsequently, the yarn Y2 runs toward the downstream side in the second yarn running direction via the yarn guides 62b and 63b.

[0074] While causing the yarns Y to run as described

above, the driving mechanism 58 rotationally drives the five rotational shafts 53 in the same direction in order to apply the twisting to the yarns Y in contact with the rotating circular plate members 57. To be more specific, in the five-axial false-twisting device 15a for the Z-twisting (as shown in FIGs. 7(a) and 7(b)), Z-twisting is applied to both of the yarn Y1 and the yarn Y2. In the five-axial false-twisting device 15b for the S-twisting (as shown in FIGs. 8(a) and 8(b)), S-twisting is applied to both of the yarn Y1 and the yarn Y2.

[0075] As described above, the draw texturing machine 1 includes the combining units 17, and the winding devices 21 each of which can switch the operational mode (as shown in FIG. 1 and FIG. 2). Because of this, the yarns Y can be wound to the winding bobbins Bw by various ways. For example, a yarn Y Z-twisted by the five-axial false-twisting device 15a is combined with a yarn Y which is S-twisted by the five-axial false-twisting device 15b placed adjacent to the five-axial false-twisting device 15a by the combining unit 17 so that one non-torque yarn in which torque of the Z-twisted yarn and torque of the S-twisted yarn cancel each other out is formed. The non-torque yarn described above can be wound by a winding device 21 which is set the operational mode in the first mode. Alternatively, two yarns Y which are Z-twisted, or two yarns Y which are S-twisted may be combined with each other by the combining unit 17. In this case, a yarn which has good crimpiness and texture can be formed as compared with a case in which one yarn applied twisting is simply wound. Alternatively, two yarns Y may be guided downward in the yarn running direction without being combined with each other. In this case, the two yarns Y can be wound at the same time by a winding device 21 which is set the operational mode in the second mode.

[0076] The yarn path of the yarn Y1 and the yarn path of the yarn Y2 may be greatly different from each other depending on the layout of the five-axial false-twisting device 15 described above. For example, as shown in the reference drawing in FIG. 9(a), in a case in which the first false-twisting unit 51 is placed on the near side relative to the working space 22 and the second false-twisting unit 52 is placed on the far side relative to the working space 22, as shown in the reference drawing in FIG. 9(b), the yarn path of the yarn Y1 and the yarn path of the yarn Y2 are placed to be different in position from each other when viewed in the base longitudinal direction. As a result, for example, a bending angle of the yarn Y1 and length of the yarn path of the yarn Y1 are different from a bending angle of the yarn Y2 and length of the yarn path of the yarn Y2. Because of this, twisting of the yarn Y1 and twisting of the yarn Y2 may be different from each other, with the result that yarn quality may be different between the yarn Y1 and the yarn Y2. Therefore, for example, in dyeing the yarn Y1 and the yarn Y2, a problem in which color of the yarn Y1 and color of the yarn Y2 are different from each other may occur. Therefore, in the present embodiment, the five-axial false-twisting device

15 is placed as described below in order to suppress the difference in yarn quality between the yarn Y1 and the yarn Y2.

(Layout of Five-Axial False-Twisting Device)

[0077] The layout of the five-axial false-twisting device 15 will be described with reference to FIG. 7(a) and FIG. 8(a). As shown in FIG. 7(a) and FIG. 8(a), a straight line 223 passing through the centroid 221 of the first triangle 201 and the centroid 222 of the second triangle 202 extends along the base longitudinal direction. In this regard, "along the base longitudinal direction" is not limited to "substantially orthogonal to the base longitudinal direction". In other words, the straight line 223 may be tilted a little relative to the base longitudinal direction. In the present embodiment, in a case in which an angle formed between the straight line 223 and the base longitudinal direction is 10° or less when viewed in the axial direction, the straight line 223 may be considered to extend along the base longitudinal direction. Preferably, the angle formed between the straight line 223 and the base longitudinal direction is as small as possible. It is more preferable that the angle is, e.g., 5° or less.

[0078] As described above, the straight line 223 extends along the base longitudinal direction, so that the yarn paths in the vicinity of the five-axial false-twisting device 15 are arranged as shown in FIG. 10. In other words, the first false-twisting unit 51 substantially overlaps the second false-twisting unit 52 when viewed in the base longitudinal direction. Because of this, it is possible to arrange the yarn path of the yarn Y1 running through the first false-twisting unit 51 to substantially overlap the yarn path of the yarn Y2 running through the second false-twisting unit 52. Therefore, in the five-axial false-twisting device 15 and its surroundings, the bending angle of the yarn Y1 and length of the yarn path of the yarn Y1 are arranged to be substantially identical to the bending angle of the yarn Y2 and length of the yarn path of the yarn Y2. Furthermore, the five-axial false-twisting devices 15 are aligned to form a single line so that the yarn path of the yarn Y1 substantially overlaps the yarn path of the yarn Y2 even between, e.g., two adjacent five-axial false-twisting devices 15 when viewed in the base longitudinal direction.

[0079] Other structures of the five-axial false-twisting device 15 will be described with reference to, e.g., FIGS. 11(a) to 11(c). FIG. 11(a) shows a guide supporter 90 (described below) viewed from the leading end side in the axial direction. FIG. 11(b) shows yarn paths viewed in the base longitudinal direction before positions of the yarn guides 61a and 61b are adjusted. FIG. 11(c) shows yarn paths viewed in the base longitudinal direction after the positions of the yarn guides 61a and 61b are adjusted.

(Yarn Guides and Its Surroundings)

[0080] The structure of the yarn guides 61a and 61b

and its surroundings will be described. As shown in FIG. 5 and FIG. 11(a), the five-axial false-twisting device 15 includes the guide supporter 90 supporting the yarn guides 61a and 61b placed upstream in the yarn running direction. The guide supporter 90 includes, for example, a first supporting member 91 and a second supporting member 92. The first supporting member 91 is a member extending in the axial direction, and attached to a one side end of the supporting table 54 on the far side in the base longitudinal direction. The second supporting member 92 is a member attached to the leading end portion of the first supporting member 91 in the axial direction. The second supporting member 92 includes an extending portion 93 which extends to the inner side in the base longitudinal direction of the five-axial false-twisting device 15 and a pair of guide mounting portions 94a and 94b which are provided integrally with the extending portion 93 and extend in a direction substantially orthogonal to both of the axial direction and the base longitudinal direction. The guide mounting portion 94a is placed on one side (first false-twisting unit 51 side) in the base longitudinal direction of the five-axial false-twisting device 15. The guide mounting portion 94b is placed on the other side (second false-twisting unit 52 side) in the base longitudinal direction of the five-axial false-twisting device 15.

[0081] As shown in FIG. 5, an attachment hole 95a is formed at the guide mounting portion 94a in order to mount the yarn guide 61a, and an attachment hole 95b is formed at the guide mounting portion 94b in order to mount the yarn guide 61b. In addition to that, as shown in FIG. 11(a), the yarn guide 61a is attached to the guide mounting portion 94a by a fastener 96a which includes an unillustrated screw passing through the attachment hole 95a. Likewise, the yarn guide 61b is attached to the guide mounting portion 94b by a fastener 96b. Furthermore, the attachment holes 95a and 95b extend in a direction substantially orthogonal to both of the axial direction and the base longitudinal direction (as shown in FIG. 5). Because of this, the yarn guides 61a and 61b are movable yarn guides which are able to be adjusted in position in a direction substantially orthogonal to the base longitudinal direction, when viewed in the axial direction. To be more specific, the yarn guide 61a can be moved along the attachment hole 95a when the fastener 96a is loosened. The yarn guide 61a can be fixed in position by fastening the fastener 96a. The yarn guide 61b is similarly arranged.

[0082] As described above, the circular plate member 81 of the first false-twisting unit 51 and the circular plate member 82 of the second false-twisting unit 52 are placed point-symmetrically with each other (as shown in FIG. 7(a)). In other words, the positions of the circular plate members 81 and 82 are different from each other when viewed in the base longitudinal direction. Therefore, as shown in FIG. 11(b), a bending angle of the yarn Y1 running via the yarn guide 61a and a bending angle of the yarn Y2 running via the yarn guide 61b are different from

each other if the yarn guides 61a and 61b are placed to overlap with each other when viewed in the base longitudinal direction. In this case, yarn quality of the yarn Y1 and yarn quality of the yarn Y2 may be different from each other. In this regard, in the present embodiment, relative positional relationship between the yarn guides 61a and 61b can be adjusted because the yarn guides 61a and 61b are the movable yarn guides. Therefore, a gap between the bending angle of the yarn Y1 and the bending angle of the yarn Y2 can be reduced by adjusting the positions of the yarn guides 61a and 61b properly (as shown in FIG. 11(c)).

[0083] The following arrangement is especially effective for performing false-twisting on yarns Y made of nylon: yarn paths of yarns Y substantially overlap (yarn paths are aligned) each other when viewed in the base longitudinal direction. Typically, yarns made of nylon have a higher running resistance described above as compared to yarns made of polyester. When the running resistance is high, it is disadvantageous that production rates of yarns Y are difficult to be improved. For example, the running resistance becomes high as the bending angles of the yarns are increased. For example, when the bending angle is greatly different between the yarn Y1 and the yarn Y2, the maximal speed in which the yarns can run may be greatly different between the yarn Y1 and the yarn Y2. Generally, among the running speed of the yarn Y1 and the running speed of the yarn Y2, the faster one is adjusted to be as slow as the slower one in order to keep the production rates of these the same. Therefore, when the maximal speed of the yarn Y1 and the maximal speed of the yarn Y2 are greatly different from each other, an improvement in the production efficiency of yarns is disadvantageously obstructed. In this regard, in the present embodiment, the bending angle of the yarn Y1, etc. is arranged to be substantially identical to the bending angle of the yarn Y2, etc. Because of this, the running resistance of the yarn Y1 is arranged to be substantially equal to the running resistance of the yarn Y2.

[0084] As described above, the straight line 223 passing through the centroid 221 of the first triangle 201 and the centroid 222 of the second triangle 202 extends along the base longitudinal direction. Because of this, the yarn path of the yarn Y1 running through the first false-twisting unit 51 is arranged to substantially overlap the yarn path of the yarn Y2 running through the second false-twisting unit 52 when viewed in the base longitudinal direction. Therefore, the bending angle of the yarn Y1 and length of the yarn path of the yarn Y1 are arranged to be substantially identical to the bending angle of the yarn Y2 and length of the yarn path of the yarn Y2. Therefore, in the draw texturing machine 1 in which the five-axial false-twisting devices 15 are aligned in the base longitudinal direction, the difference in yarn quality can be suppressed from the yarn Y1 and yarn Y2.

[0085] The positions of the yarn guides 61a and 61b are adjusted so that a difference between the yarn path

of the yarn Y1 guided by the yarn guide 61a and the yarn path of the yarn Y2 guided by the yarn guide 61b is suppressed to be small. Therefore, the difference in quality between the yarn Y1 and the yarn Y2 is suppressed.

[0086] The yarn guides 61a and 61b are movable in the direction substantially orthogonal to the base longitudinal direction, when viewed in the axial direction. Therefore, movable areas of the yarn guides 61a and 61b can be widened while the yarn guides 61a and 61b are suppressed from interfering with each other, so that the yarn paths are effectively adjusted.

[0087] Between two adjacent five-axial false-twisting devices 15, the yarn path of the yarn Y1 is arranged to substantially overlap the yarn path of the yarn Y2 when viewed in the base longitudinal direction, with the result that the difference in yarn quality can be suppressed between the yarn Y1 and the yarn Y2. Therefore, in the case in which the Z-twisted yarn is combined with the S-twisted yarn by the combining unit 17, the torque of the Z-twisted yarn and the torque of the S-twisted yarn can cancel each other out, with the result that a high-quality non-torque yarn can be formed. In the case in which two Z-twisted yarns or two S-twisted yarns are combined with each other, a yarn Y can be combined with a yarn Y which has the same physical property.

[0088] The winding device 21 can change the operational mode between the first mode and the second mode. Because of this, one of the following modes can be selected while increase in number of the winding devices 21 (i.e., increase in size of the draw texturing machine 1) is avoided: a mode in which two yarns Y1 and Y2 are combined with each other, and then wound; and a mode in which each yarn Y is simply wound. In the present embodiment, because the difference in yarn quality can be suppressed between the yarn Y1 and the yarn Y2 as described above, packages in which the difference in quality is small can be produced in quantity in a space which is small in size of the device.

[0089] If the yarn paths of the yarns Y1 and Y2 which are twisted by the five-axial false-twisting device 15 are different from each other, the cooler 14 cannot be used in the draw texturing machine 1. In this regard, in the present embodiment, the bending angle of the yarn Y1 and length of the yarn path of the yarn Y1 which is twisted by the five-axial false-twisting device 15 are arranged to be substantially identical to the bending angle of the yarn Y2 and length of the yarn path of the yarn Y2 as described above, so that the cooler 14 can be used. Therefore, it is possible to achieve, e.g., the decrease in size of the cooler 14 as described above.

[0090] The circular plate member 81 placed at the most upstream in the first yarn running direction of the first false-twisting unit 51 and the circular plate member 82 placed at the most upstream in the second yarn running direction of the second false-twisting unit 52 are placed in the same first plane 203. Furthermore, the circular plate member 83 placed at the most downstream in the first yarn running direction of the first false-twisting unit 51

and the circular plate member 84 placed at the most downstream in the second yarn running direction of the second false-twisting unit 52 are placed in the same second plane 204. Because of this, the circular plate members 57 can be small in size in the axial direction. Therefore, increase in size of the device can be suppressed in the axial direction.

[0091] Because the bending angle or the like of the yarn Y1 is arranged to be substantially identical to the bending angle or the like of the yarn Y2, the running resistance of the yarn Y1 is arranged to be substantially equal to the running resistance of the yarn Y2. Therefore, the running speed of the yarn Y1 can be as fast as the running speed of the yarn Y2, with the result that the production efficiency can be improved. The improvement of the production efficiency described above is especially effective in a case of processing a yarn Y which is made of nylon and has the higher running resistance.

[0092] The following will describe modifications of the above-described embodiment. The members which are identical with those in the above-described embodiment will be denoted by the same reference numerals, and the explanations thereof are not repeated.

(1) In the present embodiment, in the draw texturing machine 1, the circular plate members 57 are attached to all rotational shafts 53 of all five-axial false-twisting devices 15. However, the disclosure is not limited to this. An unnecessary circular plate member 57 may be detached from a rotational shaft 53 which is not used for processing yarns Y (for example, some of the rotational shafts 53 of the five-axial false-twisting device 15 placed at the most left part in FIG. 2), for an object such as cost reduction. In this regard, in a structure in which five rotational shafts 53 are driven together by the above-described motor 85, the following problems may occur. If circular plate members 57 are simply detached from some rotational shafts 53 in one five-axial false-twisting device 15, a load on the motor 85 of the five-axial false-twisting device 15 becomes smaller than a load on each of motors 85 of other five-axial false-twisting devices 15. Because of this, in the five-axial false-twisting device 15 from which some of the circular plate members 57 are detached, five rotational shafts 53 rotate unintentionally at high speed. As a result, yarn quality of yarns which are processed at the five-axial false-twisting device 15 may be greatly different from yarn quality of yarns which are processed at other five-axial false-twisting devices 15. In this regard, as shown in FIGs. 12(a) and 12(b), in the five-axial false-twisting device 15 from which some of the circular plate members 57 are detached, weights may be provided in place of the detached circular plate members 57. For example, as shown in FIG. 12(a), in a five-axial false-twisting device 15c in which circular plate members 57 are detached from first independent rotational shafts 72 and 73,

weights 110 may be provided in place of the circular plate members 57. Likewise, as shown in FIG. 12(b), in a five-axial false-twisting device 15d in which circular plate members 57 are detached from second independent rotational shafts 74 and 75, weights 110 may be provided in place of the circular plate members 57. Because of this, the rotational shafts 53 are prevented from rotating unintentionally at high speed, thanks to these weights 110 functioning as loads. Therefore, by using members which are more inexpensive than the circular plate members 57 as the weights 110, the difference in yarn quality between the five-axial false-twisting devices 15 is suppressed while increase in cost is suppressed.

Alternatively, instead of providing the weights 110, the five-axial false-twisting device 15 from which some of the circular plate members 57 are detached may perform feedback control on the number of rotations of the motor 85. For example, the five-axial false-twisting device 15 may include an unillustrated inverter device for controlling the number of rotations of the motor 85 which drives five rotational shafts 53 together. Alternatively, as another way, the five-axial false-twisting device 15 from which some of the circular plate members 57 are detached may include five unillustrated motors which rotationally drive the rotational shafts 53 individually.

(2) In the embodiment above, the circular plate members 57, which include the contact parts making a contact with the yarns Y and being made of polyurethane, are attached to each of the rotation shafts 53. However, the disclosure is not limited to this. In other words, both of the yarn Y1 and the yarn Y2 make a contact with the circular plate members 57 provided at the common rotational shaft 71 in principle, so that these circular plate members 57 may be worn away earlier than the other circular plate members 57 provided to other rotational shafts 53. For this reason, for example, the contact parts, making a contact with the yarns Y, of all of the circular plate members 57 attached to the common rotational shaft 71 may be made of ceramic which has higher abrasion resistance than polyurethane. In other words, the abrasion resistance of the contact parts, making a contact with the yarns Y, of the circular plate members 57 attached to the common rotational shaft 71 may be higher than the abrasion resistance of the contact parts, making a contact with the yarn Y, of the circular plate members 57 attached to other rotational shafts 53 except the common rotational shaft 71. Because of this, it is possible to suppress the circular plate members 57 provided at the common rotational shaft 71 from being worn earlier than the other circular plate members 57. Therefore, it is possible to avoid the necessity of replacement of some circular plate members 57 earlier than the other circular plate members 57. In this regard, materials of the contact parts, making a contact with the

yarns Y, of the circular plate members 57 are not limited to the above-described polyurethane or ceramic.

(3) In the present embodiment, the circular plate member 81 of the first false-twisting unit 51 and the circular plate member 82 of the second false-twisting unit 52 are placed in the same first plane 203. However, the disclosure is not limited to this. The circular plate members 81 and 82 may not be necessarily placed in the same plane. Likewise, the circular plate member 83 of the first false-twisting unit 51 and the circular plate member 84 of the second false-twisting unit 52 may not be necessarily placed in the same second plane 204.

(4) In the present embodiment, the rotational shafts 53 are driven by belts. However, the disclosure is not limited to this. For example, gears or chains may be provided instead of the belts, as transmission members which transmit power of the drive source to each of the rotational shafts 53.

(5) In the present embodiment, the yarn guides 61a and 61b are movable in the direction orthogonal to the base longitudinal direction, when viewed in the axial direction. However, the disclosure is not limited to this. A movable direction of the yarn guides 61a and 61b may be tilted from the direction orthogonal to the base longitudinal direction. In other words, the yarn guides 61a and 61b may be movable in a direction crossing the base longitudinal direction.

(6) In the embodiment described above, both of the yarn guides 61a and 61b can be adjusted in position. However, the disclosure is not limited to this. That is to say, only one of the yarn guides 61a and 61b may be adjustable in position relative to the other. In other words, at least one of the yarn guides 61a and 61b may be adjustable in position relative to the other.

(7) In the modification described in the (6), at least one of the yarn guides 61a and 61b may be able to be adjusted in position relative to the other. However, the disclosure is not limited to this. The yarn guides 61a and 61b may not be necessarily able to be adjusted in position.

(8) In the present embodiment, the draw texturing machine 1 includes the combining units 17. However, the draw texturing machine 1 may not include the combining units 17.

(9) In the present embodiment, the winding device 21 can switch the operational mode between the first mode in which the yarn Y is wound to one winding bobbin Bw and the second mode in which the yarns Y are wound to two winding bobbins Bw. However, the disclosure is not limited to this. For example, the winding device 21 may be able to select an operational mode in which the yarns Y are wound to three or more winding bobbins Bw. Alternatively, the winding device 21 may wind the yarn Y to only one winding bobbin Bw.

(10) In the present embodiment, the straight line 223

connecting the centroid 221 with the centroid 222 extends along the base longitudinal direction. However, the disclosure is not limited to this. The following will describe a modification with reference to FIGs. 13(a) and 13(b). Among the circular plate members 57 provided at the first independent rotational shafts 72 and 73 and the common rotational shaft 71, the circular plate member 57 provided at the most leading end side in the axial direction is the circular plate member 81 (as shown in FIG. 13(a)) as described above. A circular plate member 57 provided at the second most leading end side in the axial direction is a circular plate member 231 (as shown in FIG. 13(a)). The circular plate member 231 is provided downstream of the circular plate member 81 in the axial direction. The circular plate member 231 is provided at the common rotation shaft 71. When viewed in the axial direction, among intersections between an outer edge of the circular plate member 81 and an outer edge of the circular plate member 231, an intersection formed inside of the first triangle 201 is a first intersection 232. Among the circular plate members 57 provided at the second independent rotational shafts 74 and 75 and the common rotational shaft 71, the circular plate member 57 provided at the most leading end side in the axial direction is the circular plate member 82 as described above. The circular plate member 231 is on the second most leading end side in the axial direction. The circular plate member 231 is provided downstream of the circular plate member 82. When viewed in the axial direction, among intersections between an outer edge of the circular plate member 82 and an outer edge of the circular plate member 231, an intersection formed inside of the second triangle 202 is a second intersection 233. In this regard, a straight line 234 passing through the first intersection 232 and the second intersection 233 may extend along the base longitudinal direction. In this regard, "along the base longitudinal direction" is not limited to "substantially parallel to the base longitudinal direction". In other words, in a case in which an angle formed between the straight line 234 and the base longitudinal direction is 10° or less when viewed in the axial direction, the straight line 234 may be considered to extend along the base longitudinal direction. Preferably, the angle formed between the straight line 234 and the base longitudinal direction is as small as possible. It is more preferable that the angle is, e.g., 5° or less. Because of this, the first intersection 232 is arranged to substantially overlap the second intersection 233 when viewed in the base longitudinal direction. In other words, at least a part of the yarn Y1 is arranged to substantially overlap a part of the yarn Y2 in the yarn running direction when viewed in the base longitudinal direction. The part of the yarn Y1 is placed upstream of the first intersection 232 in the yarn running direction, and the part

of the yarn Y2 is placed upstream of the second intersection 233 in the yarn running direction. In other words, the yarn path of the yarn Y1 placed upstream of the circular plate member 81 in the yarn running direction is arranged to be substantially identical to the yarn path of the yarn Y2 placed upstream of the circular plate member 82 in the yarn running direction (as shown in FIG. 13(b)). Therefore, in the draw texturing machine 1 in which the five-axial false-twisting devices 15 are aligned in the base longitudinal direction, the difference in yarn quality can be suppressed between the yarn Y1 and yarn Y2.

(11) In the embodiment described above, the draw texturing machine 1 performs the false twisting on the yarns Y made of nylon. However, the disclosure is not limited to this. For example, the draw texturing machine 1 may perform false twisting on yarns made of, e.g., polyester.

Claims

1. A draw texturing machine (1) comprising: five-axial false-twisting devices (15) aligned in a base longitudinal direction, each of the five-axial false-twisting devices (15) being able to apply twisting to two yarns (Y) at the same time by circular plate members (57), the circular plate members (57) being provided at five rotational shafts (53), the five rotational shafts (53) extending in an axial direction orthogonal to the base longitudinal direction, and each of the five-axial false-twisting devices (15) including:

a first false-twisting unit (51) which includes, among the five rotational shafts (53), two first independent rotational shafts (72, 73) and a common rotational shaft (71) which virtually form apexes of a first triangle (201) when viewed in the axial direction, the first false-twisting unit (51) applying the twisting to a first yarn (Y1) running inside of the first triangle (201); and

a second-false twisting unit (52) which includes, among the five-rotational shafts (53), two second independent rotational shafts (74, 75) and the common rotational shaft (71) which virtually form apexes of a second triangle (202) when viewed in the axial direction, the second false-twisting unit (52) applying the twisting to a second yarn (Y2) running inside of the second triangle (202),

the two first independent rotational shafts (72, 73) opposing the two second independent rotational shafts (74, 75) over the common rotational shaft (71) in the base longitudinal direction,

a straight line (223) passing through a centroid (221) of the first triangle (201) and a centroid (222) of the second triangle (202) when viewed

in the axial direction, and the straight line (223) extending along the base longitudinal direction.

2. A draw texturing machine (1) comprising: five-axial false-twisting devices (15) aligned in a base longitudinal direction, each of the five-axial false-twisting devices (15) being able to apply twisting to two yarns (Y) at the same time by circular plate members (57), the circular plate members (57) being provided at five rotational shafts (53), the five rotational shafts (53) extending in an axial direction orthogonal to the base longitudinal direction, and each of the five-axial false-twisting devices (15) including:

a first false-twisting unit (51) which includes, among the five rotational shafts (53), two first independent rotational shafts (72, 73) and a common rotational shaft (71) which virtually form apexes of a first triangle (201) when viewed in the axial direction, the first false-twisting unit (51) applying the twisting to a first yarn (Y1) running inside of the first triangle (201); and

a second-false twisting unit (52) which includes, among the five-rotational shafts (53), two second independent rotational shafts (74, 75) and the common rotational shaft (71) which virtually form apexes of a second triangle (202) when viewed in the axial direction, the second false-twisting unit (52) applying the twisting to a second yarn (Y2) running inside of the second triangle (202),

the two first independent rotational shafts (72, 73) opposing the two second independent rotational shafts (74, 75) over the common rotational shaft (71) in the base longitudinal direction,

in the two first independent rotational shafts (72, 73) and the common rotational shaft (71), an intersection between an outer edge of one circular plate member (81) of the circular plate members (57) and an outer edge of another circular plate member (231) of the circular plate members (57) being a first intersection (232), the first intersection (232) being formed inside of the first triangle (201) when viewed in the axial direction, the one circular plate member (81) being on the most leading end side in the axial direction among the circular plate members (57), and the another circular plate member (231) being on the second most leading end side in the axial direction,

in the second independent rotational shafts (74, 75) and the common rotational shaft (71), an intersection between an outer edge of one circular plate member (82) of the circular plate members (57) and the outer edge of the another circular plate member (231) of the circular plate members (57) being a second intersection

- (233), the second intersection (233) being formed inside of the second triangle (202) when viewed in the axial direction, the one circular plate member (82) being on the most leading end side in the axial direction among the circular plate members (57), the another circular plate member (231) being on the second most leading end side in the axial direction, and a straight line (234) passing through the first intersection (232) and the second intersection (233) extending along the base longitudinal direction, when viewed in the axial direction.
3. The draw texturing machine (1) according to claim 1 or 2, wherein, the first false-twisting unit (51) further includes, a first yarn guide (61a) placed upstream of a circular plate member (81) which is the most upstream circular plate member in a first yarn running direction in which the first yarn (Y1) runs, among the circular plate members (57), the second false-twisting unit (52) further includes, a second yarn guide (61b) placed upstream of a circular plate member (82) which is the most upstream circular plate member in a second yarn running direction in which the second yarn (Y2) runs, among the circular plate members (57), and at least one of the first yarn guide (61a) and the second yarn guide (61b) is a movable yarn guide which is able to be adjusted in position relative to the other.
 4. The draw texturing machine (1) according to claim 3, wherein, the first yarn guide (61a) and the second yarn guide (61b) are aligned in the base longitudinal direction, and the movable yarn guide is movable in a direction crossing the base longitudinal direction when viewed in the axial direction.
 5. The draw texturing machine (1) according to any one of claims 1 to 6, wherein, each of the five-axial false-twisting devices (15) further includes a common driving source (85) for driving the five rotational shafts (53) together, and among the five rotational shafts (53), at a rotational shaft (53) which is not used for processing the yarns (Y), a weight (110) is provided instead of at least one of the circular plate members (57).
 6. The draw texturing machine (1) according to any one of claims 1 to 5, wherein, a first five-axial false-twisting device (15a) which is one of the five-axial false-twisting devices (15) is able to perform Z-twisting on a yarn (Y), a second five-axial false-twisting device (15b) which is placed to be adjacent to the first five-axial false-twisting device (15a) in the base longitudinal direction is able to perform S-twisting on a yarn (Y), and the draw texturing machine (1) further comprises a combining unit (17) which combines the yarn (Y) Z-twisted by the first false-twisting unit (51) of the first five-axial false-twisting device (15a) with the yarn (Y) S-twisted by the second false-twisting unit (52) of the second five-axial false-twisting device (15b).
 7. The draw texturing machine (1) according to any one of claims 1 to 6, further comprising winding devices (21) each of which forms a wound package (Pw) by winding a running yarn (Y) to at least one winding bobbin (Bw), and each of the winding devices (21) includes:
 - a single cradle (43) which is able to support the at least one winding bobbin (Bw) to be rotatable; and
 - a traverse unit (42) to which traverse guides (45) for traversing yarns (Y) are attachable, and an operational mode of the winding devices (21) being switchable between a first mode in which a yarn (Y) is wound to one of the at least one winding bobbin (Bw) and a second mode in which yarns (Y) are wound to the respective winding bobbins (Bw) at the same time.
 8. The draw texturing machine (1) according to any one of claims 1 to 7, further comprising a cooler (14) which cools the first yarn (Y1) and the second yarn (Y2), the cooler (14) being placed upstream of the five-axial false-twisting devices (15) in a yarn running direction in which a yarn (Y) runs, and the cooler (14) including:
 - a first guide member (25a) which forms a first running space (27a) communicating with an external space (22) in which the first yarn (Y1) runs;
 - a second guide member (25b) which forms a second running space (27b) communicating with the external space (22) in which the second yarn (Y2) runs; and
 - a common duct (24) in which an internal space (28) communicating with both of the first running space (27a) and the second running space (27b) is formed, the internal space (28) extending in the base longitudinal direction, the common duct (24) sucking air by a sucking power source (29), and the air flowing in the internal space (28).
 9. The draw texturing machine (1) according to any one of claims 1 to 8, wherein, a circular plate member (81) placed at the most upstream in the first yarn running direction in which the first yarn (Y1) runs in the first false-twisting unit (51) and a circular plate member (82) placed at the most upstream in the second yarn running direction in which the second yarn (Y2) runs in the second false-twisting unit (52) are placed in a same first plane (203) which is orthogonal to the axial direction, and

a circular plate member (83) placed at the most downstream in the first yarn running direction in the first false-twisting unit (51) and a circular plate member (84) placed at the most downstream in the second yarn running direction in the second false-twisting unit (52) are placed in a same second plane (204) which is orthogonal to the axial direction.

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10. The draw texturing machine (1) according to any one of claims 1 to 9, wherein, the yarn (Y) made of nylon is false-twisted.

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FIG.1

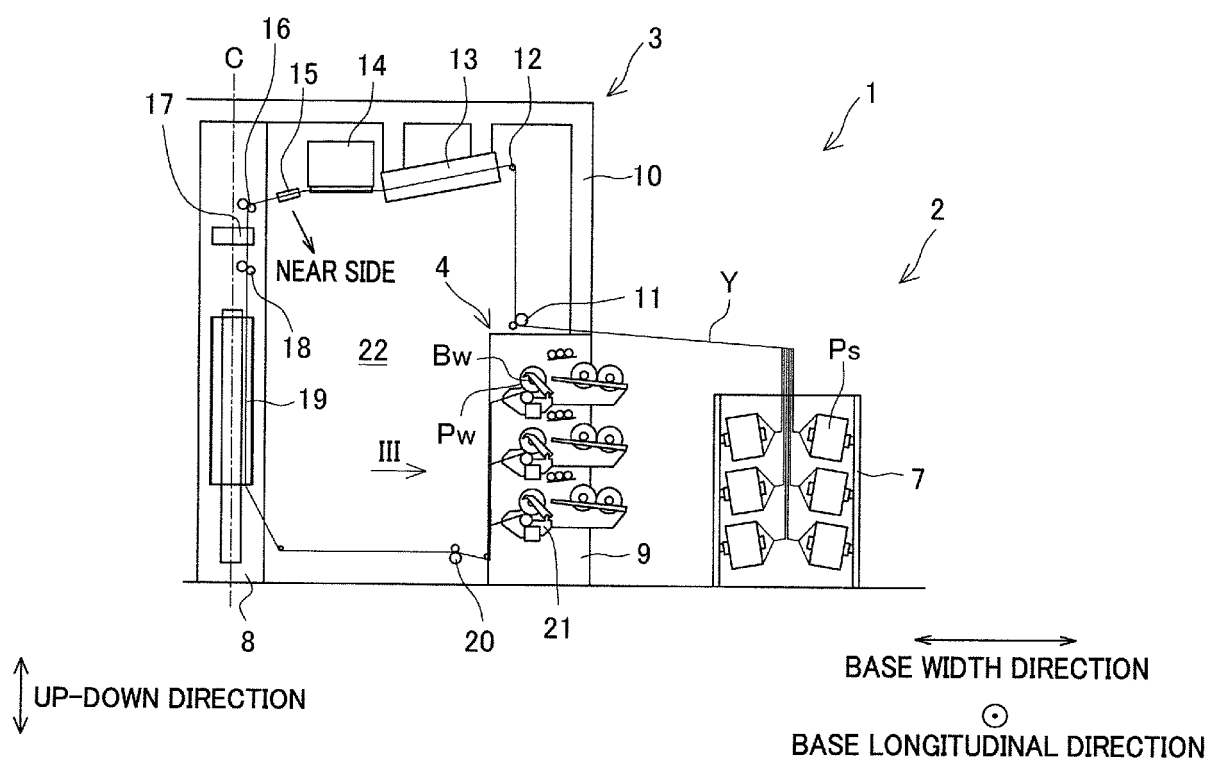


FIG.2

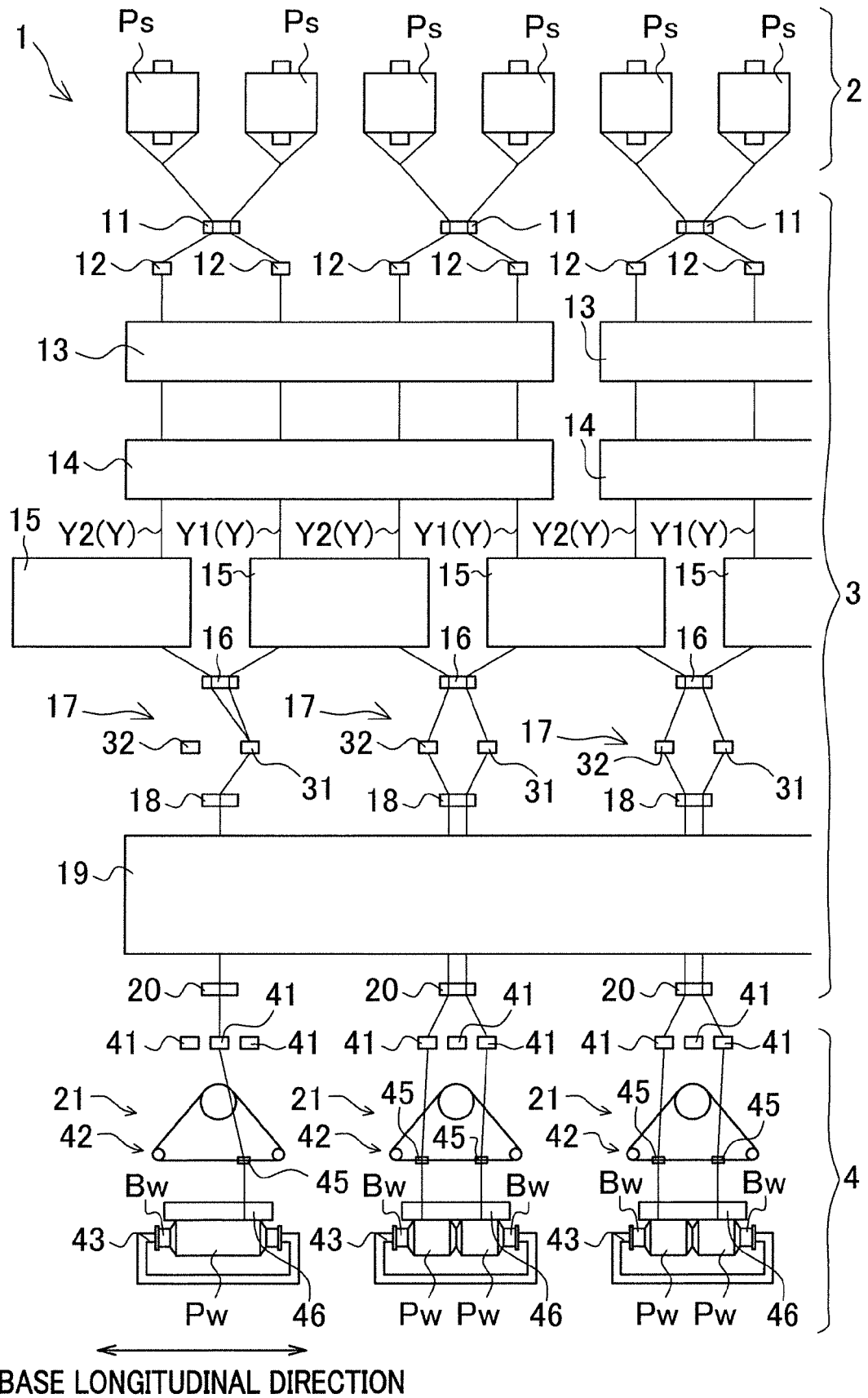


FIG.3

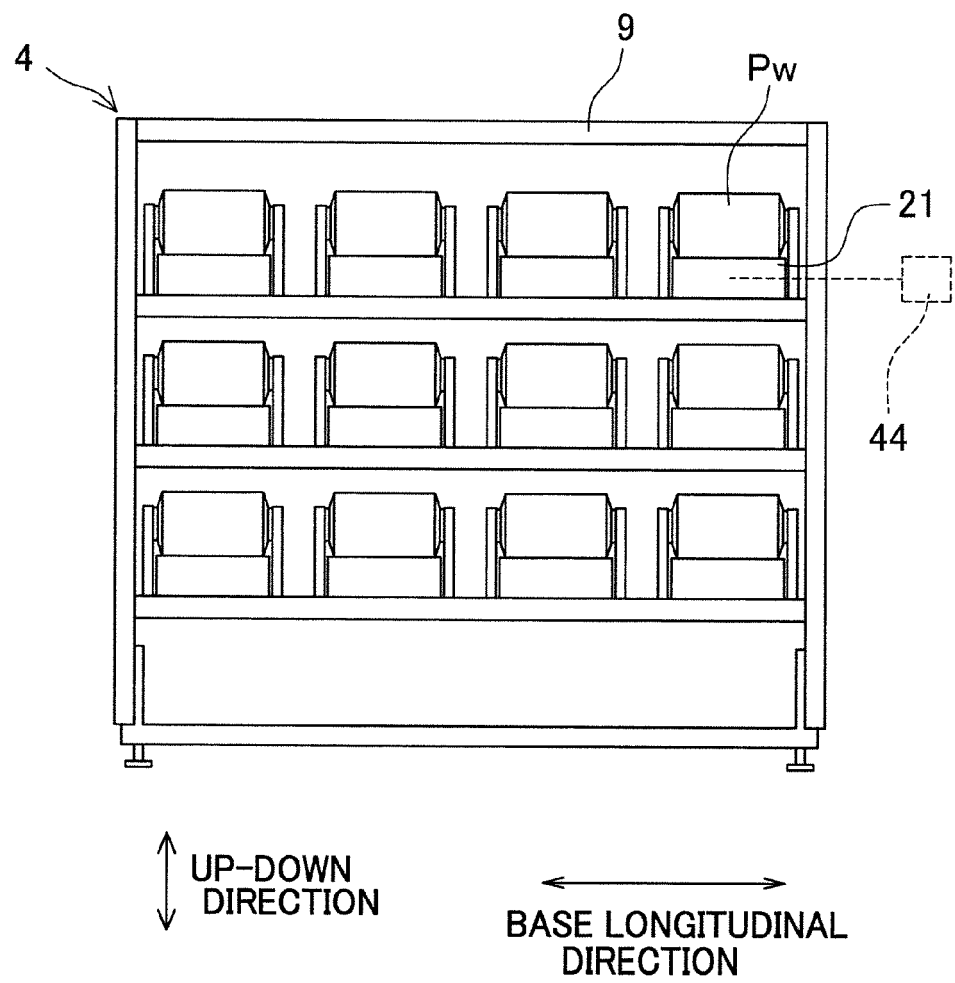


FIG.4

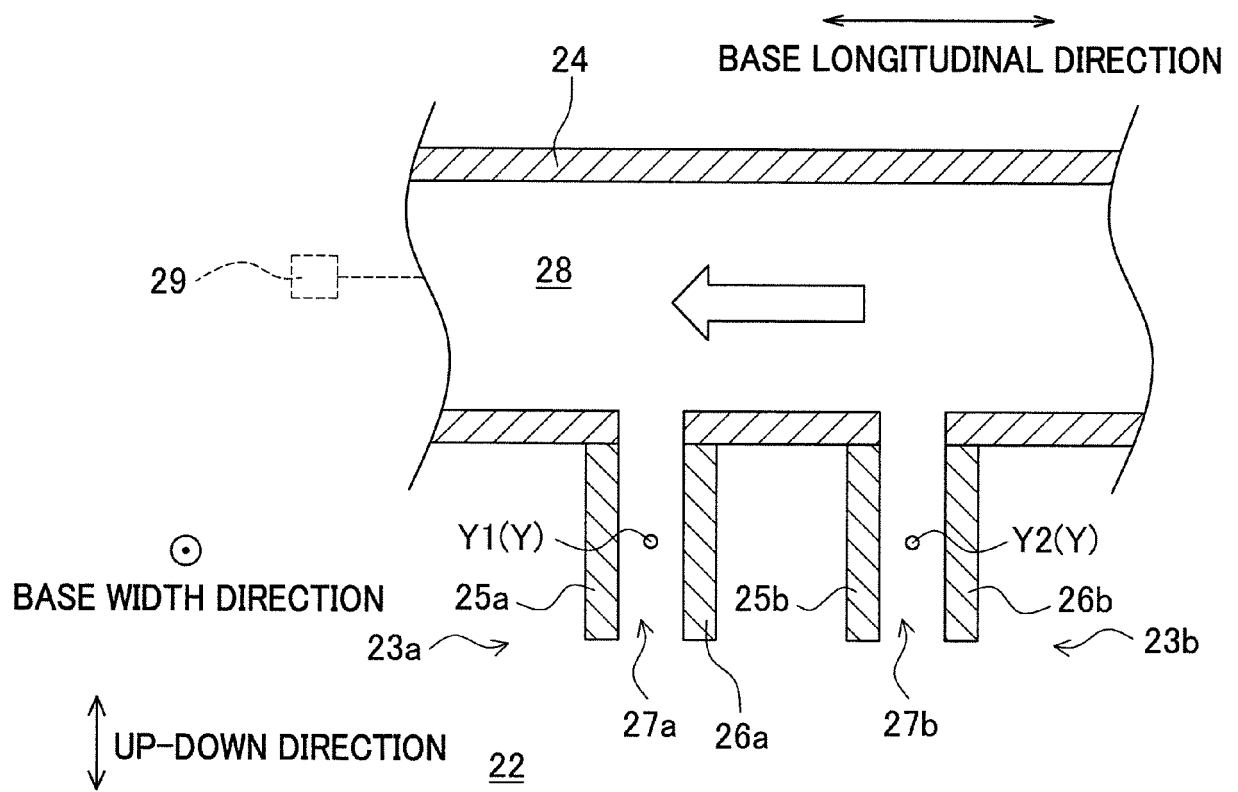
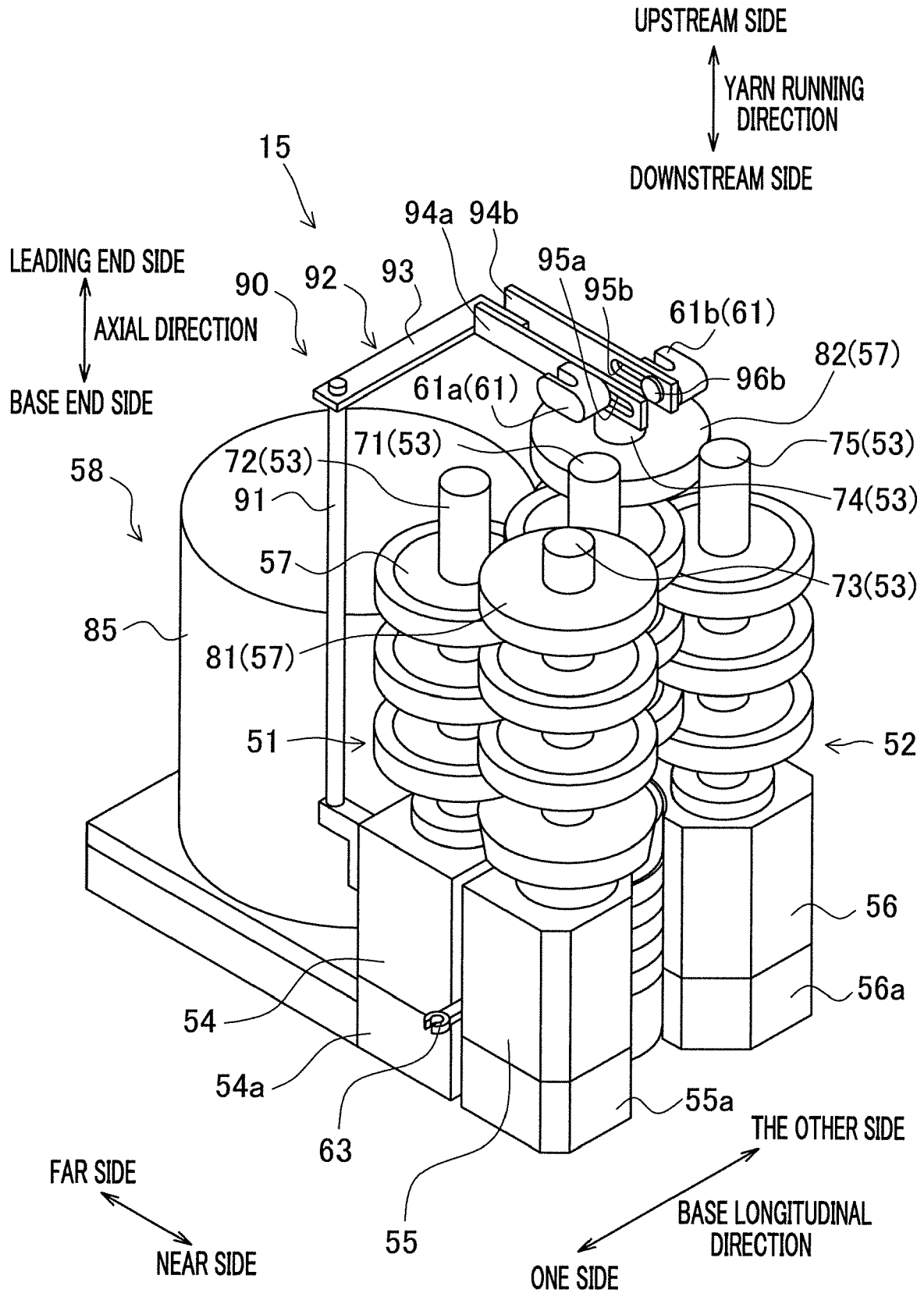


FIG.5



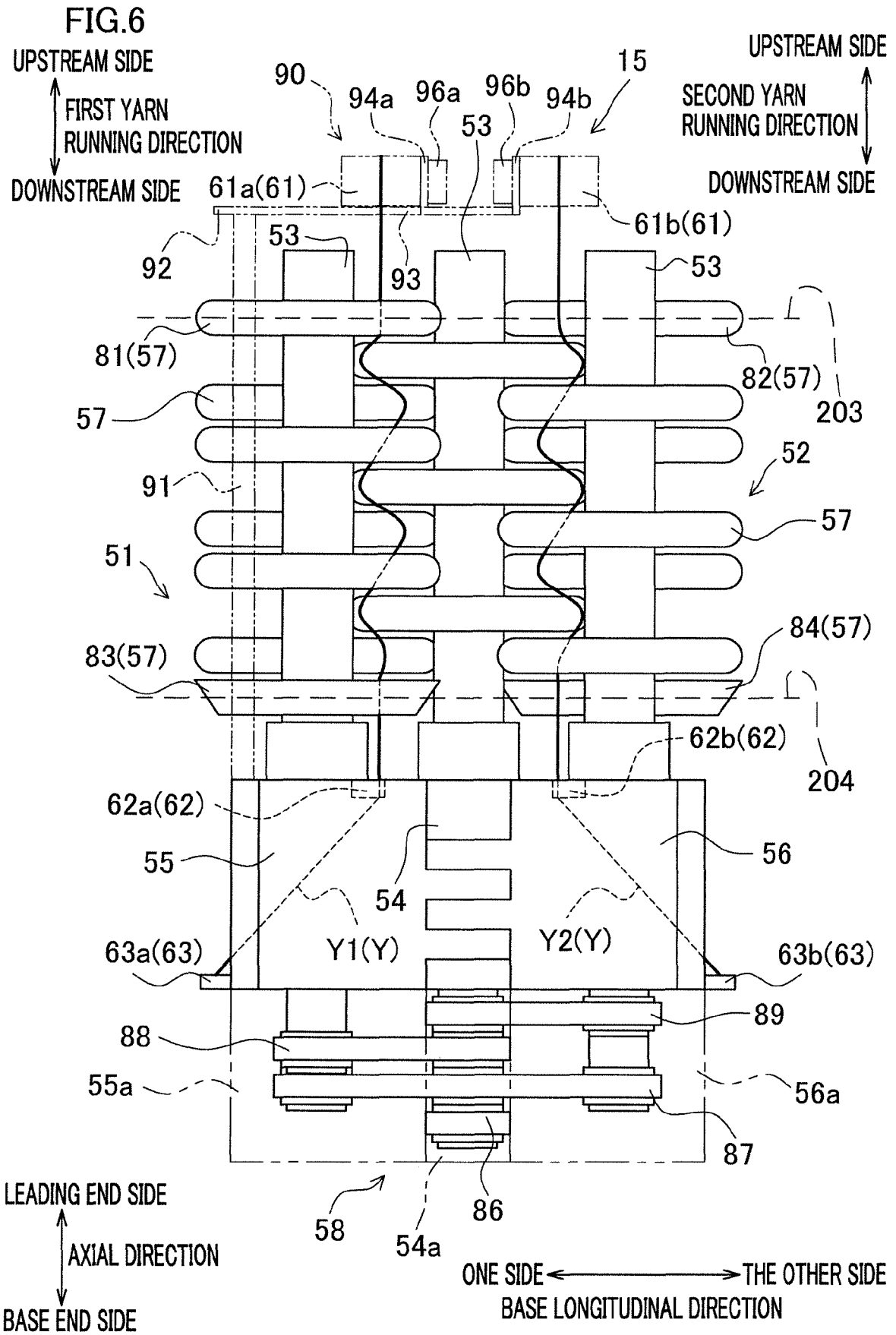


FIG. 7

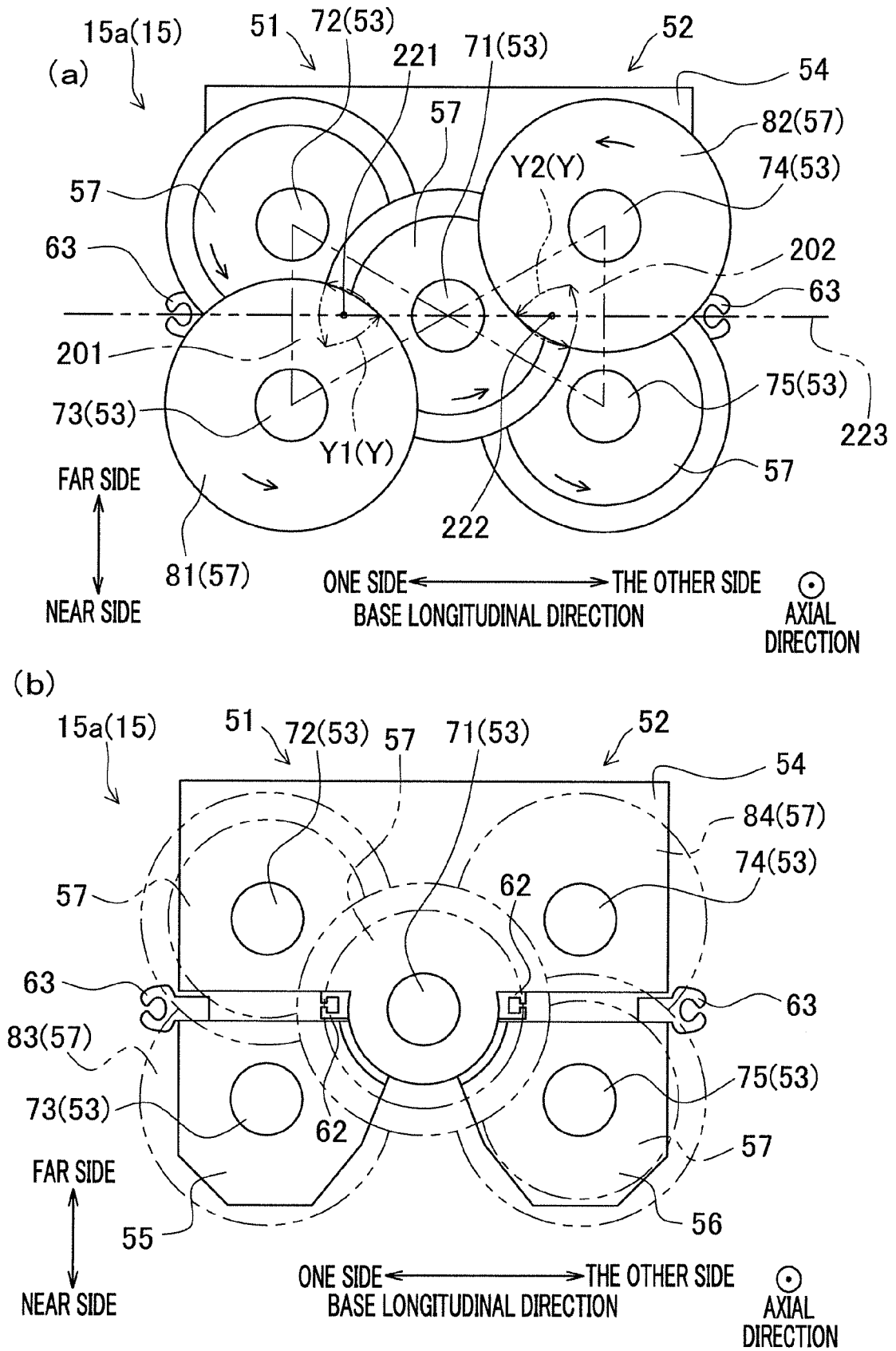


FIG.8

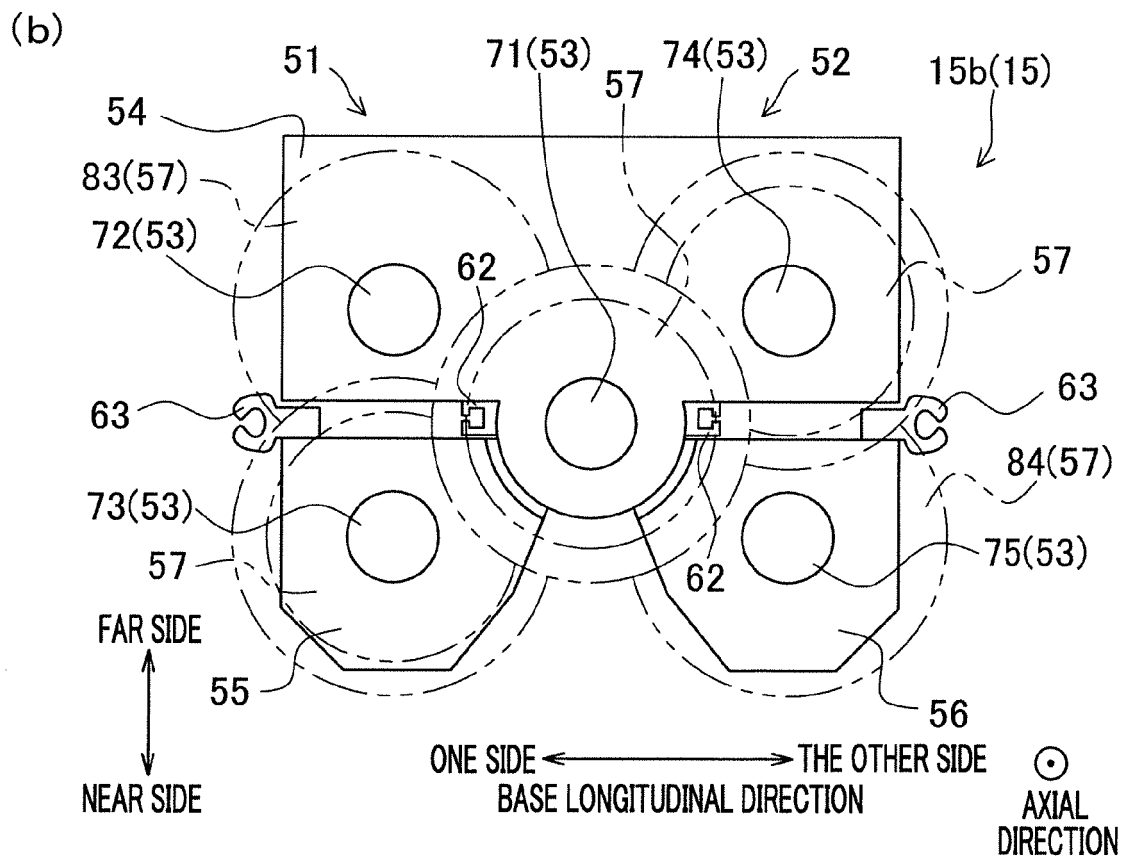
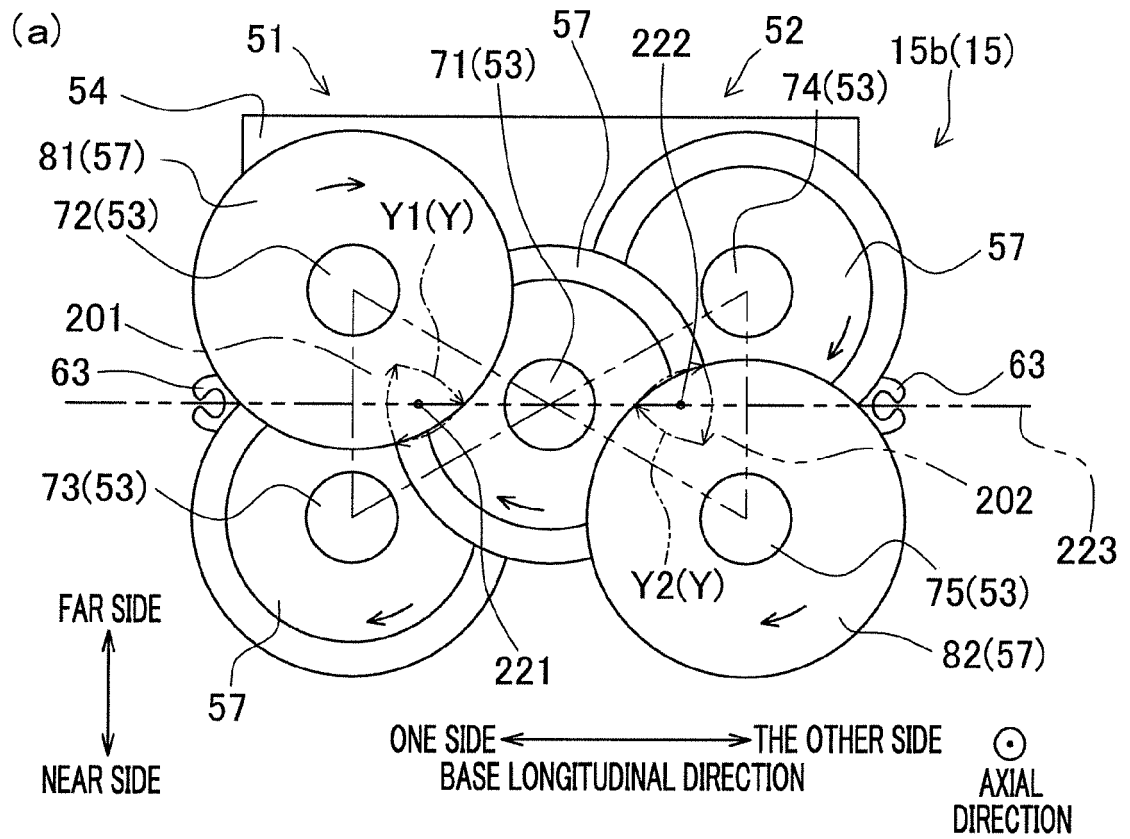
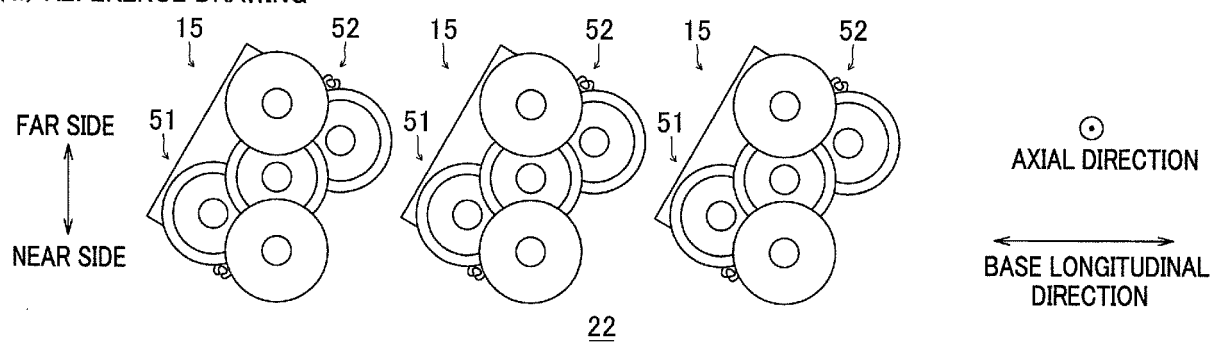


FIG.9

(a) REFERENCE DRAWING



(b) REFERENCE DRAWING

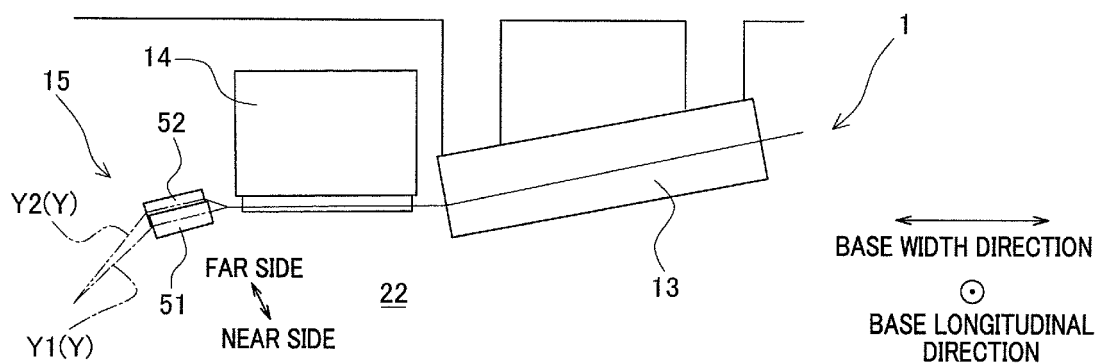


FIG.10

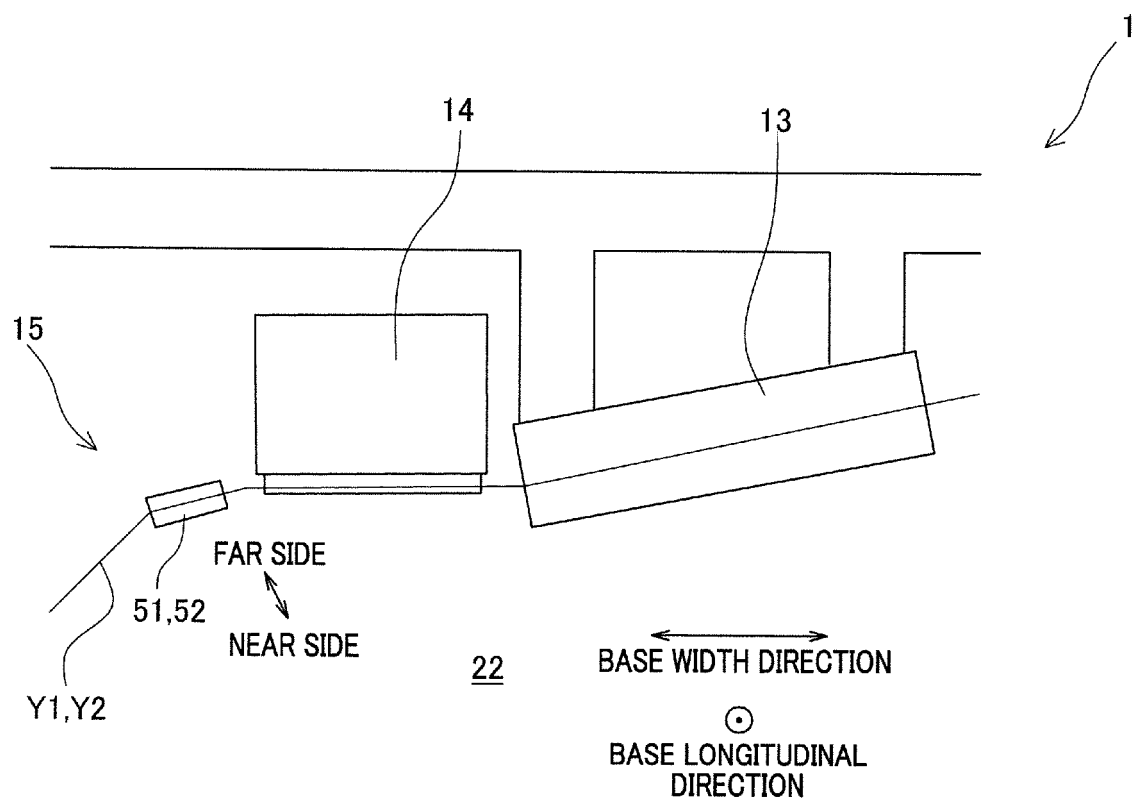
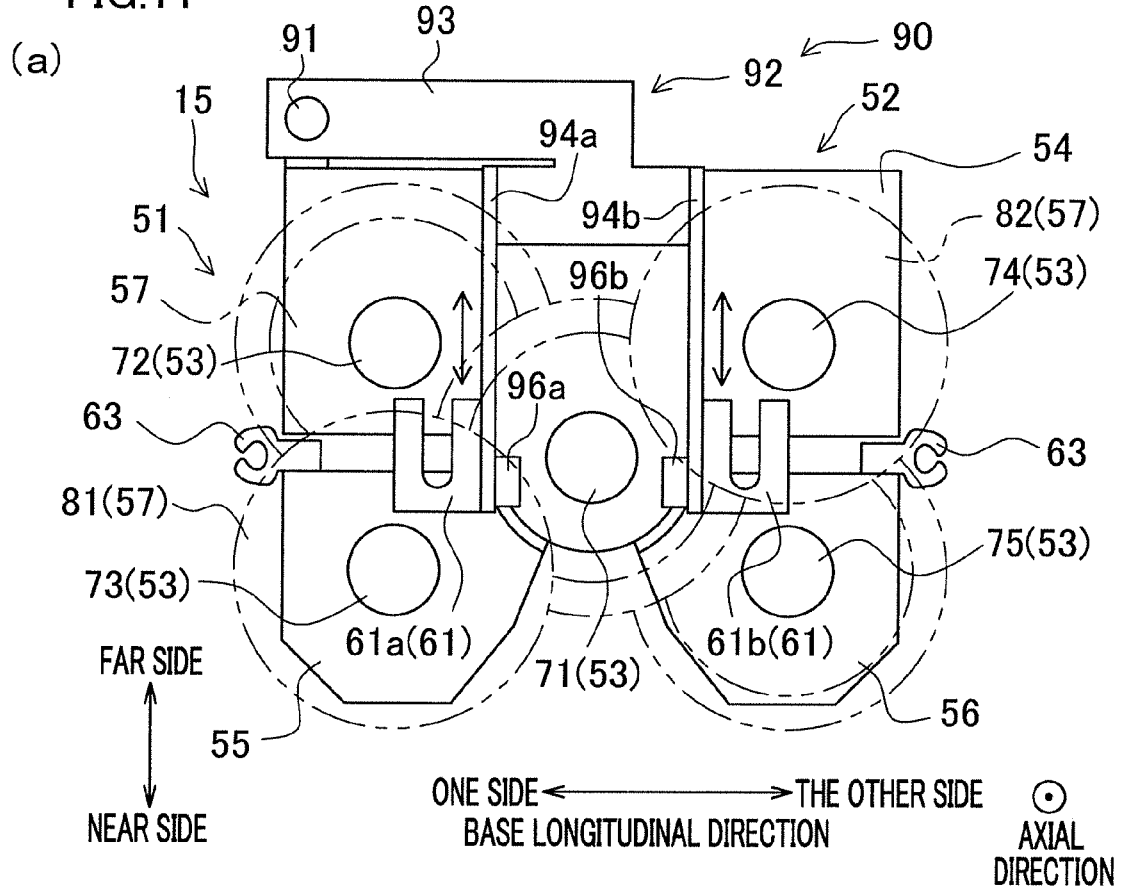
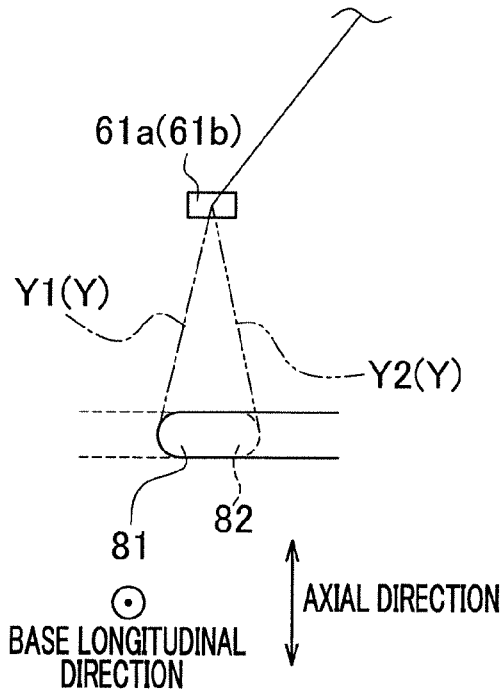


FIG.11



(b) BEFORE POSITIONS OF YARN GUIDES ARE ADJUSTED



(c) AFTER POSITIONS OF THE YARN GUIDES ARE ADJUSTED

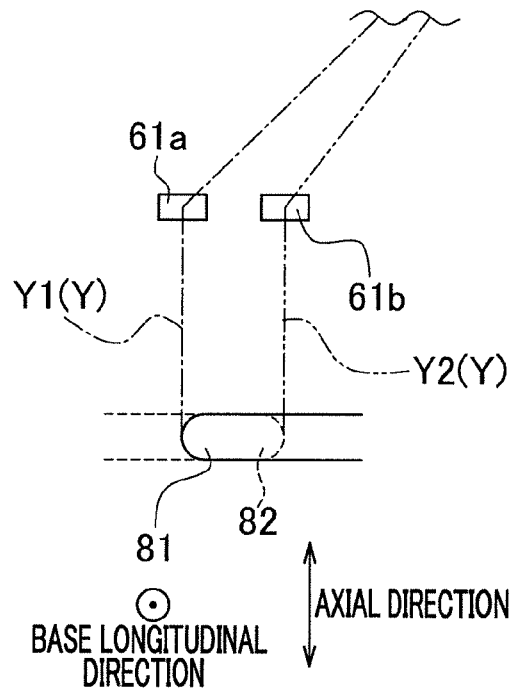


FIG.12

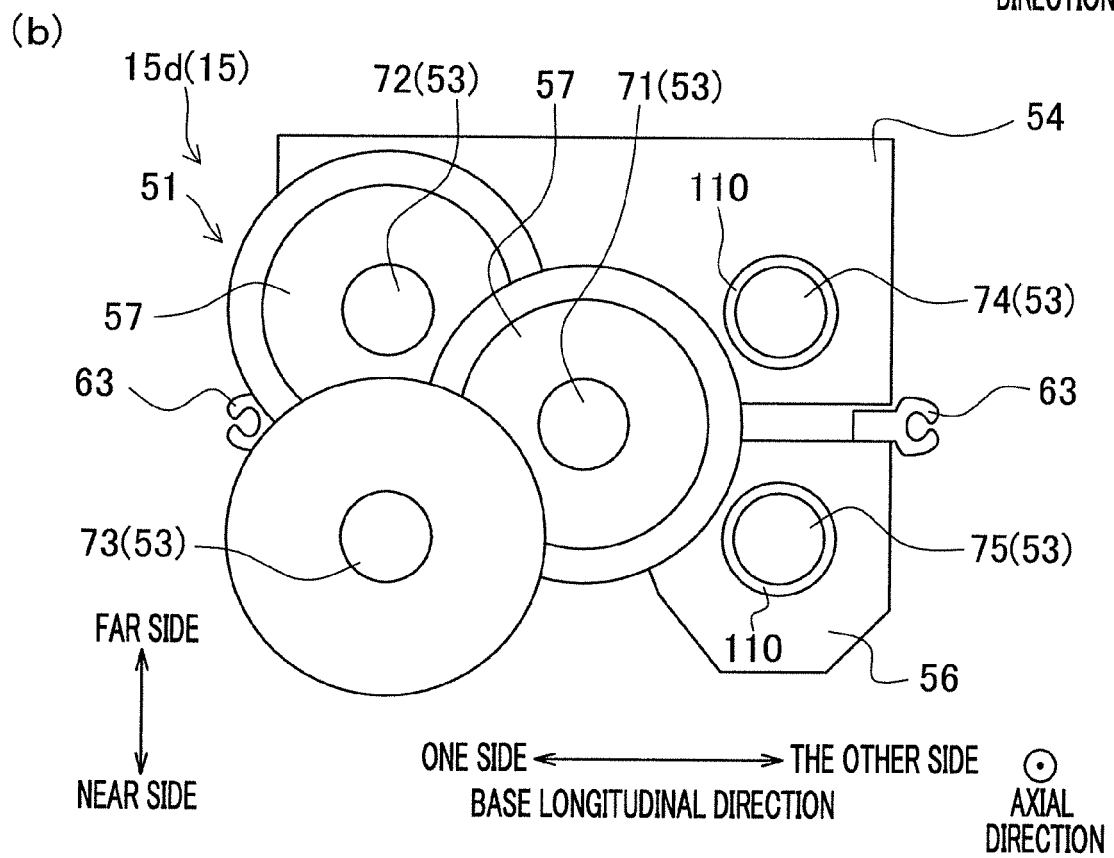
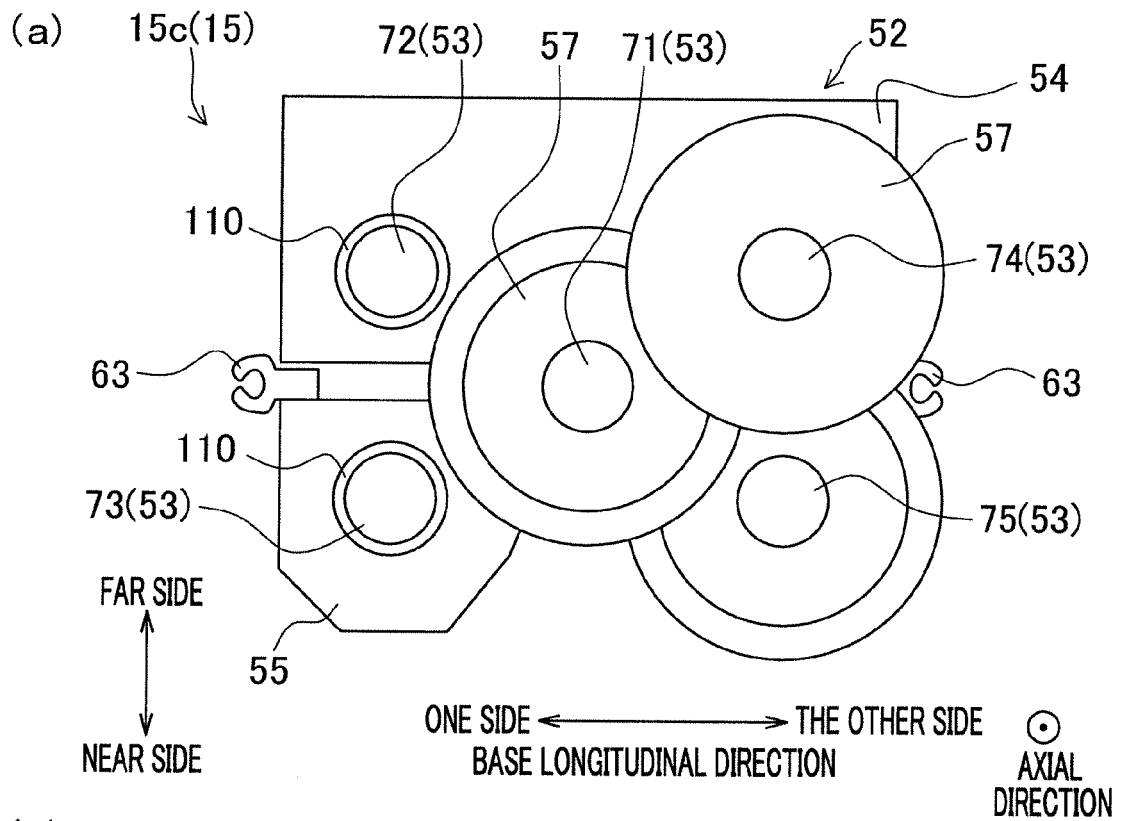
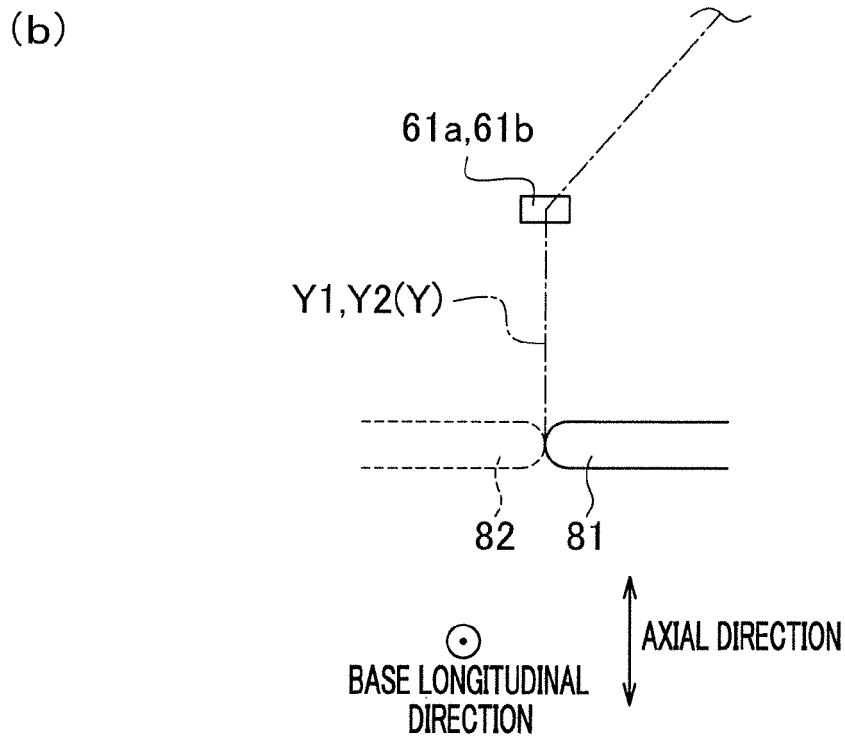
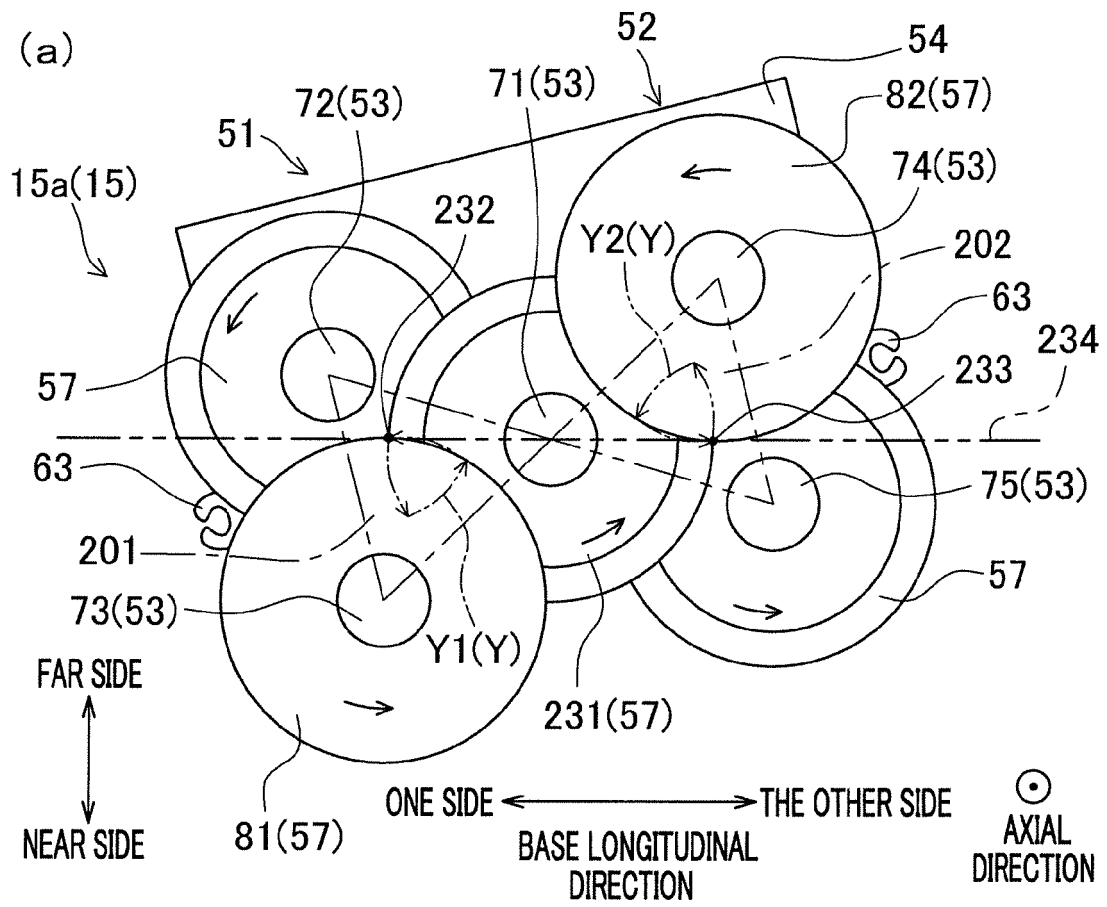


FIG.13





EUROPEAN SEARCH REPORT

Application Number
EP 20 17 2333

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			D02G
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 7 September 2020	Examiner Van Beurden-Hopkins
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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07-09-2020

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