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

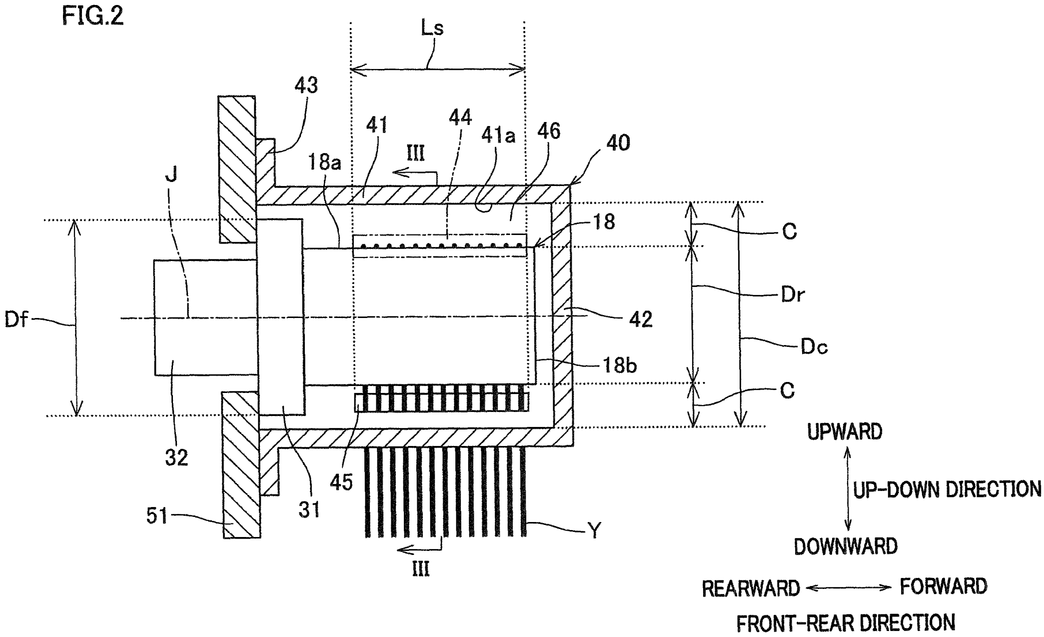
(72) Inventors:
- **Sawada, Jun**
  Kyoto, 612-8686 (JP)
- **Hashimoto, Kinzo**
  Kyoto, 612-8686 (JP)

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

(54) YARN PROCESSING APPARATUS AND ROLLER COVER

(57) Power consumption when a yarn is conveyed by a yarn conveyance roller is effectively reduced. A guide roller 18 conveying yarns Y is covered with a roller cover 40. The roller cover 40 includes a first part 41 formed to be cylindrical and surround an outer circumferential surface 18a of a guide roller 18 and a circular second part 42 provided to face a leading end surface 18b of the guide roller 18 and connected to a leading end portion of the first part 41. The inner diameter Dc of the first part 41 is 1.6 times or more as long as and 1.9 times or less as long as the outer diameter Dr of the guide roller 18. In regard to the outer circumferential surface 18a of the guide roller 18 and the inner wall surface 41a of the first part 41, a difference between the distance (=Dc/2) from the axis J of the guide roller 18 and the radius (=Dr/2) of the guide roller 18 is constant and is equal to or longer than 40mm and equal to or shorter than 55mm.

FIG.2



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a yarn processing apparatus and a roller cover.

[0002] A spun yarn drawing apparatus recited in Patent Literature 1 (Japanese Unexamined Patent Publication No. 2016-164314) is configured to draw, by godet rollers, a yarn Y spun out from a spinning apparatus and convey the drawn yarn to a winding unit by a guide roller. Then the spun yarn drawing apparatus forms a package by winding the drawn yarn onto a bobbin at the winding unit.

SUMMARY OF THE INVENTION

[0003] According to Patent Literature 1, when the yarn is conveyed by the guide roller, the rotating guide roller stirs circumambient air. In this connection, when the energy consumed for the stirring of the circumambient air by the guide roller (hereinafter, this may be referred to as "power consumption") is large, the power consumption of a motor which rotationally drives the guide roller is disadvantageously large.

[0004] An object of the present invention is to provide a yarn processing apparatus and a roller cover, which make it possible to effectively reduce power consumption when a yarn is conveyed by a yarn conveyance roller.

[0005] A yarn processing apparatus of the first aspect of the invention includes: a yarn conveyance roller conveying yarns: and a roller cover covering the yarn conveyance roller, the roller cover including: a first part which is provided to surround the outer circumferential surface of the yarn conveyance roller, a yarn inlet through which yarns are introduced from outside into a space in which the yarn conveyance roller is provided and a yarn outlet through which the yarns in the space are taken out being formed in the first part; and a second part which faces a leading end surface of the yarn conveyance roller in a direction along an axis of the yarn conveyance roller and is connected to the first part, the distance from the central axis of the yarn conveyance roller to an inner wall surface of the first part being 1.6 times or more as long as and 1.9 times or less as long as the radius of the yarn conveyance roller, at every part of the inner wall surface.

[0006] According to the present invention, because the roller cover is provided to cover the yarn conveyance roller, an amount of air surrounding the yarn conveyance roller is reduced, and hence the power consumption is reduced. In this regard, to simply reduce an amount of air surrounding the yarn conveyance roller, it appears to be preferable to minimize the capacity of the gap between the outer circumferential surface of the yarn conveyance roller and the inner wall surface of the first part by shortening the distance between the outer circumferential surface of the yarn conveyance roller and the inner wall surface of the first as much as possible.

[0007] However, when the yarns are introduced into the space in the roller cover through the yarn inlet, an airflow (accompanied flow) generated around the running yarns flows into the space in the roller cover through the yarn inlet. Meanwhile, when the yarns go out from the space through the yarn outlet, an airflow (accompanied flow) generated around the running yarns flows out from the roller cover through the yarn outlet. In this regard, when the capacity of the gap between the outer circumferential surface of the yarn conveyance roller and the inner wall surface of the roller cover is too small, the airflow in the gap is significantly influenced by an airflow flowing into the space in the roller cover and an airflow flowing out from the space of the roller cover, with the result that the airflow in the gap tends to be disturbed. Consequently, the power consumption is disadvantageously large.

[0008] In this connection, according to the present invention, the distance from the central axis of the roller cover to the inner wall surface of the first part is arranged to be 1.6 times or more as long as and 1.9 times or less as long as the radius of the yarn conveyance roller, at every part of the inner wall surface. When the roller cover is sized in this way, the power consumption is effectively reduced.

[0009] A yarn processing apparatus of the second aspect of the invention includes: a yarn conveyance roller conveying yarns: and a roller cover covering the yarn conveyance roller, the roller cover including: a first part which is provided to surround the outer circumferential surface of the yarn conveyance roller, a yarn inlet through which yarns are introduced from outside into a space in which the yarn conveyance roller is provided and a yarn outlet through which the yarns in the space are taken out being formed in the first part; and a second part which faces a leading end surface of the yarn conveyance roller in a direction along an axis of the yarn conveyance roller and is connected to the first part, a difference between the distance from the central axis of the yarn conveyance roller to an inner wall surface of the first part and the radius of the yarn conveyance roller being equal to or longer than 40mm and equal to or shorter than 55mm, at every part of the inner wall surface.

[0010] According to the present invention, because the roller cover is provided to cover the yarn conveyance roller, an amount of air surrounding the yarn conveyance roller is reduced, and hence the power consumption is reduced. In this regard, as described above, if the distance between the outer circumferential surface of the yarn conveyance roller and the inner wall surface of the first part is too short, an airflow in the gap between the outer circumferential surface of the yarn conveyance roller and the inner wall surface of the first part tends to be disturbed, with the result that the power consumption is disadvantageously increased.

[0011] On this account, according to the present invention, the difference between the distance from the central axis of the yarn conveyance roller to the inner wall surface of the first part and the radius of the yarn conveyance roller is arranged to be equal to or longer than 40mm and equal to or shorter than 55mm, at every part of the inner wall surface. When the roller cover is sized in this way, the power consumption is effectively reduced.

[0012] According to the third aspect of the invention, the yarn processing apparatus of the first or second aspect is arranged such that, the inner wall surface of the roller cover is circular in shape and centered at the axis of the yarn conveyance roller, when viewed in the direction along the axis of the yarn conveyance roller.

[0013] According to the present invention, the inner wall surface of the first part of the roller cover is circular in shape and centered at the axis of the yarn conveyance roller when viewed in the axial direction of the yarn conveyance roller. With this arrangement, the distance between the outer circumferential surface of the yarn conveyance roller and the inner wall surface of the first part of the roller cover is constant, and hence stabilization of the airflow in the gap is facilitated. This makes it possible to further effectively reduce the power consumption.

[0014] According to the fourth aspect of the invention, the yarn processing apparatus of any one of the first to third aspects is arranged such that the running speed of the outer circumferential surface of the yarn conveyance roller is equal to or higher than 1000m/min and equal to or lower than 6000m/min.

[0015] According to the present invention, the roller cover with the above-described size is provided for the yarn conveyance roller when the running speed of the outer circumferential surface of the yarn conveyance roller is equal to or higher than 1000m/min and equal to or lower than 6000m/min. With this arrangement, the power consumption is effectively reduced.

[0016] A roller cover of the fifth aspect of the invention, covering a yarn conveyance roller by which yarns are conveyed, includes: a first part which is provided to surround the outer circumferential surface of the yarn conveyance roller, a yarn inlet through which yarns are introduced from outside into a space in which the yarn conveyance roller is provided and a yarn outlet through which the yarns in the space are taken out being formed in the first part; and a second part which faces a leading end surface of the yarn conveyance roller in a direction along an axis of the yarn conveyance roller and is connected to the first part, the distance from the central axis of the yarn conveyance roller to an inner wall surface of the first part being 1.6 times or more as long as and 1.9 times or less as long as the radius of the yarn conveyance roller, at every part of the inner wall surface.

[0017] A roller cover of the sixth aspect of the invention, covering a yarn conveyance roller by which yarns are conveyed, includes: a first part which is provided to surround the outer circumferential surface of the yarn conveyance roller, a yarn inlet through which yarns are introduced from outside into a space in which the yarn conveyance roller is provided and a yarn outlet through which the yarns in the space are taken out being formed in the first part; and a second part which faces a leading end surface of the yarn conveyance roller in a direction along an axis of the yarn conveyance roller and is connected to the first part, a difference between the distance from the central axis of the yarn conveyance roller to an inner wall surface of the first part and the radius of the yarn conveyance roller being equal to or longer than 40mm and equal to or shorter than 55mm, at every part of the inner wall surface.

[0018] According to the present invention, when the distance from the center of the yarn conveyance roller is 1.6 times or more as long as and 1.9 times or less as long as the radius of the yarn conveyance roller at every part, or when the difference between the distance from the central axis of the yarn conveyance roller to the inner wall surface of the first part of the roller cover and the radius of the yarn conveyance roller is equal to or longer than 40mm and equal to or shorter than 55mm at every part of the inner wall surface, power consumption is effectively reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 is a schematic diagram of a spun yarn take-up apparatus of an embodiment of the present invention.

FIG. 2 is a cross section of the guide roller and the roller cover shown in FIG. 1, which is taken in the axial direction.

FIG. 3 is a cross section taken along the line III-III in FIG. 2.

FIG. 4 corresponds to FIG. 2 and shows an analytical model for calculating power consumption when the inner diameter of the roller cover is longer than the outer diameter of a flange portion of the guide roller.

FIG. 5 corresponds to FIG. 3 and shows an analytical model for calculating power consumption when the inner diameter of the roller cover is longer than the outer diameter of the flange portion of the guide roller.

FIG. 6 corresponds to FIG. 2 and shows an analytical model for calculating power consumption when the inner diameter of the roller cover is equal to or shorter than the outer diameter of the flange portion of the guide roller.

FIG. 7(a) is a table showing analysis results of the relationship between the inner diameter of the roller cover and the power consumption in Examples 1 to 3 and Comparative Examples 1 to 6, whereas FIG. 7(b) graphically shows the table of FIG. 7(a).

FIG. 8(a) is a block diagram of an experimental apparatus for measuring the power consumption of a motor by which the guide roller is driven, whereas FIG. 8(b) is a table showing experimentation results of the relationship between the presence/absence of the roller cover and the power consumption.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] The following will describe a preferred embodiment of the present invention.

<Spun Yarn Take-Up Apparatus>

[0021] As shown in FIG. 1, the spun yarn take-up apparatus 1 includes a spun yarn drawing apparatus 3 and a yarn winding apparatus 4. A spinning apparatus 2 is provided above the spun yarn take-up apparatus 1. A molten fibrous material such as polyester, which is continuously spun out from a spinneret of the spinning apparatus 2, is solidified by cooling air blown onto the material at a cooling cylinder 5, with the result that yarns Y are formed. The spun yarn drawing apparatus 3 is provided below the cooling cylinder 5 to draw the yarns Y coming down from the cooling cylinder 5. The yarn winding apparatus 4 is configured to form wound packages 9 by winding the yarns Y drawn by the spun yarn drawing apparatus 3 onto bobbins 29. Hereinafter, a left-right direction in FIG. 1, which is orthogonal to an up-down direction, will be referred to as "left-right direction", and "leftward" and "rightward" in the left-right direction are defined as shown in FIG. 1 for facilitating explanation. Furthermore, a direction which is orthogonal to the up-down direction, the left-right direction, and the sheet of FIG. 1 will be referred to as "front-rear direction", and a direction orthogonal to the sheet of FIG. 1 and toward the viewer of FIG. 1 will be referred to as "forward" whereas a direction orthogonal to the sheet of FIG. 1 and away from the viewer of FIG. 1 will be referred to as "rearward".

<Spun Yarn Drawing Apparatus>

[0022] The spun yarn drawing apparatus 3 includes an oil guide 6 and a heating-drawing unit 7. The oil guide 6 is configured to apply oil to each of the yarns Y spun out from the spinning apparatus 2. The yarns Y to which oil has been applied by the oil guide 6 are sent to the heating-drawing unit 7 via a guide roller 17.

[0023] The heating-drawing unit 7 includes a thermal insulation box 16 and five godet rollers 11a to 11e housed in the thermal insulation box 16. The thermal insulation box 16 is a box made of a heat insulating material. In a right side wall member of the thermal insulation box 16, a yarn inlet 16a through which the yarns Y are introduced into the thermal insulation box 16 and a yarn outlet 16b through which the yarns Y go outside from the thermal insulation box 16 are formed. The yarn inlet 16a is formed at a lower end portion of the side wall member of the thermal insulation box 16, whereas the yarn outlet 16b is formed at an upper end portion of the side wall member of the thermal insulation box 16.

[0024] The godet rollers 11a to 11e are rollers which are long in the front-rear direction. Among the five godet rollers 11a to 11e, the godet roller 11a is provided in the vicinity of a bottom portion of the thermal insulation box 16. Above this godet roller 11a, the remaining four godet rollers 11b to 11e are arranged to form left and right columns which are staggered. The yarns Y introduced into the thermal insulation box 16 through the yarn inlet 16a are wound onto the five godet rollers 11a to 11e in order. The yarns Y are wound onto the lowest godet roller 11, then onto the second lowest godet roller 11, and so on. The yarns Y are wound onto each of the five godet rollers 11a to 11e at a wining angle of less than 270 degrees. On each of the godet rollers 11a to 11e, the yarns Y are not wound more than once. As the yarns Y are conveyed in order by the five godet rollers 11a to 11e, the yarns Y run from the yarn inlet 16a to the yarn outlet 16b along a meandering and non-crossing yarn path which is on a plane which is in parallel to the sheet of FIG. 1.

[0025] Each of the five godet rollers 11a to 11e is rotationally driven by an unillustrated motor. Each of the five godet rollers 11a to 11e is a yarn heating roller including a heater therein.

[0026] Among the five godet rollers 11, the lower three godet rollers 11a to 11c on the upstream in the yarn running direction are yarn heating rollers for preliminarily heating the yarns Y to a drawable temperature. When the yarns are formed of polyester fibers, the glass transition temperature of the yarns Y is about 80 degrees centigrade, and hence the heating temperatures (roller surface temperatures) of the three godet rollers 11a to 11c are set at temperatures (e.g., 80 to 95 degrees centigrade) slightly higher than the glass transition temperature. Meanwhile, the upper two godet rollers 11d and 11e on the downstream in the yarn running direction are yarn heating rollers for thermally setting the drawn yarns Y. The heating temperatures (roller surface temperatures) of the two godet rollers 11d and 11e are set at temperatures (e.g., 120 to 150 degrees centigrade) higher than the heating temperatures of the lower three godet rollers 11a to 11c. The yarn feeding speeds of the upper two godet rollers 11d and 11e are higher than those of the lower three godet rollers 11a to 11c.

[0027] The yarns Y introduced into the thermal insulation box 16 are, to begin with, preliminarily heated to the drawable temperature, i.e., the glass transition temperature while the yarns Y are conveyed by the lower three godet rollers 11a to 11c. The yarns Y having been preliminarily heated to the glass transition temperature are then drawn on account of a yarn feeding speed difference between the two godet rollers 11c and 11d. The yarns Y are heated to a higher temperature while being conveyed by the upper two godet rollers 11d and 11e, with the result that the drawn yarns Y are thermally set. The yarns Y which have been drawn in this way go outside from the thermal insulation box 16 through the yarn outlet 16b, and are then sent to the yarn winding apparatus 4 by the guide roller 18. The guide roller 18 and a later-described roller cover 40 covering the guide roller 18 will be detailed later.

<Yarn Winding Apparatus>

[0028] The yarn winding apparatus 4 is provided below the spun yarn drawing apparatus 3. The yarn winding apparatus 4 includes a bobbin holder 27 and a contact roller 28. The bobbin holder 27 is long in the front-rear direction, is column-shaped, and is rotationally driven by an unillustrated motor. To this bobbin holder 27, bobbins 29 are attached to be lined up along the axis of the bobbin holder 27. The yarn winding apparatus 4 is configured to form wound packages 9 by simultaneously winding the yarns Y onto the bobbins 29 by rotating the bobbin holder 27. The contact roller 28 is a roller which is long in the front-rear direction. The contact roller 28 adjusts the shape of each of the wound packages 9 in such a way that the contact roller 28 makes contact with the surface of each of the wound packages 9 and applies a predetermined contact pressure thereto.

<Guide Roller and Roller Cover>

[0029] The following will describe the guide roller 18 and the roller cover 40. As shown in FIG. 1 to FIG. 3, the guide roller 18 is, for example, a roller which is long in the front-rear direction and is about 110mm in outer diameter Dr. The guide roller 18 is substantially identical in height with the yarn outlet 16b of the thermal insulation box 16. Onto the guide roller 18, the yarns Y sent from the thermal insulation box 16 are wound. The yarns Y are wound onto the guide roller 18 at a winding angle θ of, for example, 90 degrees. The guide roller 18 forwards the yarns Y from the thermal insulation box 16 toward the yarn winding apparatus 4 which is provided below the guide roller 18. At a base end portion of the guide roller 18, a flange portion 31 is provided. The outer diameter Df (e.g., about 160mm) of the flange portion 31 is longer than the outer diameter Dr of the guide roller 18. A motor 32 is attached to the flange portion 31. The guide roller 18 is rotationally driven by the motor 32. The motor 32 rotationally drives the guide roller 18 at a rotation speed with which the running speed of the outer circumferential surface 18a of the guide roller 18 is not lower than 1000m/min and not higher than 6000m/min.

[0030] The guide roller 18 is covered with the roller cover 40. The roller cover 40 is made of, for example, a synthetic resin material and a metal material, and is attached to a frame 51 of the spun yarn take-up apparatus 1 to which the guide roller 18 is attached. The roller cover 40 includes a first part 41, a second part 42, and a third part 43.

[0031] The first part 41 is formed to be cylindrical in shape (i.e., an inner wall surface 41a is circular in shape when viewed in the direction along the axis of the guide roller 18), and is provided to surround the outer circumferential surface 18a of the guide roller 18. The first part 41 and the guide roller 18 are coaxial and share the same axis J as the central axis. The inner diameter Dc of the first part 41 is 1.6 times or more as long as and 1.9 times or less as long as the outer diameter Dr of the guide roller 18. To put it differently, the distance (=Dc/2) from the axis J to the inner wall surface 41a at every part thereof is 1.6 times or more as long as and 1.9 times or less as long as the radius (=Dr/2) of the guide roller 18. For example, while the outer diameter Dr of the guide roller 18 is about 110mm, the inner diameter Dc of the first part 41 is equal to or longer than 190mm and equal to or shorter than 220mm. In the present embodiment, a difference (=[Dc/2] - [Dr/2]) between the distance from the inner wall surface 41a to the axis J and the radius of the guide roller 18 is equal to or longer than 40mm and equal to or shorter than 55mm. This difference is constant at every part of the inner wall surface 41a. On account of the difference between the outer diameter Dr of the guide roller 18 and the inner diameter Dc of the first part 41, a gap 46 is formed between the outer circumferential surface 18a of the guide roller 18 and the inner wall surface 41a of the first part 41 so that the distance C between the outer circumferential surface 18a and the inner wall surface 41a is equal to or longer than 40mm and equal to or shorter than 55mm. In the present embodiment, the distance C is constant at every part of the gap 46.

[0032] The first part 41 extends along the entire length of the guide roller 18 in the axial direction of the guide roller 18, and the front end of the first part 41 is positioned forward of the leading end of the guide roller 18. At a left end portion of the first part 41, a yarn inlet 44 is formed to be substantially identical in height with the upper end of the guide roller 18. At a lower end portion of the first part 41, a yarn outlet 45 is formed to be substantially identical in position with the right end of the guide roller 18 in the left-right direction. The yarns Y coming out to the outside of the thermal insulation box 16 from the godet roller 11e pass the yarn inlet 44 and are then introduced into a space inside the roller cover 40, where the guide roller 18 is provided. The yarns Y conveyed by the guide roller 18 go outside from the roller cover 40 through the yarn outlet 45, and are then sent to the yarn winding apparatus 4. Each of the yarn inlet 44 and the yarn outlet 45 is long in the axial direction of the guide roller 18. For example, the length Ls of each of these inlet 44 and outlet 45 is about 134mm in the axial direction of the guide roller 18, and the width Ws thereof is about 10mm.

[0033] In the front-rear direction, the second part 42 faces a leading end surface 18b of the guide roller 18. The second part 42 is circular in shape and is substantially identical in diameter with the first part 41 when viewed in the axial direction of the guide roller 18. The second part 42 is connected to a front end portion of the first part 41. The third part 43 is provided at a rear end portion of the first part 41. The third part 43 juts outward from the first part 41 in the radial direction of the guide roller 18, and is substantially rectangular in shape when viewed in the axial direction of the guide roller 18. The third part 43 is fixed to the frame 51 by an unillustrated bolt or the like.

[0034] In the present embodiment, as the roller cover 40 is attached to the frame 51, the guide roller 18 is provided in a space surrounded by the frame 51 and the roller cover 40 (the first part 41 and the second part 42). This space communicates with the outside only at the yarn inlet 44 and the yarn outlet 45.

[0035] When the yarns Y are conveyed by the rotation of the guide roller 18, the guide roller 18 stirs circumambient air. In this connection, when power consumption which is energy consumed for the stirring of the circumambient air by the guide roller 18 is large, the power consumption of the motor 32 is disadvantageously large. In the present embodiment, because the guide roller 18 is covered with the roller cover 40, an amount of air surrounding the outer circumferential surface 18a of the guide roller 18 is reduced, and hence the power consumption is reduced.

[0036] In this regard, to simply reduce an amount of air surrounding the outer circumferential surface 18a of the guide roller 18, it appears to be preferable to minimize the capacity of the gap 46 between the outer circumferential surface 18a of the guide roller 18 and the inner wall surface 41a of the first part 41 by shortening the inner diameter Dc of the first part 41 of the roller cover 40 as much as possible on condition that the inner diameter Dc is longer than the outer diameter Dr of the guide roller 18.

[0037] However, in the present embodiment, the yarn inlet 44 for introducing the yarns Y and the yarn outlet 45 for taking the yarns Y out are formed at the first part 41. When the yarns Y are introduced into the space in the roller cover 40 through the yarn inlet 44, an airflow (accompanied flow) generated around the running yarns Y flows into the space in the roller cover 40 through the yarn inlet 44, together with the yarns Y. Meanwhile, when the yarns Y go out from the roller cover 40 through the yarn outlet 45, an airflow (accompanied flow) generated around the running yarns Y flows out from the roller cover 40 through the yarn outlet 45, together with the yarns Y. The smaller the capacity of the gap 46 is, the more the accompanied flows influence on an airflow in the gap 46. For this reason, when the capacity of the gap 46 at the first part 41 is too small (i.e., when the inner diameter Dc is too short), the airflow in the gap 46 is significantly disturbed due to an influence of the accompanied flows, with the result that the power consumption is disadvantageously increased.

[0038] In consideration of this, in the present embodiment, the inner diameter Dc of the first part 41 is arranged to be 1.6 times or more as long as and 1.9 times or less as long as the outer diameter Dr of the guide roller 18, as described above, and hence the gap 46 which is equal to or longer than 40mm and equal to or shorter than 55mm is formed between the outer circumferential surface 18a of the guide roller 18 and the inner wall surface 41a of the first part 41. With this arrangement, the power consumption is effectively reduced, as analysis results and experimentation results described below indicate.

[0039] In the present embodiment, because the first part 41 is formed to be cylindrical in shape and the first part 41 and the guide roller 18 share the same central axis, the distance between the outer circumferential surface 18a of the guide roller 18 and the inner wall surface 41a of the first part 41 is constant, and hence stabilization of the airflow in the gap 46 is facilitated. This makes it possible to effectively reduce the power consumption.

[0040] In the spun yarn take-up apparatus 1, the running speed of the outer circumferential surface 18a of the guide roller 18 is high, i.e., is about 1000m/min or higher and 6000m/min or lower. The power consumption is therefore high without the roller cover 40. In the present embodiment, the roller cover 40 is sized as described above. The power consumption is therefore effectively reduced as the analysis results and experimentation results described below indicate.

[Examples]

[0041] The following will describe specific examples of the present invention.

<Examples 1 to 3 and Comparative Examples 1 to 6>

[0042] In Examples 1 to 3 and Comparative Examples 1 and 2, the power consumption was calculated by using an analytical model shown in FIG. 4 and FIG. 5, corresponding to a guide roller 18 and a roller cover 40 identical with those in the embodiment above. In Comparative Examples 3 to 5, the power consumption was calculated by using an analytical model shown in FIG. 6.

[0043] In the analytical model shown in FIG. 4 and FIG. 5, the outer diameter Dr of the guide roller 18 was 110mm and the outer diameter Df of the flange portion 31 was 160mm. The entire length Lr in the axial direction of the guide roller 18 inclusive of the flange portion 31 was 217.5mm, the length Lc of the space formed by the roller cover 40 and the frame 51 was 237.5mm in the axial direction of the guide roller 18, and the distance K1 between the leading end surface 18b of the guide roller 18 and the second part 42 of the roller cover 40 was 10mm. The height H of the frame 51 was 240mm. The thickness Tc of the roller cover 40 was 10mm. Furthermore, in each of the yarn inlet 44 and the yarn outlet 45, the length Ls was 134mm in the axial direction of the guide roller 18 and the width Ws thereof was 10mm.

[0044] In the analytical model of FIG. 4 and FIG. 5, the inner diameter Dc of the first part 41 was constant. In Examples 1 to 3, the inner diameters Dc were 220mm, 200mm, and 190mm, respectively. In Comparative Examples 1 and 2, the inner diameters Dc were 280mm and 240mm, respectively.

[0045] In the meanwhile, in the analytical model of FIG. 6, the first part 41 was arranged such that the inner diameter Db of a part surrounding the flange portion 31 of the guide roller 18 was 180mm whereas the inner diameter Dc of a part surrounding a portion which was on the leading end side as compared to the flange portion 31 was shorter than the inner diameter Db. In Comparative Examples 3 to 5, the inner diameters Dc were 160mm, 140mm, and 120mm, respectively. Furthermore, in the axial direction of the guide roller 18, the distance K3 between the leading end of the flange portion 31 and the leading end of the inner wall surface of the part surrounding the flange portion 31 was 10mm. The lengths in the analytical model of FIG. 6 other than the above were identical with those in the analytical model of FIG. 4 and FIG. 5. Note that the analytical model of FIG. 6 was used in Comparative Examples 3 to 5 in place of the analytical model of FIG. 4 and FIG. 5 because the inner diameter Dc was equal to or shorter than the outer diameter Df (=160mm) of the flange portion 31 and hence the guide roller 18 could not be housed in the roller cover 40 in the analytical model of FIG. 4 and FIG. 5.

[0046] In Comparative Example 6, the power consumption was calculated by using an analytical model which was identical with the analytical model of FIG. 4 and FIG. 5 except that the roller cover 40 was not provided.

[0047] In Examples 1 to 3 and Comparative Examples 1 to 6, the running speed of the outer circumferential surface 18a of the guide roller 18 was 5000m/min. Furthermore, as shown in FIG. 4 to FIG. 6, analysis was performed with the assumption that a band body B having the width Lb of 124mm and the thickness Tb of 0.088mm ran. The band body B was a simplification of 32 yarns Y each of which was 0.088mm in diameter (=83dtex/36f) and which were provided at intervals of 4mm. The distance K4 between an end of the band body B on the leading end side of the guide roller 18 and the leading end of the guide roller 18 was 30mm. The winding angle of the band body B onto the guide roller 18 was 90 degrees. A part of the band body B, which was upstream of a part of the band body B wound onto the guide roller 18, was arranged to extend in parallel to the left-right direction, and the length Lb1 of this part was 120mm. A part of the band body B, which was downstream of the part of the band body B wound onto the guide roller 18, was arranged to extend in parallel to the up-down direction, and the length Lb2 of this part was 120mm.

[0048] A circle which was centered at the central axis (axis J) of the guide roller 18 and had a diameter De (500mm) was set as an exit boundary Ek in the radial direction of the guide roller 18. A line, which was on the side opposite to the frame 51 over the center in the axial direction of the guide roller 18 inclusive of the flange portion 31 and was away from the center in the axial direction of the guide roller 18 inclusive of the flange portion 31 by Le1 (150mm), was set as a front exit boundary Ej1 in the axial direction of the guide roller 18. A line, which was on the same side as the frame 51 with respect to the center in the axial direction of the guide roller 18 inclusive of the flange portion 31 and was away from the center in the axial direction of the guide roller 18 inclusive of the flange portion 31 by Le2 (150mm), was set as a front exit boundary Ej2 in the axial direction of the guide roller 18.

[0049] In addition to the above, in regard to an airflow, a k-ε turbulence model was applied to each of governing equations (1) and (2) below, discretization was done by a finite volume method, and approximate solutions were calculated by an iteration method. The equation (1) indicates that the fluid is incompressible fluid. The equation (2) is a RANS equation. In the analyses in Examples 1 to 3 and Comparative Examples 1 to 6, the front-rear direction was an x direction, the left-right direction was a y direction, and the up-down direction was a z direction.

[Equations 1]

$$\operatorname{div} U = 0 \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (1)$$

$$\frac{\partial U}{\partial t} + \operatorname{div}(U\vec{U}) = -\frac{\partial P}{\partial x} + \mu \operatorname{div}(\operatorname{grad} U) + \frac{1}{\rho}\left[\frac{\partial(-\rho\overline{u'^2})}{\partial x} + \frac{\partial(-\rho\overline{u'v'})}{\partial y} + \frac{\partial(-\rho\overline{u'w'})}{\partial z}\right] \quad \cdots \quad (2)$$

P : Pressure
t : Time
x,*y*,*z* : Coordinate axes

$\vec{U}=(u,v,w)$: Average speed vector
U : Average speed component
u',v',w': Variation components of u, v, and w
ρ : Air density
μ : Coefficient of kinematic viscosity

[0050] In addition to the above, a torque M acting on the guide roller 18 was obtained by a numerical calculation, and a power consumption L was calculated by L=MΩ. Ω indicates an angular speed of the guide roller 18. The torque M was calculated by using a pressure P obtained by numerical calculation by the equations (1) and (2) and by using equations (3), (4), and (5) below. The pressure P obtained by numerical calculation by the equations (1) and (2) corresponds to Pf in the equation (4).
[Equations 2]

$$M=\sum_{f}\left[r_f\times\left(\vec{f}_f^{\,pressure}+\vec{f}_f^{\,shear}\right)\right]\cdot\vec{a} \quad \cdots\cdots\cdots\cdots\cdots \quad (3)$$

$$\vec{f}_f^{\,pressure}=\left(P_f-P_{ref}\right)\cdot\vec{A}_f \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (4)$$

$$\vec{f}_f^{\,shear}=-\vec{T}_f\cdot\vec{A}_f \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (5)$$

r_f : Position of element f relative to X_0 (X_0 is a point where moment is obtained)
$\vec{a}$: Vector defining axis passing X_0
$\vec{f}_f^{\,pressure}$: Vector of pressure
$\vec{f}_f^{\,shear}$: Vector of shearing force
P_f : Pressure of element f
P_{ref} : Reference pressure
$\vec{A}_f$: Vector of area of element
$\vec{T}_f$: Stress tensor of element f

[0051] The analyses were done by using "STAR-CCM+" which was CDF software produced by CD-adapco. FIG. 7(a) and FIG. 7(b) show the analysis results of Examples 1 to 3 and Comparative Examples 1 to 6. As shown in FIG. 7(a) and FIG. 7(b), as a result of comparison between (i) Comparative Example 6 and (ii) Examples 1 to 3 and Comparative Examples 1 to 5, it is found that the power consumption is reduced when the roller cover 40 covering the guide roller 18 is provided, as compared to cases where the roller cover 40 is not provided. Furthermore, as a result of comparison between Examples 1 to 3 and Comparative Examples 1 to 5, it is found that, when the roller cover 40 is provided, the power consumption is reduced by at least 25% when the inner diameter Dc of the first part 41 is equal to or longer than 190mm and equal to or shorter than 220mm (i.e., the difference between the distance Dc/2 from the inner wall surface 41a to the axis J and the radius Dr/2 of the guide roller 18 is equal to or longer than 40mm and equal to or shorter than 55mm).

<Example 4 and Comparative Example 7>

[0052] In Example 4, by using an apparatus shown in FIG. 8(a), the power consumption of the motor 32 rotationally driving the guide roller 18 covered with the roller cover 40 as in the embodiment above was measured. To be more specific, in Example 4, an AC voltage supplied from an AC power source 101 was transformed by a transformer 102, the voltage was converted to a DC voltage by an inverter 103, and the motor 32 was rotationally driven by the DC voltage output to the motor 32. In Example 4, furthermore, a power meter 104 was connected between the inverter 103 and the motor 32 and the power consumption of the motor 32 was measured by the power meter 104.

[0053] In Example 4, the outer diameter Dr of the guide roller 18 was 110mm, the outer diameter Df of the flange portion 31 was 160mm, and the inner diameter Dc of the first part 41 was 190mm. Furthermore, the entire length Lr in the axial direction of the guide roller 18 inclusive of the flange portion 31 was 218mm, and the length Lc of the space formed by the roller cover 40 and the frame 51 was 248mm in the axial direction of the guide roller 18. The height of the frame 51 was 240mm. The thickness Tc of the roller cover 40 was 10mm. Furthermore, in each of the yarn inlet 44 and the yarn outlet 45, the length Ls was 134mm in the axial direction of the guide roller 18 and the width Ws thereof was 10mm. In Example 4, 32 yarns Y each of which was 0.088mm (=83dtex/36f) in diameter and made of polyester fibers ran at intervals of 4mm. Furthermore, the winding angle of the yarn Y onto the guide roller 18 was 90 degrees. Furthermore, in Example 4, the motor 32 was rotationally driven so that the running speed of the outer circumferential surface 18a of the guide roller 18 was about 5000m/min (an average speed was 4921m/min).

[0054] The power consumption of the motor 32 was measured in Comparative Example 7 on the same conditions as in Example 4 except that the roller cover 40 was detached.

[0055] FIG. 8(b) shows the experimentation results of Example 4 and Comparative Example 7. The "measured power" in FIG. 8(b) indicates the power consumption of the motor 32 measured by the power meter 104 in FIG. 8(a). The power consumption in FIG. 8(b) was calculated by subtracting, from the power consumption measured by the power meter 104, energy (≅79W) equivalent to a loss by the motor 32 and energy (≅110W) equivalent to a loss by the tension of the yarns Y. The energy equivalent to the loss by the motor 32 is, for example, obtained by measuring the power consumption when the motor 32 is independently driven. The energy equivalent to the loss by the tension of the yarns Y is calculated, for example, based on a difference between the power consumption in Comparative Example 7 and the power consumption (e.g., 175W) measured by the power meter 104 when the motor 32 is driven while the roller cover 40 is detached and the yarns Y do not run.

[0056] As a result of comparison between Example 4 and Comparative Example 7 in FIG. 8(b), it is found that the power consumption is effectively reduced by providing, on the guide roller 18, the roller cover 40 in which the inner diameter Dc of the first part 41 is 190mm. As a result of comparison between Example 4 and Comparative Example 7 and the above-described Example 3 and Comparative Example 6, it is understood that the analysis results are more or less matched with the experimentation results.

[0057] In this regard, the analysis results in Examples 1 to 3 and Comparative Examples 1 to 6 and the experimentation results in Example 4 and Comparative Example 7 were obtained when the running speed of the outer circumferential surface 18a of the guide roller 18 was 5000m/min. When the running speed of the outer circumferential surface 18a of the guide roller 18 is varied, the magnitude of the airflow generated in the gap 46 is varied, too. However, when the shape of the guide roller 18, the shape of the roller cover 40, and the rotational direction of the guide roller 18 remain the same, the type of the airflow in the gap 46 is similar. On this account, in Examples 1 to 3 and Comparative Examples 1 to 6 and Example 4 and Comparative Example 7, it is assumed that results similar to the above are obtained when the running speed of the outer circumferential surface 18a of the guide roller 18 is lower than or higher than 5000m/min.

[0058] A preferred embodiment of the present invention has been described. It should be noted that the present invention is not limited to the above-described embodiment and examples, and various changes can be made herein without departing from the spirit and scope of the invention as defined by the appended claims.

[0059] In the embodiment above, the running speed of the outer circumferential surface 18a of the guide roller 18 is equal to or higher than 1000m/min and equal to lower than 6000m/min. The disclosure, however, is not limited to this arrangement. The running speed of the outer circumferential surface 18a of the guide roller 18 may be lower than 1000m/min or higher than 6000m/min. As described above, even if the running speed of the outer circumferential surface 18a of the guide roller 18 is lower than 1000m/min or higher than 6000m/min, it is considered that results similar to Examples 1 to 3 and Comparative Examples 1 to 6 and Example 4 and Comparative Example 7 described above are obtained.

[0060] In the embodiment above, the first part 41 of the roller cover 40 is cylindrical in shape, the inner wall surface 41a of the first part 41 is circular and centered at the axis of the guide roller 18 when viewed in the axial direction of the guide roller 18, and the distance between the outer circumferential surface 18a of the guide roller 18 and the inner wall surface 41a of the first part 41 is constant at any part of the gap 46. The disclosure, however, is not limited to this. For example, the inner wall surface 41a of the first part 41 may not be circular in shape, and may be polygonal or elliptical in shape when viewed in the axial direction of the guide roller 18. Also in these cases, when the distance from the axis of the guide roller 18 to the inner wall surface 41a at every part of the inner wall surface 41a is 1.6 times or more as long as and 1.9 times or less as long as the radius Dr/2 of the guide roller 18, or when the difference between the distance from the axis J to the inner wall surface 41a of the first part 41 and the radius Dr/2 of the guide roller 18 is equal to or longer than 40mm and equal to or shorter than 55mm at every part of the inner wall surface 41a, variations in distance between the outer circumferential surface 18a of the guide roller 18 and the inner wall surface 41a of the first part 41 are not so great. As a result, the airflow generated in the gap 46 is similar to the airflow when the inner wall surface 41a is circular, and hence the power consumption is effectively reduced.

[0061] While in the embodiment above the space in the roller cover 40 communicates with the outside only via the yarn inlet 44 and the yarn outlet 45, the disclosure is not limited to this arrangement. In the roller cover 40, a hole or notch through which the space in the roller cover communicates with the outside may be formed in addition to the yarn inlet 44 and the yarn outlet 45. Such a hole or notch is small enough not to influence on the airflow in the space.

[0062] While in the embodiment above the roller cover 40 is provided for the guide roller 18 by which the yarns Y coming out from the thermal insulation box 16 is sent toward the yarn winding apparatus 4, the disclosure is not limited to this arrangement. For example, a roller cover may be provided for the guide roller 17 or the godet rollers 11a to 11e. When the spun yarn take-up apparatus 1 is provided with another roller for conveying yarns in addition to the godet rollers 11a to 11e and the guide rollers 17 and 18, a roller cover may be provided for that roller.

[0063] The descriptions above presuppose that the present invention is applied to a spun yarn take-up apparatus in which yarns spun out from a spinning apparatus are drawn and then wound, the disclosure is not limited to this arrangement. The present invention may be applied to a processing apparatus including a yarn conveyance roller, which is not a spun yarn take-up apparatus.

Claims

1. A yarn processing apparatus comprising:

a yarn conveyance roller conveying yarns: and
a roller cover covering the yarn conveyance roller,
the roller cover including:

a first part which is provided to surround the outer circumferential surface of the yarn conveyance roller, a yarn inlet through which yarns are introduced from outside into a space in which the yarn conveyance roller is provided and a yarn outlet through which the yarns in the space are taken out being formed in the first part; and
a second part which faces a leading end surface of the yarn conveyance roller in a direction along an axis of the yarn conveyance roller and is connected to the first part,
the distance from the central axis of the yarn conveyance roller to an inner wall surface of the first part being 1.6 times or more as long as and 1.9 times or less as long as the radius of the yarn conveyance roller, at every part of the inner wall surface.

2. A yarn processing apparatus comprising:

a yarn conveyance roller conveying yarns: and
a roller cover covering the yarn conveyance roller,
the roller cover including:

a first part which is provided to surround the outer circumferential surface of the yarn conveyance roller, a yarn inlet through which yarns are introduced from outside into a space in which the yarn conveyance roller is provided and a yarn outlet through which the yarns in the space are taken out being formed in the first part; and
a second part which faces a leading end surface of the yarn conveyance roller in a direction along an axis of the yarn conveyance roller and is connected to the first part,
a difference between the distance from the central axis of the yarn conveyance roller to an inner wall surface of the first part and the radius of the yarn conveyance roller being equal to or longer than 40mm and equal to or shorter than 55mm, at every part of the inner wall surface.

3. The yarn processing apparatus according to claim 1 or 2, wherein, the inner wall surface of the roller cover is circular in shape and centered at the axis of the yarn conveyance roller, when viewed in the direction along the axis of the yarn conveyance roller.

4. The yarn processing apparatus according to any one of claims 1 to 3, wherein, the running speed of the outer circumferential surface of the yarn conveyance roller is equal to or higher than 1000m/min and equal to or lower than 6000m/min.

5. A roller cover covering a yarn conveyance roller by which yarns are conveyed, the roller cover comprising:

a first part which is provided to surround the outer circumferential surface of the yarn conveyance roller, a yarn inlet through which yarns are introduced from outside into a space in which the yarn conveyance roller is provided and a yarn outlet through which the yarns in the space are taken out being formed in the first part; and

a second part which faces a leading end surface of the yarn conveyance roller in a direction along an axis of the yarn conveyance roller and is connected to the first part,
the distance from the central axis of the yarn conveyance roller to an inner wall surface of the first part being 1.6 times or more as long as and 1.9 times or less as long as the radius of the yarn conveyance roller, at every part of the inner wall surface.

6. A roller cover covering a yarn conveyance roller by which yarns are conveyed, the roller cover comprising:

a first part which is provided to surround the outer circumferential surface of the yarn conveyance roller, a yarn inlet through which yarns are introduced from outside into a space in which the yarn conveyance roller is provided and a yarn outlet through which the yarns in the space are taken out being formed in the first part; and
a second part which faces a leading end surface of the yarn conveyance roller in a direction along an axis of the yarn conveyance roller and is connected to the first part,
a difference between the distance from the central axis of the yarn conveyance roller to an inner wall surface of the first part and the radius of the yarn conveyance roller being equal to or longer than 40mm and equal to or shorter than 55mm, at every part of the inner wall surface.

FIG.1

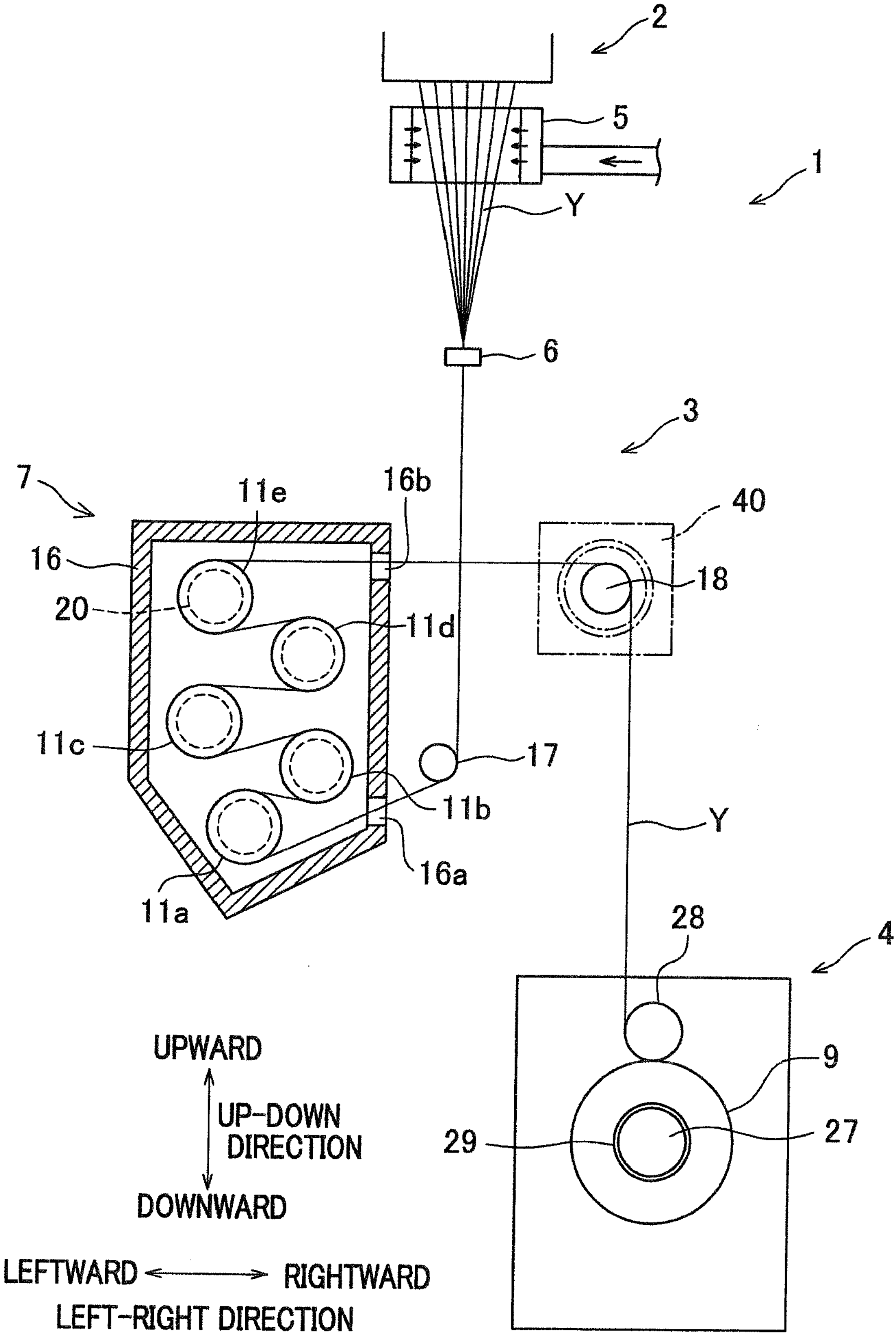
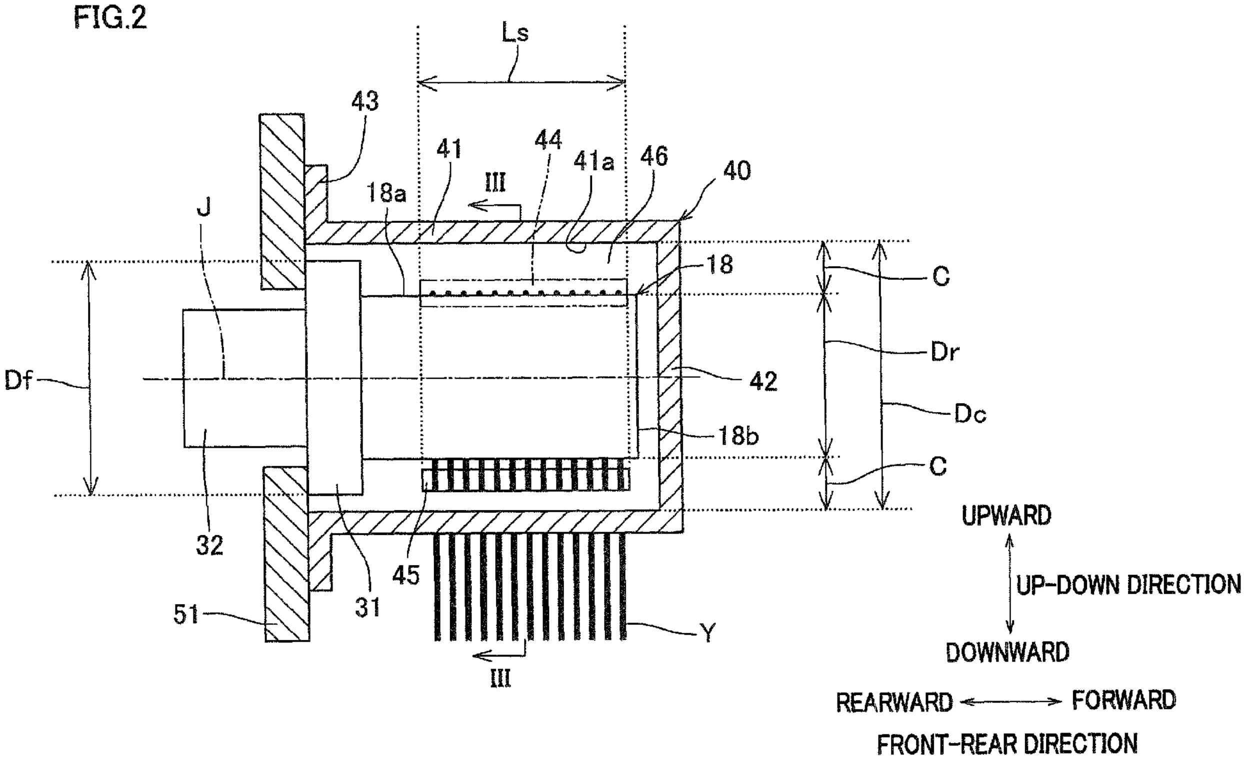

2
5
1
Y
6
3
7
11e
16b
40
16
20
18
11d
11c
17
11b
Y
16a
11a
28
4
9
UPWARD
UP-DOWN
DIRECTION
DOWNWARD
29
27
LEFTWARD
RIGHTWARD
LEFT-RIGHT DIRECTION

FIG.2


Ls
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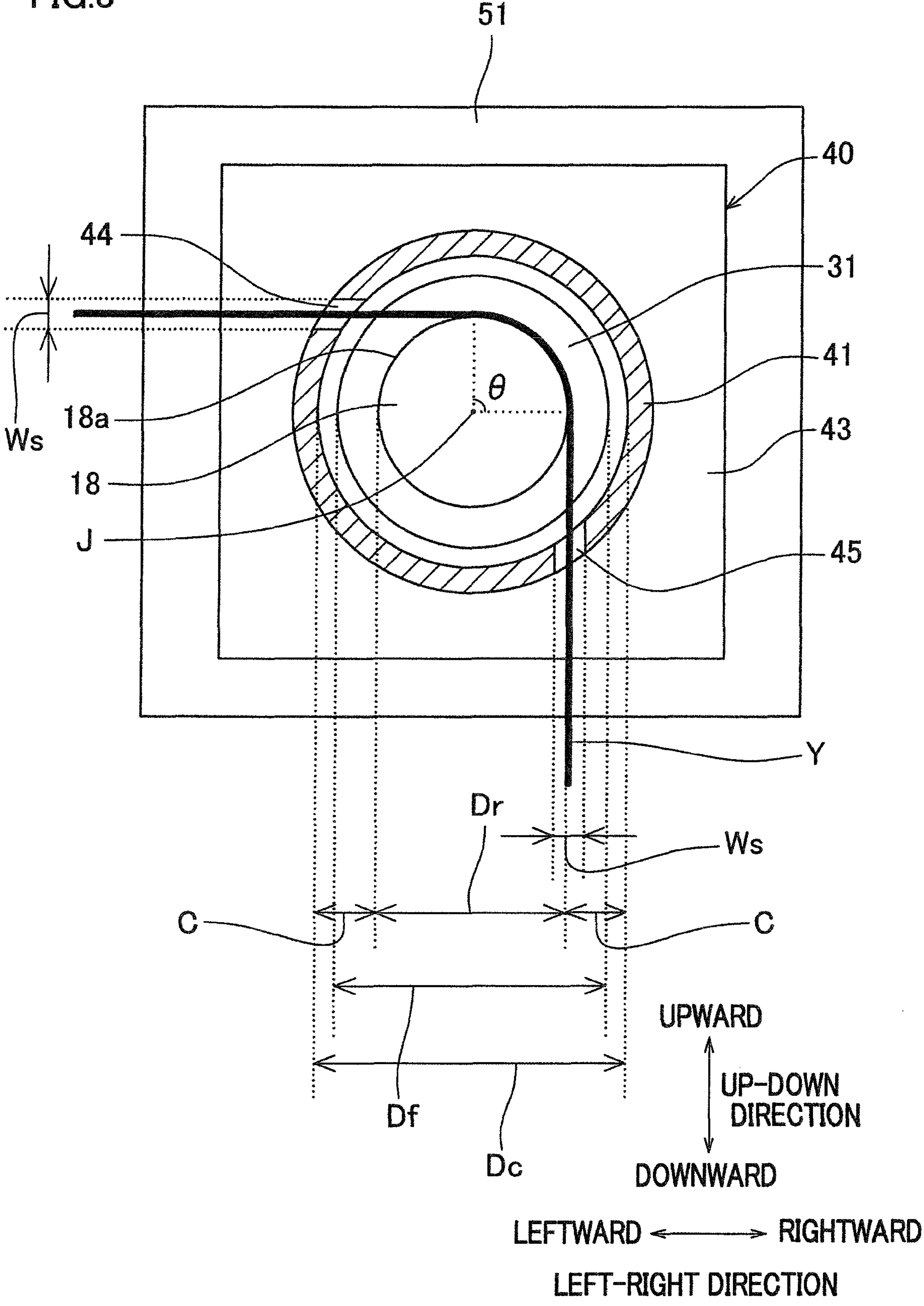
41
44
41a
46
40
III
18a
J
18
C
Dr
Df
42
Dc
18b
C
32
31
45
51
Y
III
UPWARD
UP-DOWN DIRECTION
DOWNWARD
REARWARD
FORWARD
FRONT-REAR DIRECTION

FIG.3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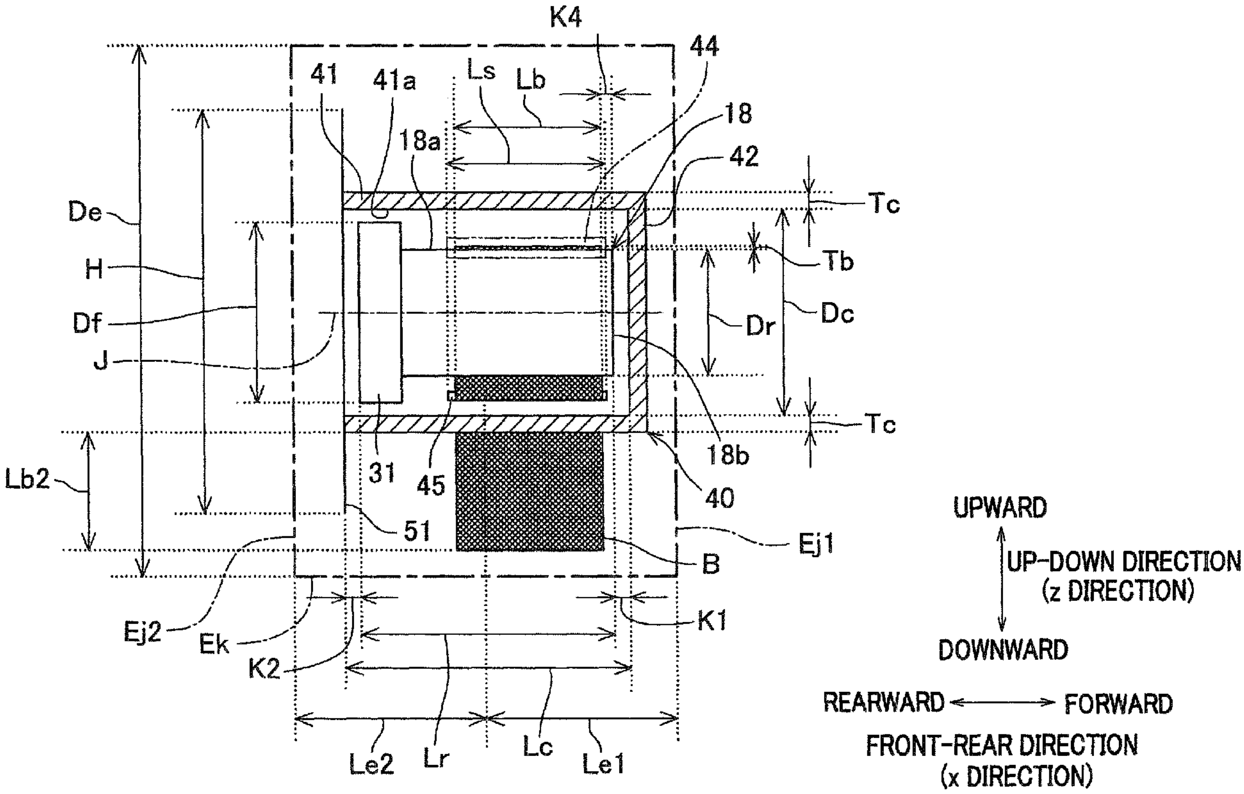
44
31
41
Ws
18a
θ
43
18
J
45
Y
Dr
Ws
C
C
Df
Dc
UPWARD
UP-DOWN
DIRECTION
DOWNWARD
LEFTWARD
RIGHTWARD
LEFT-RIGHT DIRECTION

FIG.4


K4
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41
41a
Ls
Lb
18
18a
42
Tc
De
Tb
H
Dc
Df
Dr
J
Tc
18b
31
45
Lb2
40
51
UPWARD
Ej1
B
UP-DOWN DIRECTION
(z DIRECTION)
Ej2
Ek
K1
K2
DOWNWARD
REARWARD
FORWARD
Le2
Lr
Lc
Le1
FRONT-REAR DIRECTION
(x DIRECTION)

FIG.5

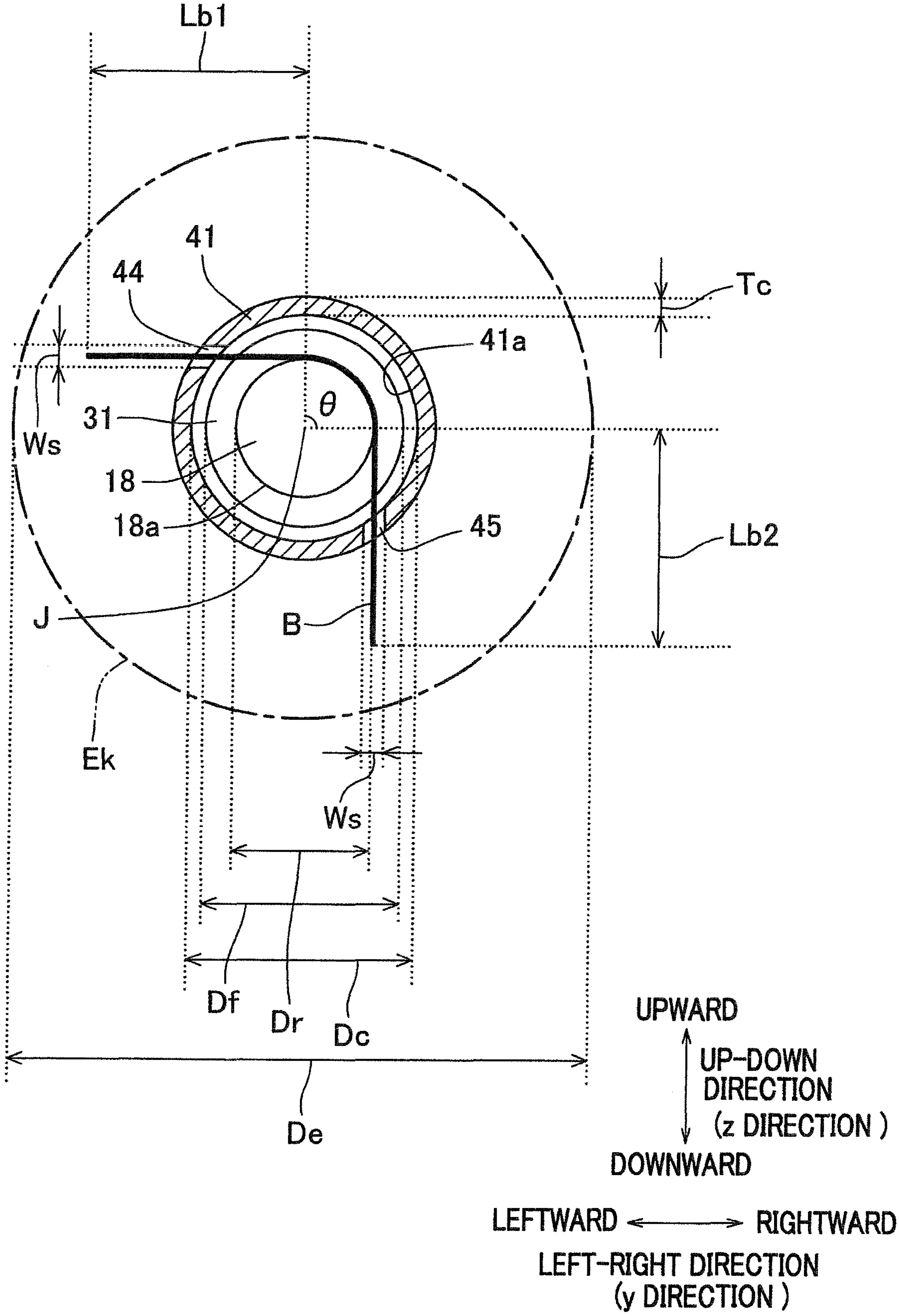
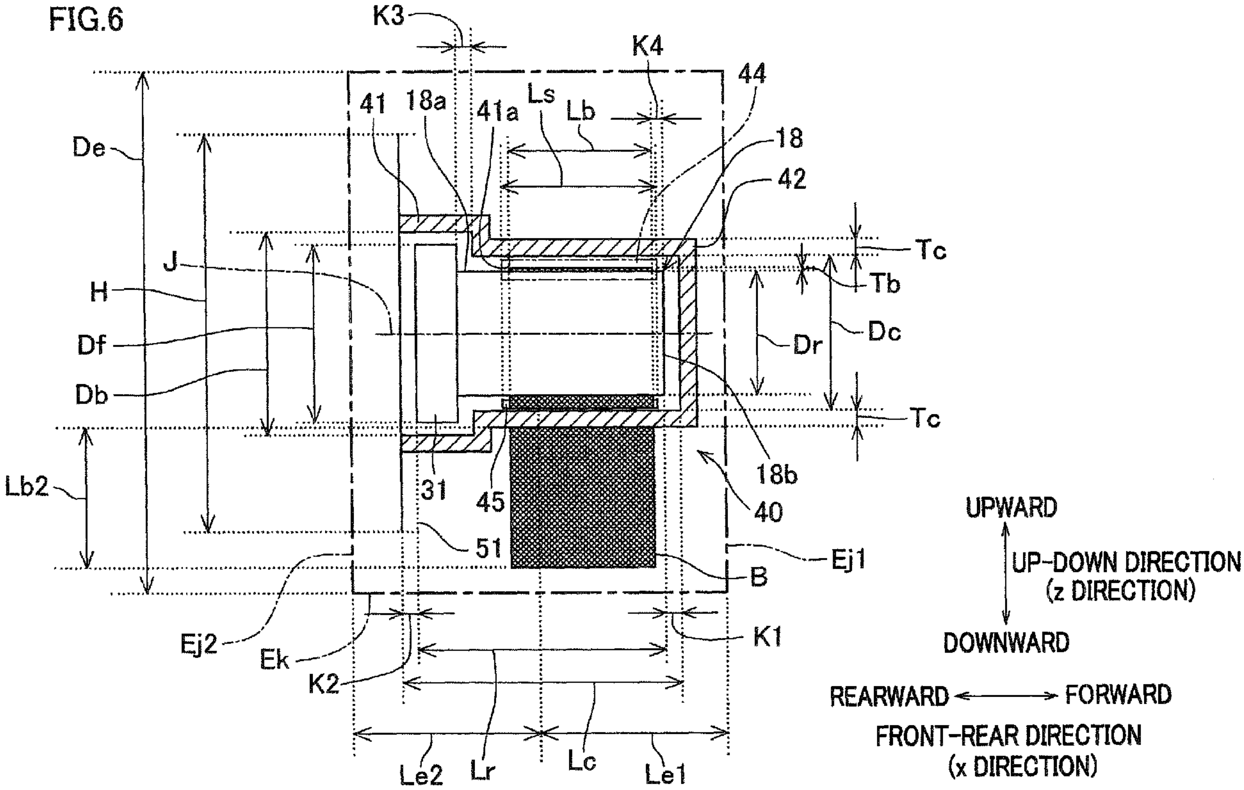

Lb1
41
44
Tc
41a
Ws
31
θ
18
18a
45
Lb2
J
B
Ek
Ws
Df
Dr
Dc
De
UPWARD
UP-DOWN
DIRECTION
(z DIRECTION)
DOWNWARD
LEFTWARD
RIGHTWARD
LEFT-RIGHT DIRECTION
(y DIRECTION)

FIG.6


K3
K4
44
41
18a
41a
Ls
Lb
18
42
De
Tc
J
Tb
H
Dc
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Dr
Db
Tc
18b
31
45
40
Lb2
51
Ej1
B
Ej2
Ek
K2
K1
Le2
Lr
Lc
Le1
UPWARD
UP-DOWN DIRECTION
(z DIRECTION)
DOWNWARD
REARWARD
FORWARD
FRONT-REAR DIRECTION
(x DIRECTION)

FIG.7

(a)

	INNER DIAMETER OF COVER (mm)	POWER CONSUMPTION (W)	DECREASING RATE OF POWER CONSUMPTION
COMPARATIVE EXAMPLE 6	NO COVER	90.4	0%
COMPARATIVE EXAMPLE 1	280	72.9	19.4%
COMPARATIVE EXAMPLE 2	240	70.3	22.2%
EXAMPLE 1	220	65.5	27.5%
EXAMPLE 2	200	64.9	28.2%
EXAMPLE 3	190	61.1	32.4%
COMPARATIVE EXAMPLE 3	160	74.7	17.4%
COMPARATIVE EXAMPLE 4	140	73.8	18.4%
COMPARATIVE EXAMPLE 5	120	79.5	12.1%

(b)

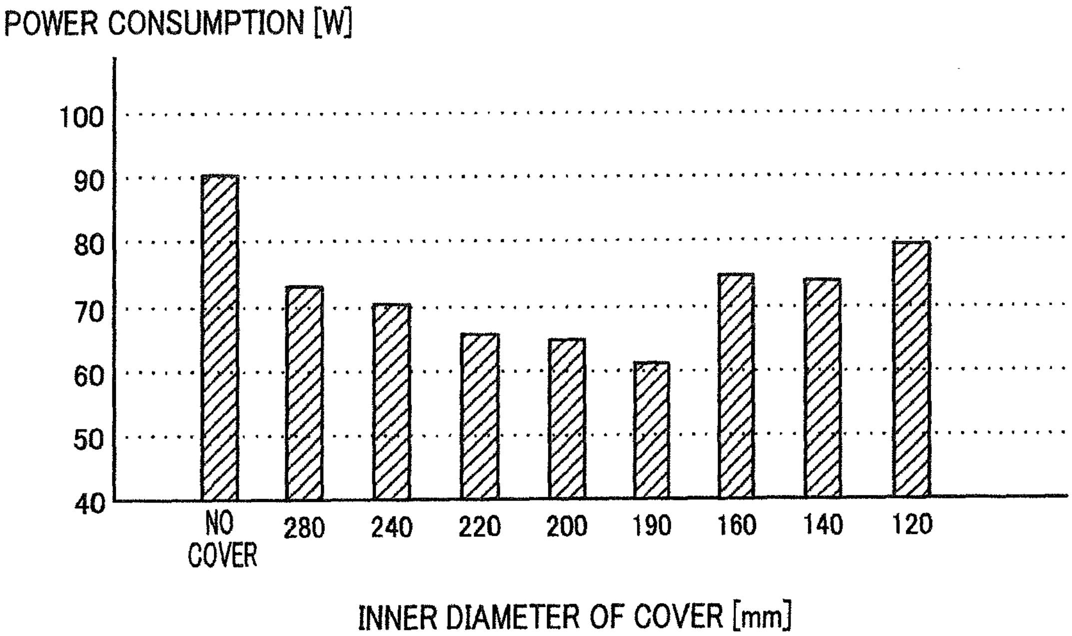
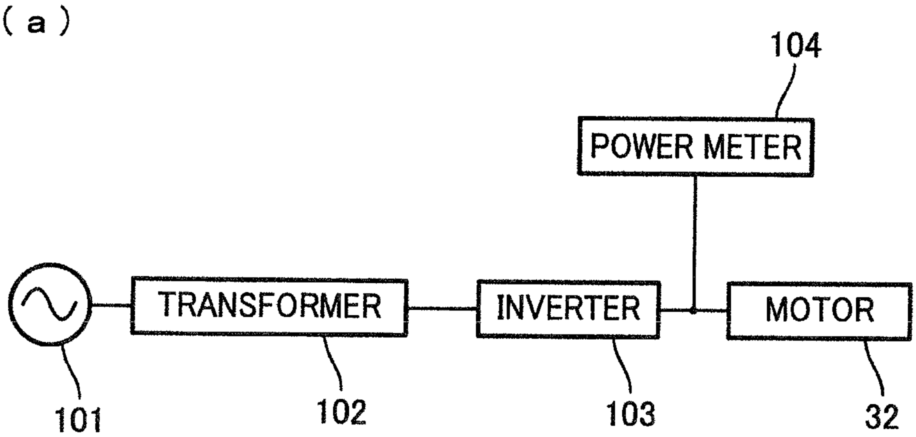


FIG.8

(a)



(b)

	NO COVER	WITH COVER
MEASURED POWER [W]	285	268
POWER CONSUMPTION [W]	96	79

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EUROPEAN SEARCH REPORT

Application Number
EP 18 17 1191

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2016/005063 A1 (OERLIKON TEXTILE GMBH & CO KG [DE]) 14 January 2016 (2016-01-14) * page 21, line 9 - line 19 * * figure 4 * -----	1-6	INV. B65H51/04
A	DE 10 2013 223663 A1 (TMT MACHINERY INC [JP]) 22 May 2014 (2014-05-22) * paragraph [0043] * * figure 3 * -----	1-6	
A	JP S61 11661 U (.) 23 January 1986 (1986-01-23) * claim 1 * * figure 2 * -----	1-6	
A	EP 3 064 621 A1 (TMT MACHINERY INC) 7 September 2016 (2016-09-07) * the whole document *	1-6	
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			TECHNICAL FIELDS SEARCHED (IPC)
			B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	9 October 2018	Guisan, Thierry

3

CATEGORY OF CITED DOCUMENTS

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		EP 3064621 A1	07-09-2016
		JP 2016164314 A	08-09-2016

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

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- JP 2016164314 A **[0002]**