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(54) **FIBER GUIDE**

(57) A fiber guide according to an embodiment of the present disclosure comprises a contact surface with a fiber having a ratio of Ra1/Ra2 that is 0.5 or more and less than 1.0, where Ra1 is an arithmetic mean roughness in a feed direction of the fiber and Ra2 is an arithmetic mean roughness in an orthogonal direction orthogonal to the feed direction.

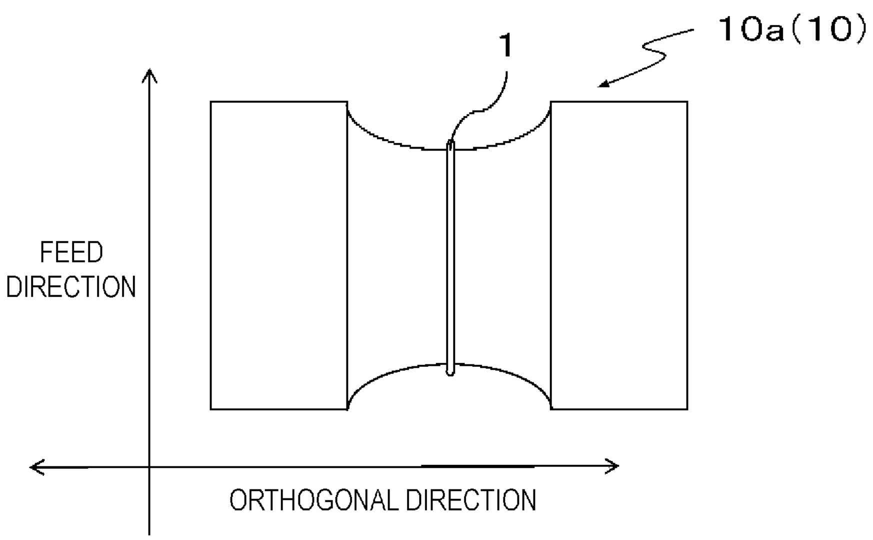

FIG. 2

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Description

Technical Field

[0001] The present disclosure relates to a fiber guide.

Background Art

[0002] Fiber guides of various shapes are used in textile machinery to guide fibers. Examples include roller guides, oiling nozzles, rod guides, and traverse guides. There is a demand for fiber guides that have a surface that comes into contact with the fibers (also referred to below as a contact surface) that minimizes damage and fraying of the fibers. For example, Patent Document 1 describes a fiber guide with a surface that comes into contact with the bundles of fed fibers having a surface roughness Ra of 0.1 μm or less.

Citation List

Patent Literature

[0003] Patent Document 1: JP-A-2000-73225

Summary of Invention

[0004] A fiber guide according to an embodiment of the present disclosure comprises a contact surface with a fiber with a ratio Ra1/Ra2 of from 0.5 to less than 1.0, where Ra1 is an arithmetic mean roughness in a feed direction of the fiber and Ra2 is an arithmetic mean roughness in an orthogonal direction orthogonal to the feed direction.

Brief Description of Drawings

[0005]

FIGS. 1A to 1D schematically illustrate fiber guides according to examples of the present disclosure. FIG. 1A is a perspective view of a roller guide. FIG. 1B is a perspective view of an oiling nozzle. FIG. 1C is a perspective view of a rod guide. FIG. 1D is a perspective view of a traverse guide.

FIG. 2 is an enlarged view of the roller guide illustrated in FIG. 1A, which is a fiber guide according to an embodiment of the present disclosure, as viewed from a side with the white arrow.

Description of Embodiments

[0006] In an attempt to minimize damage and fraying of the fibers, simply reducing the arithmetic mean roughness of the contact surface of the fiber guide may cause the fibers guided by the fiber guide to slide at an angle (also referred to below as angled sliding). When fibers slide at an angle, the area where the fibers and the contact surface come into contact increases. This makes the fibers more susceptible to damage from friction.

[0007] When the contact surface of the fiber guide has a large arithmetic mean roughness in the direction orthogonal to the feed direction of the fibers, fibers guided by the fiber guide tend to slide along the same place on the contact surface (also referred to below as invariable sliding). When the fibers slide along the same place, this portion is worn away by friction, and fibers that come into contact with the worn away portion are more likely to be damaged.

[0008] Currently, increases in productivity have resulted in the feed rate of fibers being greatly increased to speeds ranging from 3000 to 8000 m/min. At such high fiber feed rates, the likelihood of fibers being damaged by angled sliding and invariable sliding is further increased. Because of the reasons described above, there is a demand for a fiber guide that can minimize damage to fibers even at high fiber feed rates.

[0009] The fiber guide of an embodiment of the present disclosure can suppress damage to the fibers. Below, embodiments of the fiber guide of the present disclosure will be described with reference to the drawings.

[0010] First, various typical types of fiber guides will be described with reference to FIGS. 1A to 1D. The roller guide 10a illustrated in FIG. 1A includes a contact surface that is a U-shaped groove. The roller guide 10a guides a fiber 1 when rotated. The oiling nozzle 10b illustrated in FIG. 1B includes a contact surface that is the bottom surface of a groove. Oil is applied to the fiber 1 when the fiber 1 is slid over the contact surface. The rod guide 10c illustrated in FIG. 1C includes a contact surface that is the outer circumferential surface. The rod guide 10c is used for gathering and separating the fibers 1. The traverse guide 10d illustrated in FIG. 1D includes a contact surface that is the surface of a groove. The feed direction of the fiber 1 that passes along the contact surface is changed so the fiber 1 can be wound around the outer circumference of a cylindrical package. Hereinafter, specific fiber guides will not be referred to, and the fiber guide will be denoted with the reference sign 10.

[0011] The fiber guide 10 according to an embodiment of the present disclosure includes the contact surface with the fiber 1 with a ratio of Ra1/Ra2 between an arithmetic mean roughness Ra1 (also referred to below simply as Ra1) in the feed direction of the fiber 1 (also referred to below simply as "feed direction") and an arithmetic mean roughness Ra2 (also referred to below simply as Ra2) in an orthogonal direction orthogonal to the feed direction (also referred to below simply as "orthogonal direction) that is 0.5 or more and less than 1.0.

[0012] Using the roller guide 10a as an example of the fiber guide 10, the arithmetic mean roughness Ra1 in the feed direction and the arithmetic mean roughness Ra2 in the orthogonal direction will be described with reference to FIG. 2.

[0013] As illustrated in FIG. 2, "feed direction" refers to the direction the fiber 1 slides along the contact surface that comes into contact with the fiber 1. "Ra1" refers to the arithmetic mean roughness in the feed direction. In FIG. 2 which illustrates the fiber 1 sliding along the center of the contact surface, "feed direction" can also refer to the rotational direction of the roller guide 10a. As illustrated in FIG. 2, "orthogonal direction" refers to the direction orthogonal to the feed direction of the fiber 1 with respect to the contact surface that comes into contact with the fiber 1. "Ra2" refers to the arithmetic mean roughness in the orthogonal direction.

[0014] By the fiber guide 10 according to an embodiment of the present disclosure having the ratio of Ra1/Ra2 of from 0.5 to less than 1.0, where Ra1 is the arithmetic mean roughness in the feed direction and Ra2 is the arithmetic mean roughness in the orthogonal direction, damage to the fiber 1 can be suppressed. Damage to the fiber 1 can be suppressed because the surface texture of the contact surface of the fiber guide 10 according to an embodiment of the present disclosure is such that the sliding position can change a moderate degree while allowing the fiber 1 to slide with a small contact area and without sliding in the same place.

[0015] When the ratio of Ra1/Ra2 is 1.0 or greater, the surface texture of the contact surface with the fiber 1 is identical in the feed direction and the orthogonal direction, or the surface texture in the feed direction is rougher than in the orthogonal direction. When the contact surface has such a surface texture, the fiber 1 is likely to jump when sliding, and when the surface texture in the orthogonal direction is flatter than in the feed direction, the fiber 1 is more likely to slide at an angle. This increases the area of contact between the fiber 1 and the contact surface, thus increasing the likelihood that the fiber 1 is damaged by friction.

[0016] When the ratio of Ra1/Ra2 is less than 0.5, although angled sliding is less likely to occur, invariable sliding is more likely to occur. Thus, the fiber 1 is more likely to be damaged by coming into contact with the portion worn away by friction.

[0017] Herein, the arithmetic mean roughness Ra1 in the feed direction and the arithmetic mean roughness Ra2 in the orthogonal direction of the contact surface with the fiber 1 can be measured in accordance with JIS B 0601 (2001). An example of measurement conditions may include using a measurement length of from 0.1 to 5.0 mm, a cutoff value of from 0.01 to 0.8 mm, a stylus diameter of from 1 to 10 μm, and setting the stylus scanning speed to from 0.01 to 1 mm/sec. Measurements are taken at five locations in both the feed direction and the orthogonal direction. The mean of the values obtained from the measurement are taken as the arithmetic mean roughness Ra1 and Ra2.

[0018] The fiber guide 10 according to an embodiment of the present disclosure which has the arithmetic mean roughness Ra2 in the orthogonal direction of from 0.03 μm to 0.05 μm can further suppress damage to the fiber 1.

[0019] Additionally, the fiber guide 10 according to an embodiment of the present disclosure which has a skewness of Rsk1 obtained from the roughness curve in the feed direction greater than 0 and a skewness of Rsk2 obtained from the roughness curve in the orthogonal direction less than 0 mitigates damage to the fiber 1. "Skewness found from the roughness curve" is an index representing a ratio between peak regions and valley regions with respect to a central line representing the average height of the roughness. When skewness is a value greater than 0, valley regions are greater than peak regions, and when skewness is a value less than 0, peak regions are greater than valley regions.

[0020] The greater the skewness of Rsk1 found from the roughness curve in the feed direction is from 0, the more valley regions the surface texture in the feed direction has. When the fiber 1 slides along the contact surface, by the contact surface having few peak regions where the fiber 1 and the contact surface come into contact, the area of contact between the two is reduced. This reduces the damage to the fiber 1. The lower the skewness of Rsk2 found from the roughness curve in the orthogonal direction is from 0, the less valley regions the contact surface has in the orthogonal direction. This can suppress invariable sliding and thus mitigate damage to the fiber 1.

[0021] Note that skewness obtained from the roughness curve can be measured in accordance with JIS B 0601 (2001), in a similar manner to the arithmetic mean roughness.

[0022] Additionally, the fiber guide 10 according to an embodiment of the present disclosure includes a take-up portion and a let-off portion on the contact surface. When an arithmetic mean roughness Ra3 of the let-off portion in the feed direction is greater than an arithmetic mean roughness Ra4 of the take-up portion in the feed direction, damage to the fiber 1 can be further reduced.

[0023] Here, the fiber guide 10 including a take-up portion and a let-off portion on the contact surface only applies to guides which have a clear distinction between the sides of the contact surface which take up and let off the fiber 1. An example of such a guide is with the oiling nozzle 10b illustrated in FIG. 1B. The contact surface of such an oiling nozzle 10b includes a first end and a second end in the feed direction of the fiber 1. "First end" refers to the portion of the contact surface on the take-up side that first comes into contact with the fiber 1. "Second end" refers to the portion of the contact surface on the let-off side that last comes into contact with the fiber 1. "Take-up portion" refers to a portion from the start in the feed direction of the fiber 1 to a position 1/5 the total length, where the total length of the contact surface is from the first end and the second end. "Let-off portion" refers to a portion from the end in the feed direction of the fiber 1 to a position 1/5 the total length.

[0024] When the relationship between the arithmetic mean roughness Ra3 and Ra4 is satisfied, the fiber 1 is unlikely to jump at the take-up portion, allowing the fiber 1 to be taken up smoothly. Also, the contact area with the fiber 1 at the let-off portion is small, allowing the fiber 1 to be let off smoothly. This further decreases damage to the fiber 1.

[0025] The arithmetic mean roughness Ra3 and Ra4 can be measured in accordance with JIS B 0601 (2001). First, the take-up portion and the let-off portion of the contact surface are measured in the feed direction at three locations. The mean of the values obtained from the measurement are taken as the arithmetic mean roughness Ra3 and Ra4. Note that the measurement conditions may be the same as that for finding the arithmetic mean roughness Ra1 and Ra2 described above.

[0026] In the fiber guide 10 according to an embodiment of the present disclosure, by the arithmetic mean roughness Ra1 in the feed direction increasing in a step-like manner from the take-up portion toward the let-off portion, damage to the fiber 1 can be further suppressed. In such a configuration, the arithmetic mean roughness Ra1 in the feed direction of the contact surface changes in a step-like manner allowing the fiber 1 to further slide smoothly. This further suppresses damage to the fiber 1.

[0027] Here, "the arithmetic mean roughness Ra1 in the feed direction increasing in a step-like manner from the take-up portion toward the let-off portion" means an arithmetic mean roughness Ra7 of the region of the contact surface from the take-up portion to the let-off portion (also referred to below as intermediate portion) in the feed direction is greater than the arithmetic mean roughness Ra4 of the take-up portion in the feed direction and less than the arithmetic mean roughness Ra3 of the let-off portion in the feed direction. In other words, the relationship between the arithmetic mean roughness in the feed direction at each location on the contact surface satisfies the following: take-up portion (Ra4) < intermediate portion (Ra7) < let-off portion (Ra3). Note that the arithmetic mean roughness Ra1 in the feed direction may also progressively increase from the take-up portion toward the let-off portion.

[0028] Here, the arithmetic mean roughness Ra7 of the intermediate portion in the feed direction can be measured in accordance with JIS B 0601 (2001), in a similar manner to how the arithmetic mean roughness Ra3 and Ra4 is obtained.

[0029] Additionally, the fiber guide 10 according to an embodiment of the present disclosure with an arithmetic mean roughness Ra5 of the let-off portion in the orthogonal direction being greater than an arithmetic mean roughness Ra6 of the take-up portion in the orthogonal direction can suppress damage to the fiber 1. In such a configuration, the fiber 1 is less likely to jump at the take-up portion, allowing the fiber 1 to be taken up smoothly. Also, when the fiber 1 is let off, even if the fiber 1 strays to the sides, because the contact area between the let-off portion and the fiber 1 in the orthogonal direction is small, damage to the fiber 1 can be suppressed.

[0030] The arithmetic mean roughness Ra5 and Ra6 can be measured in accordance with JIS B 0601 (2001). First, the take-up portion and the let-off portion of the contact surface is measured in the orthogonal direction at three locations. The mean of the values obtained from the measurement are taken as the arithmetic mean roughness Ra5 and Ra6. Note that the measurement conditions may be the same as that for finding the arithmetic mean roughness Ra1 and Ra2 described above.

[0031] In the fiber guide 10 according to an embodiment of the present disclosure, by the arithmetic mean roughness Ra2 in the orthogonal direction increasing in a step-like manner from the take-up portion toward the let-off portion, damage to the fiber 1 can be further suppressed. In such a configuration, the arithmetic mean roughness Ra2 in the orthogonal direction of the contact surface changes in a step-like manner allowing the fiber 1 to further slide smoothly. This further suppresses damage to the fiber 1.

[0032] The arithmetic mean roughness Ra2 in the orthogonal direction increasing in a step-like manner from the take-up portion toward the let-off portion means that the relationship between the arithmetic mean roughness in the orthogonal direction at each location on the contact surface satisfies the following: take-up portion (Ra6) < intermediate portion (Ra8) < let-off portion (Ra5). Note that the arithmetic mean roughness Ra2 in the orthogonal direction may also progressively increase from the take-up portion toward the let-off portion.

[0033] The arithmetic mean roughness Ra8 of the intermediate portion in the orthogonal direction can be measured in accordance with JIS B 0601 (2001), in a similar manner to how the arithmetic mean roughness Ra5 and Ra6 is found.

[0034] The contact surface of the fiber guide 10 according to an embodiment of the present disclosure may be made from ceramic. Such a contact surface made from ceramic has greater abrasion resistance and thermal resistance than contact surfaces made from metal or resin. This allows damage to the fiber 1 to be further suppressed. Examples of the ceramic include alumina, zirconia, titania, silicon carbide, silicon nitride, and any composite thereof.

[0035] Note that in an embodiment in which the contact surface is made of ceramic, a member provided with the contact surface or the fiber guide 10 itself may be made from ceramic, or a base body of the fiber guide 10 may be made from metal or resin and the surface may be coated with ceramic. Alternatively, a member provided with the contact surface may be made from ceramic and this may be joined with a base body made from metal or resin. The material of the contact surface can be identified from the value of 2θ (2θ indicates a diffraction angle) obtained by measurement using an X-ray diffractometer (XRD), by using a JCPDS card.

[0036] Next, an example of a manufacturing method of the fiber guide 10 according to an embodiment of the present disclosure will be described. Note that the oiling nozzle 10b will be used as an example of the fiber guide 10 in the following description.

[0037] First, alumina (aluminum oxide) powder is added to a mill together with a solvent and balls. This is ground until a predetermined particle size is obtained to make a slurry.

[0038] Next, a binder is added to the obtained slurry. Then, spray drying using a spray drier is performed to produce granules.

[0039] The granules are charged into a mechanical press. Pressure is applied to the granules to produce a compact with a predetermined shape. Then, the compact is cut into the shape of the oiling nozzle. Note that the contact surface of the compact cut into the shape of the oiling nozzle has a rougher surface texture in the straight direction than in the feed direction. Alternatively, an injection molding method using pellets made from the same raw material may be used to produce the compact.

[0040] Next, in the case in which the main raw material is alumina for example, the obtained compact with the oiling nozzle shape may be fired for 1 to 8 hours in an atmosphere kept at a maximum temperature of from 1450 to 1750°C. Note that the firing conditions for the maximum temperature and the duration kept at a particular temperature can be adjusted as necessary depending on the size and shape of the article.

[0041] Next, the obtained sintered compact with the oiling nozzle shape is fixed in place, and the contact surface of the sintered compact is finished by sliding a cord over the contact surface of the sintered compact at a feed rate of 300 m/min while supplying the contact surface with oil in which abrasives are dispersed. The cord used in this finishing may be a nylon cord with a diameter from 0.5 to 10 mm, and the abrasives used may be diamond abrasive grains with an average particle size of from 2 to 6 μm. Note that when the fiber guide is rotatable such as the roller guide 10a, the cord is preferably slid over the contact surface while the sintered compact with a roller guide shape is rotated. In this finishing method, the contact surface is finished by the cord being slid over the surface in the feed direction of the fiber 1. Thus, the surface roughness of the contact surface in the orthogonal direction is made less than that in the feed direction.

[0042] After finishing the contact surface for from 3 to 20 minutes as described above, the oiling nozzle 10b according to an embodiment of the present disclosure with the ratio Ra1/Ra2 between the arithmetic mean roughness Ra1 in the feed direction and the arithmetic mean roughness Ra2 in the orthogonal direction being from 0.5 to less than 1.0 is obtained.

[0043] To make the arithmetic mean roughness Ra2 in the orthogonal direction from 0.03 μm to 0.05 μm, the period of time the contact surface is finished as described above can be set to from 5 to 10 minutes.

[0044] Additionally, to make the skewness Rsk1 found from the roughness curve in the feed direction greater than 0 and the skewness Rsk2 found from the roughness curve in the orthogonal direction further below 0, abrasives used in the finishing of the contact surface as described above may have an average particle size of from 2 to 4 μm. In such a manner, by using abrasives with a small particle size, the contact surface is finished in a scratching manner in the feed direction. This allows the skewness Rsk1 to be kept greater than 0 while only making the skewness Rsk2 further below 0.

[0045] In the finishing of the contact surface described above, by fixing in place the sintered compact with an oiling nozzle shape so that the cord slides only over the take-up portion, intermediate portion, and let-off portion of the contact surface and adjusting the average particle size and finishing time of the finishing, the arithmetic mean roughness in the feed direction and the orthogonal direction at each location can be made a discretionary value.

[0046] Note that though the oiling nozzle 10b was used as the example in the manufacturing method described above, in cases in which the roller guide 10a, the rod guide 10c, or the traverse guide 10d are manufactured, the manufacturing method employed may be similar to that for the oiling nozzle 10b described above except for the shape of the guide.

[0047] Additionally, the present disclosure is not limited to the above-described embodiments, and various modifications, improvements and the like may be made to the embodiments without departing from the scope of the present disclosure.

Example 1

[0048] Roller guides with different ratios Ra1/Ra2 between the arithmetic mean roughness Ra1 in the feed direction of the contact surface and the arithmetic mean roughness Ra2 in the orthogonal direction of the contact surface were manufactured. Fibers were guided with the roller guides and the time taken until the fibers were damaged was compared.

[0049] First, alumina powder of 99.6% purity was added to a mill together with water (solvent) and balls, and the mixture was ground to produce a slurry.

[0050] Next, a binder was added to the slurry. Then, spray drying using a spray drier was performed to produce granules. The obtained granules were charged in a mechanical press and compacts were produced. The compacts were cut to obtain compacts with a roller guide shape.

[0051] Next, the compacts with a roller guide shape were fired for 1 hour in an atmosphere kept at a maximum temperature of 1600°C, and sintered compacts with a roller guide shape was obtained.

[0052] Next, the sintered compacts with a roller guide shape were fixed in place allowing for rotation. Then, the contact surfaces of the sintered compacts were finished by sliding a cord over the contact surfaces at a feed rate of 300 m/min for a finishing time indicated in Table 1 while supplying the contact surface with oil in which abrasives are dispersed. Note that the cord used in this finishing was a nylon cord with a diameter from 0.6 mm, and the abrasives used were diamond abrasive grains with an average particle size of 5 μm.

[0053] The arithmetic mean roughness Ra1 in the feed direction of the contact surface and the arithmetic mean roughness Ra2 in the orthogonal direction of the contact surface of each of the samples were measured in accordance with JIS B 0601 (2001). The measurement conditions were a measurement length of 1.5 mm, a cutoff value of 0.25 mm, and a stylus diameter of 2 μm, and the stylus scanning speed was set to 0.5 mm/sec. Measurements were taken at five locations in both the feed direction and the orthogonal direction. The mean of the values obtained from the measurement were taken as the arithmetic mean roughness Ra1 and Ra2.

[0054] Next, fibers were guided with the samples and the time taken until the fibers were damaged was measured. The fiber used in the testing was 75 denier, had a quadrilateral cross section, and was made from polyester containing 1.2 parts by mass of titanium oxide with an average crystalline particle size of 1.2 μm per 100 parts by mass of fiber. Additionally, a water emulsion oiling agent of from 2 to 4 parts by mass per 100 parts by mass of the fiber was supplied to the contact surfaces of the samples.

[0055] The fibers were guided along the samples at a feed rate of 5000 m/min. The fibers past the guide were inspected for fraying and damage, and the durability time from the start until damage was obtained. The results are shown in Table 1.

[Table 1]

Sample No.	Finishing time (min)	Ra1 (μm)	Ra2 (μm)	Ra1/Ra2	Durability time (h)
*1	30	0.022	0.020	1.10	660
*2	24	0.024	0.024	1.00	680
3	20	0.025	0.026	0.96	785
4	10	0.028	0.030	0.93	870
5	7	0.032	0.041	0.78	900
6	5	0.035	0.050	0.70	850
7	4	0.036	0.058	0.62	750
8	3	0.038	0.076	0.50	700
*9	1	0.040	0.100	0.40	650
* indicates configurations outside the scope of the present invention					

[0056] As seen from the results shown in Table 1, Sample No. 1 with a ratio of Ra1/Ra2 of 1.0 or greater and Sample No. 9 with a ratio Ra1/Ra2 of less than 0.5 had short durability times of 680 hours or less.

[0057] The results for Sample Nos. 3 to 8 show long usability with a durability time of 700 hours or greater. By the ratio of Ra1/Ra2 of Sample Nos. 3 to 8 being from 0.5 to less than 1.0, the contact area with the fibers is made small and the fibers do not slide in the same place due to the sliding position being able to change a moderate degree. Thus, by mounting such a roller guide to a textile machine, damage to the fibers can be suppressed and the fibers can be guided for a long period of time.

[0058] The results for Sample Nos. 4 to 6 show even longer times with a durability time of 850 hours or greater. From this, it can be seen that by the arithmetic mean roughness Ra2 being from 0.03 μm to 0.05 μm, damage to the fibers can be further suppressed and the fibers can be guided for a longer period of time.

Example 2

[0059] Next, roller guides with different positive/negative relationships between the skewness of Rsk1 obtained from the roughness curve in the feed direction of the contact surface and the skewness of Rsk2 obtained from the roughness curve in the orthogonal direction of the contact surface were manufactured. Fibers were guided with the roller guides and the time taken until the fibers were damaged was compared. Note that the manufacturing method is the same as that for Sample No. 5 of Example 1 except that the abrasives used were the diamond abrasive grains with the average particle size indicated in Table 2. Sample No. 11 is the same as Sample No. 5 of Example 1.

[0060] Next, employing the same method as in Example 1, the skewness of Rsk1 and the skewness of Rsk2 of each sample was measured. Then, the test in which the fibers are feed was performing employing the same method as in Example 1. Results are shown in Table 2. Note that in Table 2, skewness values greater than 0 are indicated by "Positive", and values less than 0 are indicated by "Negative".

[Table 2]

Sample No.	Average abrasive grain particle size (μm)	Rsk1	Rsk2	Durability time (h)
10	3	Positive	Negative	1000
11	5	Positive	Positive	900

[0061] As seen from the results shown in Table 2, Sample 10 showed long usability with a durability time of 1000 hours. From this, it can be seen that the contact surface preferably has a positive (greater than 0) skewness of Rsk1 found from the roughness curve in the feed direction and a negative (less than 0) skewness of Rsk2 found from the roughness curve in the orthogonal direction.

Example 3

[0062] Next, oiling nozzles were manufactured with different arithmetic mean roughnesses Ra4, Ra7, Ra3 in the feed direction for the take-up portion, the intermediate portion, and the let-off portion of the contact surfaces. Fibers were guided with the oiling nozzles and the time taken until the fibers were damaged was compared. First, sintered compacts with an oiling nozzle shape were produced under the same conditions of the method used to produce the sintered compacts with a roller guide in Example 1, except for the oiling nozzle shape.

[0063] The sintered compacts with an oiling nozzle were fixed in place so that the cord only slides over the take-up portion, the intermediate portion, and the let-off portion of the contact surfaces. Then, the contact surfaces were finished at each location by sliding a cord over the contact surfaces at a feed rate of 300 m/min for a finishing time indicated in Table 3 while supplying the contact surface with oil in which diamond abrasive grain abrasives are dispersed. Note that the cord used in this finishing was a nylon cord with a diameter of 0.5 mm.

[0064] Next, employing the same method as in Example 1, the arithmetic mean roughness Ra1 and Ra2 of each sample was measured. These results showed that all samples satisfied the ratio of Ra1/Ra2 of from 0.5 to less than 1.0.

[0065] Next, the arithmetic mean roughness Ra4, Ra7, Ra3 in the feed direction of the take-up portion, the intermediate portion, and the let-off portion of the contact surfaces of the samples were measured in accordance with JIS B 0601 (2001). The take-up portion, the intermediate portion, and the let-off portion, were measured at three locations in the feed direction with measurement conditions being a measurement length of 0.24 mm, a cutoff value of 0.08 mm, a stylus diameter of 2 μm, and the stylus scanning speed being set to 0.05 mm/sec. The mean of the values obtained from the measurement were taken as the arithmetic mean roughness Ra4, Ra7, Ra3.

[0066] Then, the test in which the fibers are fed was performing employing the same method as in Example 1. Results are shown in Table 3.

[Table 3]

Sample No.	Finishing time (min)			Average abrasive grain particle size (µm)			Arithmetic mean roughness in feed direction (µm)			Durability time (h)
	Take-up portion	Intermediate portion	Let-off portion	Take-up portion	Intermediate portion	Let-off portion	Take-up portion (Ra4)	Intermediate portion (Ra7)	Let-off portion (Ra3)	
12	3.5	3.5	18	6	6	3	0.034	0.034	0.024	900
13	18	3.5	3.5	6	6	3	0.024	0.034	0.032	1000
14	18	5.5	3.5	6	6	3	0.024	0.029	0.032	1050

[0067] As seen from the results shown in Table 3, Sample No. 13 showed long usability with a durability time of 1000 hours. From this, it can be seen that an oiling nozzle in which the arithmetic mean roughness Ra3 in the feed direction of the let-off portion is greater than the arithmetic mean roughness Ra4 in the feed direction of the take-up portion can prevent damage to the fibers and guide for a long period of time.

[0068] Furthermore, the results for Sample No. 14 show even longer times with a durability time of 1050 hours. From this, it can be seen that it may be preferable for the arithmetic mean roughness in the feed direction to increase in a step-like manner from the take-up portion toward the let-off portion.

Example 4

[0069] Next, oiling nozzles were manufactured with different arithmetic mean roughness Ra6, Ra8, Ra5 in the orthogonal direction for the take-up portion, the intermediate portion, and the let-off portion of the contact surfaces. Fibers were guided with the oiling nozzles and the time taken until the fibers were damaged was compared. Note that the manufacturing method is the same as that for Sample No. 14 of Example 3 except that the diamond abrasive grain abrasives are set with the average particle size indicated in Table 4 and the finishing table is set likewise. Sample No. 15 is the same as Sample No. 14 of Example 3.

[0070] Next, the arithmetic mean roughness Ra6, Ra8, Ra5 in the orthogonal direction of the take-up portion, the intermediate portion, and the let-off portion of the contact surfaces of the samples were measured in accordance with JIS B 0601 (2001). First, the take-up portion, the intermediate portion, and the let-off portion were measured in the orthogonal direction at three locations. The mean of the values obtained from the measurement were taken as the arithmetic mean roughness Ra6, Ra8, Ra5. Note that the measurement conditions were the same as that for finding the arithmetic mean roughness Ra4, Ra7, Ra3 of Example 3.

[0071] Then, the test in which the fibers are fed was performing employing the same method as in Example 1. Results are shown in Table 4.

[Table 4]

Sample No.	Finishing time (min)			Average abrasive grain particle size (μm)			Arithmetic mean roughness in orthogonal direction (μm)			Durability time (h)
	Take-up portion	Intermediate portion	Let-off portion	Take-up portion	Intermediate portion	Let-off portion	Take-up portion (Ra6)	Intermediate portion (Ra8)	Let-off portion (Ra5)	
15	18	5.5	3.5	6	6	3	0.040	0.049	0.037	1050
16	18	5.5	3.5	5	6	4	0.026	0.049	0.046	1150
17	18	5.5	3.5	5	5	4	0.026	0.039	0.046	1200

[0072] As seen from the results shown in Table 4, Sample No. 16 showed even longer usability with a durability time of 1150 hours. From this is can be seen that an oiling nozzle in which the arithmetic mean roughness Ra5 in the orthogonal direction of the let-off portion is greater than the arithmetic mean roughness Ra6 in the orthogonal direction of the take-up portion can prevent damage to the fibers and guide for an even longer period of time.

[0073] Furthermore, the results for Sample No. 17 show an extremely long period of time with a durability time of 1200 hours. From this, it can be seen that the arithmetic mean roughness in the orthogonal direction more preferably increases in a step-like manner from the take-up portion toward the let-off portion.

Reference Signs List

[0074]

1 Fiber
10a Roller guide
10b Oiling nozzle
10c Rod guide
10d Traverse guide
10 Fiber guide

Claims

1. A fiber guide, comprising:

   a contact surface with a fiber having a ratio of Ra1/Ra2 that is 0.5 or more and less than 1.0,
   where Ra1 is an arithmetic mean roughness in a feed direction of the fiber and Ra2 is an arithmetic mean roughness in an orthogonal direction orthogonal to the feed direction.

2. The fiber guide according to claim 1, wherein the arithmetic mean roughness Ra2 in the orthogonal direction is from 0.03 μm to 0.05 μm.

3. The fiber guide according to claim 1 or 2, wherein a skewness of Rsk1 obtained from a roughness curve in the feed direction is greater than 0, and a skewness of Rsk2 obtained from a roughness curve in the orthogonal direction is less than 0.

4. The fiber guide according to any one of claims 1 to 3, wherein
   the contact surface comprises a take-up portion and a let-off portion, and
   an arithmetic mean roughness Ra3 in the feed direction of the let-off portion is greater than an arithmetic mean roughness Ra4 in the feed direction of the take-up portion.

5. The fiber guide according to claim 4, wherein the arithmetic mean roughness Ra1 in the feed direction increases in a step-like manner from the take-up portion toward the let-off portion.

6. The fiber guide according to any one of claims 1 to 5, wherein:

   the contact surface comprises a take-up portion and a let-off portion; and
   an arithmetic mean roughness Ra5 in the orthogonal direction of the let-off portion is greater than an arithmetic mean roughness Ra6 in the orthogonal direction of the take-up portion.

7. The fiber guide according to claim 6, wherein the arithmetic mean roughness Ra2 in the orthogonal direction increases in a step-like manner from the take-up portion toward the let-off portion.

8. The fiber guide according to any one of claims 1 to 7, wherein the contact surface is made from ceramic.

FIG. 1A

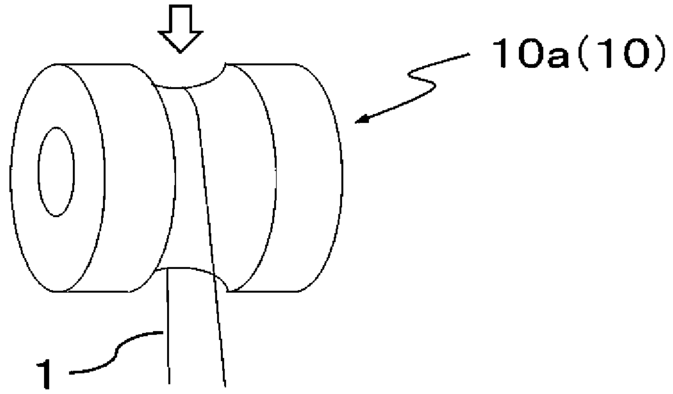


FIG. 1B

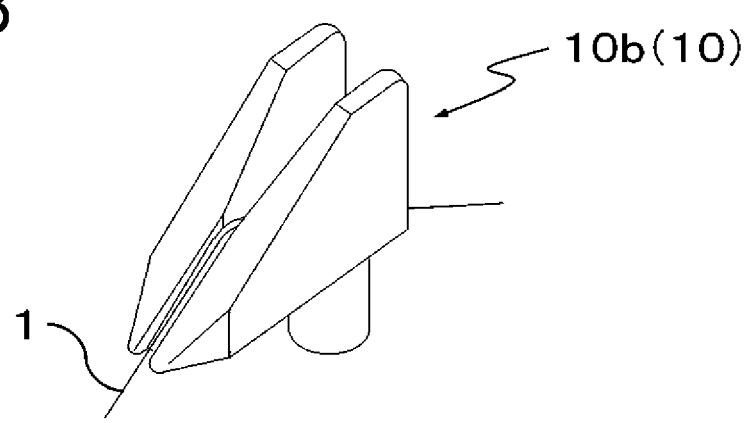


FIG. 1C

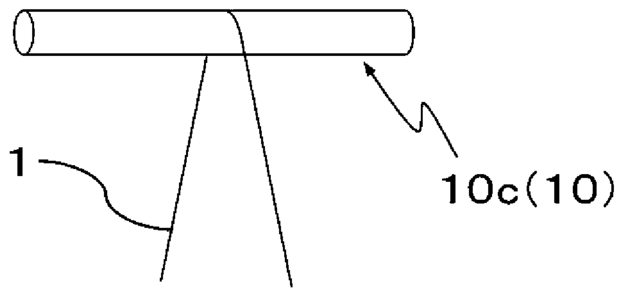
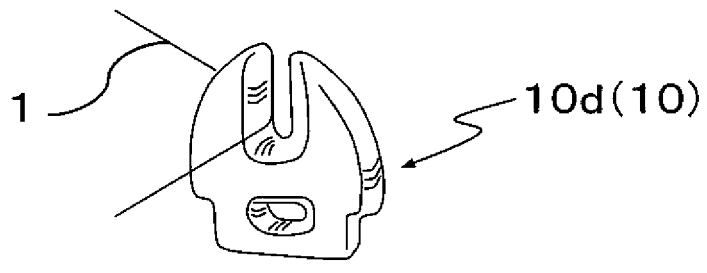


FIG. 1D



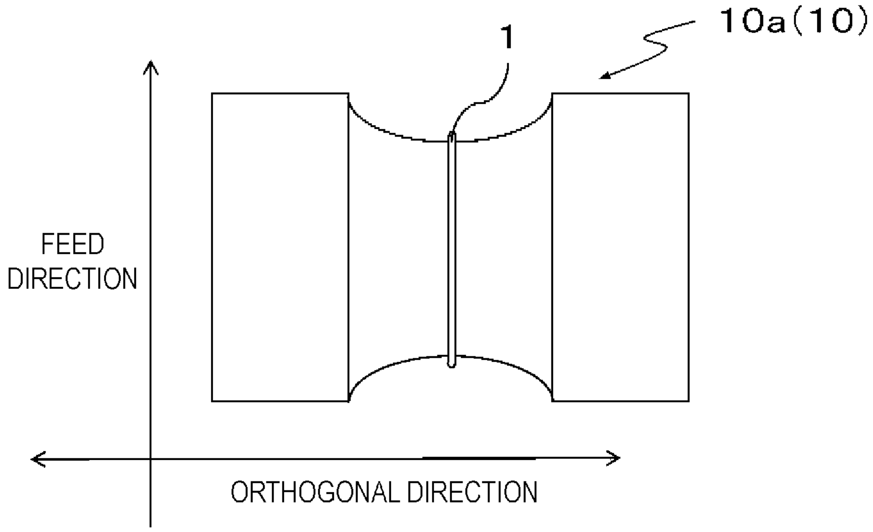


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/055464

A. CLASSIFICATION OF SUBJECT MATTER
B65H57/24(2006.01)i, *B65H54/36*(2006.01)i, *D01D11/04*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65H57/24, B65H54/36, D01D11/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2016
Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2010-229570 A (Kyocera Corp.), 14 October 2010 (14.10.2010), paragraphs [0059] to [0072] (Family: none)	1-8
A	JP 2008-013276 A (Murata Machinery Ltd.), 24 January 2008 (24.01.2008), paragraphs [0044] to [0048]; fig. 4 (Family: none)	1-8
A	JP 10-262515 A (Daido Steel Co., Ltd.), 06 October 1998 (06.10.1998), paragraphs [0013] to [0014] (Family: none)	1-8

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 May 2016 (10.05.16)	24 May 2016 (24.05.16)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/055464

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 08-067420 A (Kyocera Corp.), 12 March 1996 (12.03.1996), paragraphs [0018] to [0025] (Family: none)	1-8

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000073225 A **[0003]**