(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 871 270 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
13.05.2015 Bulletin 2015/20

(21) Application number: **13812558.8**

(22) Date of filing: **04.07.2013**

(51) Int Cl.:
D01H 5/80 *(2006.01)*

(86) International application number:
PCT/JP2013/004174

(87) International publication number:
WO 2014/006915 (09.01.2014 Gazette 2014/02)

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

(30) Priority: **05.07.2012 JP 2012151031**

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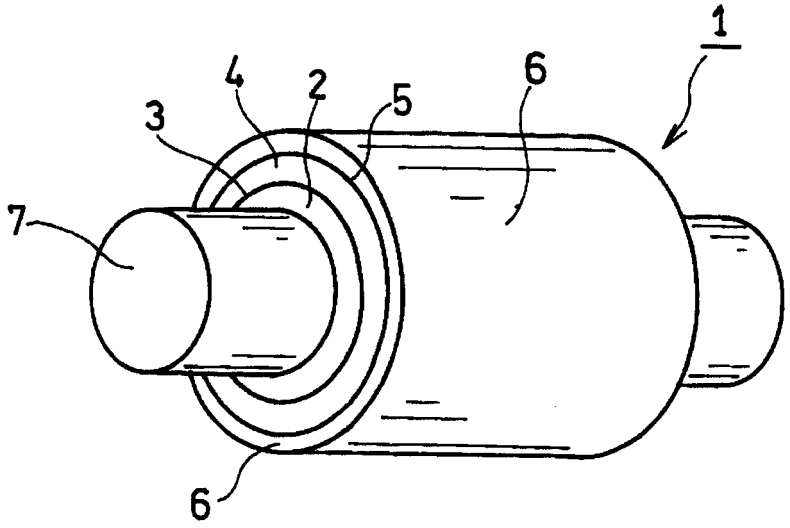
(54) **ROLLER FOR SPINNING**

(57) Provided is a spinning roller including: a cylindrical pipe configured to have an arbor inserted therein; and an elastic layer fixed to the external surface of the pipe. The elastic layer includes: a first rubber layer on the inner side; and a second rubber layer on the outer side, fixed to the first rubber layer. The hardness of the first rubber layer is 48° or less and the hardness of the second rubber layer is 60° or more. The thickness of the elastic layer is 2 to 20 mm. The ratio of a thickness T_2 of the second rubber layer to a thickness T_1 of the first rubber layer: T_2/T_1 is 1/1 to 1/10 and preferably 1/3 to 1/6.

F I G. 1



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Description

[Technical Field]

[0001] The present invention relates to a spinning roller used in processes in spinning such as combing, drawing, roving, and spinning.

[Background Art]

[0002] A conventionally known spinning roller comprises: a pipe configured to have an arbor inserted therein; and a cylindrical elastic layer adhering to the external surface of the pipe. A proposal has also been made for the elastic layer to have a double-layer structure including: a first rubber layer (inner layer) adhering to the external surface of the pipe; and a second rubber layer (outer layer) adhering to the external surface of the first rubber layer, the hardness of the second rubber layer set higher than the hardness of the first rubber layer (Patent Literatures 1 and 2).

[Prior Art]

[Patent Literature]

[0003]

[Patent Literature 1] Japanese Laid-Open Patent Publication No. 2007-138342
[Patent Literature 2] German Patent Publication No. 1685634

[Summary of Invention]

[Problem of Invention]

[0004] The external surface of a spinning roller becomes worn with use. In view of suppressing such wear, the hardness of the rubber that forms the roller surface is preferably made higher. However, if a rubber with high hardness forms the roller surface, at times of spinning, the ability of the roller to hold a fibre bundle would degrade and the yarn may become uneven. That is, it is not easy to ensure the ability of the roller to hold a fibre bundle, while also suppressing wear of the external surface of the roller.

[0005] The elastic layers for spinning rollers proposed in Patent Literatures 1 and 2 both have a double-layer structure including a first rubber layer (inner layer) and a second rubber layer (outer layer), the hardness of the first rubber layer set lower than the hardness of the second rubber layer. Since the relatively soft first rubber layer is provided as the inner layer, the apparent hardness of the roller surface becomes lower, making it easier for the respective rollers to ensure the ability to hold a fibre bundle. On the other hand, since the second rubber layer having a higher hardness than the first rubber layer is provided as the outer layer in the elastic layer, wear of the roller surface is suppressed.

[0006] However, even among the spinning rollers in which their respective second rubber layers (outer layers) are of the same material and the same apparent hardness, their abilities to hold a fibre bundle may greatly differ from one another.

[Solution to Problem]

[0007] To obtain a spinning roller excellent in the ability to hold a fibre bundle, importance is placed, not on the apparent hardness of the roller surface, but on widening the nip width. The nip width is produced when, for example, the roller is pressed against a flat surface. As a result of conducting extensive tests and studies, the present inventors found that, even among the spinning rollers in which the respective outer layers were of the same material and the respective roller surfaces were of the same apparent hardness, there was a significant difference in their nip widths; and that when the nip width became wider, the ability of the roller to hold a fibre bundle improved. Based on the above findings, the present inventors were able to complete the present invention.

[0008] That is, one aspect of the present invention relates to a spinning roller comprising:

a cylindrical pipe; and
a cylindrical elastic layer fixed to the external surface of the pipe,
the elastic layer including:

a first rubber layer on the inner side; and

a second rubber layer on the outer side fixed to the first rubber layer, the hardness of the first rubber layer being 48° or less,
the hardness of the second rubber layer being 60° or more,
the thickness of the elastic layer being 2 to 20 mm, and
the ratio of a thickness T_2 of the second rubber layer to a thickness T_1 of the first rubber layer: T_2/T_1 being 1/1 to 1/10.

[Advantageous Effect of Invention]

[0009] According to the present invention, there can be provided a spinning roller capable of producing a wide nip width and excellent in the ability to hold a fibre bundle.

[0010] While the novel features of the invention are set forth particularly in the appended claims, the invention, both as to organization and content, will be better understood and appreciated, along with other objects and features thereof, from the following detailed description taken in conjunction with the drawings.

[Brief Description of Drawings]

[0011]

Fig. 1 is an oblique view of a spinning roller according to one embodiment of the present invention, with an arbor pressed therein.
Fig. 2 is a sectional view of the spinning roller according to the embodiment in Fig. 1.
Fig. 3 is a schematic front elevation of the spinning roller when subjected to a test for measuring the nip width it produces.

[Description of Embodiment]

[0012] A spinning roller is used for a drafting mechanism in which a fibre bundle is stretched in processes such as combing, drawing, roving, and spinning. Since a fibre bundle tends to come in local contact with the external surface of a spinning roller, the surface of a spinning roller preferably has high resistance against wear. On the other hand, to suppress varied thickness and fuzzing of a fibre bundle as well as to produce a final yarn product of consistent quality, a spinning roller needs to be capable of producing a sufficient nip width to be able to firmly hold a fibre bundle and press a sufficient area of the fibre bundle.

[0013] A spinning roller according to the present invention has a cylindrical pipe and an elastic layer fixed to the external surface of the pipe. The elastic layer has a first rubber layer on the inner side and a second rubber layer on the outer side fixed to the first rubber layer. The hardness of the first rubber layer is 48° or less and the hardness of the second rubber layer is 60° or more. The thickness of the elastic layer is set to 2 to 20 mm. Since the hardnesses of the two rubber layers and the thickness of the elastic layer are set as above, the spinning roller has high resistance against wear.

[0014] When the hardness of the first rubber layer is 48° or less, the hardness of the second rubber layer is 60° or more, and the thickness of the elastic layer is 2 to 20 mm, the nip width or the ability of the roller to hold a fibre bundle greatly depends on the relative relation between the thickness of the first rubber layer (inner layer) and the thickness of the second rubber layer (outer layer). Therefore, for the spinning roller according to the present invention, the ratio of a thickness T_2 of the second rubber layer to a thickness T_1 of the first rubber layer: T_2/T_1 is set to 1/1 to 1/10. Since the thicknesses of the two rubber layers are controlled as above, the elastic layer can be moderately deformed, a wide nip width can be produced, and as a result, the roller becomes excellent in the ability to hold a fibre bundle. Thus, it is possible to obtain a final yarn product of a quality that is consistent for a long period of time.

[0015] Note that the rubber hardness is in compliance with JIS-K6253 (Type A durometer hardness).

[0016] In view of producing a final yarn product of a more consistent quality, the hardness of the first rubber layer is preferably 30° to 45° and the hardness of the second rubber layer is preferably 65° to 95°. Since the hardnesses are in the above ranges, the ability of the spinning roller to hold a fibre bundle further improves. In a similar view, the hardness of the first rubber layer may preferably be 30° to 38° and the hardness of the second rubber layer may preferably be 65° to 73°.

[0017] In view of producing a final yarn product of a more consistent quality, the thickness T_1 of the first rubber layer is preferably 1.5 to 10 mm for example. Since the thickness is in the above range, the effect of the first rubber layer with relatively low hardness is sufficiently ensured; and therefore, a wide nip width can be produced more easily.

[0018] In view of producing a final yarn product of a quality that is consistent for a long period of time, the thickness of the elastic layer (total of the first rubber layer and the second rubber layer) is preferably 3 to 20 mm. Since the thickness is in the above range, a wide nip width can be produced more easily, and also, the quality of the roller becomes consistent.

[0019] The ratio T_2/T_1 is preferably 1/1 to 1/6 and further preferably 1/3 to 1/6. Since the ratio T_2/T_1 is in the above range, the effect of the first rubber layer with relatively low hardness is sufficiently ensured; and therefore, a wide nip width can be produced more easily.

[0020] When the foregoing conditions are met, inconsistency in the roller quality associated with thinning of the second rubber layer, as well as sharp decline in the apparent hardness associated with wear, are unlikely to occur. Furthermore, the roller surface can be easily reground. Due to the above, the running cost for spinning can be significantly reduced.

[0021] Note that a cylindrical arbor is inserted in the hollow of the cylindrical pipe. Since the elastic layer including the first rubber layer 4 and the second rubber layer 6 is formed as an organized integral part on the external surface of the pipe 2 in which the arbor is inserted, when the elastic layer becomes worn, the spinning roller can be removed from the arbor and easily replaced. If the first rubber layer directly adheres to the external surface of the arbor, when the elastic layer needs to be replaced, considerable time and effort would be required to detach the elastic layer from the external surface of the arbor and then replace it with another one.

[0022] Next, an embodiment of the present invention will be described in detail. However, note that the following embodiment does not limit the present invention and various alterations and modifications can be made within the scope of the invention.

[0023] Fig. 1 is an oblique view of a spinning roller according to the present embodiment, with an arbor pressed therein. Fig. 2 is a sectional view of the spinning roller.

[0024] A spinning roller 1 comprises: a cylindrical pipe 2; a first adhesive layer 3 formed on the external surface of the pipe 2; a first rubber layer 4 fixed to the external side of the pipe 2 via the first adhesive layer 3; a second adhesive layer 5 formed on the external surface of the first rubber layer 4; and a second rubber layer 6 fixed to the external side of the first rubber layer 4 via the second adhesive layer 5. That is, the first rubber layer 4 and the second rubber layer 6 form an elastic layer.

[0025] The cylindrical pipe 2 can be made of metal or synthetic resin. The cylindrical pipe 2 is preferably made of aluminum for example, because it is lightweight and excellent in the ability to hold the inserted arbor. The inner diameter of the pipe 2 is not particularly limited, and is 10 to 50 mm for example.

[0026] The first adhesive layer 3 and the second adhesive layer 5 are not mandatory. For example, the first rubber layer 4 can be directly bonded to the pipe 2. Moreover, the second rubber layer 6 can be directly bonded to the first rubber layer 4, without the second adhesive layer 5 provided therebetween.

[0027] The first adhesive layer 3 can be of, for example, a one-part adhesive suited for bonding rubber and metal, or, a two-part adhesive that uses a primer (undercoat) and a topcoat to enable strong adhesion. The second adhesive layer 5 can be of, for example, a polyolefin-based adhesive or a phenolic resin-based adhesive.

[0028] The respective rubber materials for forming the first rubber layer 4 and the second rubber layer 6 may be solid rubber or sponge rubber. Examples of the respective rubber materials include, but are not limited to, nitrile rubber (NBR), natural rubber (NR), styrene-butadiene rubber (SBR), butadiene rubber (BR), and butyl rubber (IIR). The rubber material for forming the first rubber layer 4 and the rubber material for forming the second rubber layer 6 may be the same or be different. Among these, NBR is preferred because it has excellent oil resistance and can easily suppress electrostatic charge of a fibre bundle. The rubber layers used for the spinning roller contains relatively large amounts of sulfur as a vulcanizing agent. For example, the sulfur content in the second rubber layer 6 is preferably 3 to 10 mass%.

[0029] The hardness of the first rubber layer 4 is required to be 48° or less; and is preferably 30° to 45°, further preferably 30° to 38°, and utmost preferably about 35°, for example. If the hardness of the first rubber layer 4 is less than 30°, since the layer would become too soft, the ability of the roller to hold a fibre bundle would degrade. Moreover, since the first rubber layer would easily deform and thus cause the nip width to become too wide, the spinning roller may come in contact with an adjacent apron band and thus inhibit rotations of both the roller and the band. On the other hand, if the hardness of the first rubber layer 4 is more than 48°, it would be difficult to widen the nip width.

[0030] The hardness of the second rubber layer 6 is required to be 60° or more; and is preferably 65° to 95°, further preferably 65° to 73°, and utmost preferably about 70° for example. If the hardness of the second rubber layer 6 is less than 65°, the second rubber layer 6 would become greatly worn and it would be difficult to conduct spinning with consistency. If the hardness of the second rubber layer 6 is more than 95°, it would be difficult to widen the nip width.

[0031] The thickness of the elastic layer (total of a thickness T_1 of the first rubber layer 4 and a thickness T2 of the second rubber layer 6) is required to be 2 to 20 mm; and is preferably 3 to 20 mm and further preferably 3 to 12 mm, for example. If the thickness of the elastic layer is less than 2 mm, since the second rubber layer 6 would become considerably thin, the quality of the roller would become inconsistent. Moreover, only a slight wear of the second rubber layer 6 due to use would cause the apparent hardness to sharply decline or to become difficult to control. On the other hand, if the thickness of the elastic layer is more than 20 mm, the spinning roller would become large in size and may become unsuited for operation in a common spinning machine. Thus, there would be a problem in terms of limit on the roller size. Moreover, the first and second rubber layers would become extremely thick and behave as if they form a single-layer rubber roller when the spinning roller is operated. Thus, the spinning roller would lose its feature of having a double-layer structure.

[0032] The ratio of the thickness T_2 of the second rubber layer to the thickness T_1 of the first rubber layer: T_2/T_1 is required to be 1/1 to 1/10; and is preferably 1/1 to 1/6 and further preferably 1/3 to 1/6. Since the ratio T_2/T_1 is set in the above range, even if the apparent hardness is the same, it is possible to obtain a wider nip width and ensure a consistent yarn quality.

[0033] When the thickness of the elastic layer is 2 to 20 mm, if the ratio T_2/T_1 is larger than 1/1, the second rubber layer 6 would become too thick relative to the first rubber layer 4, and it would be difficult to obtain a sufficient nip width. Moreover, the apparent hardness of the roller surface would tend to become higher. Particularly, if the ratio T_2/T_1 is larger than 1.15/1, such tendency would increase. On the other hand, if the ratio T_2/T_1 is smaller than 1/10, since the second rubber layer 6 would become considerably thin relative to the first rubber layer 4, it would be difficult to obtain a roller of uniform quality. Thus, only a slight wear of the second rubber layer 6 due to use would cause the apparent hardness to sharply decline or become difficult to control.

[0034] The thickness T_1 of the first rubber layer is preferably 1.5 to 10 mm and further preferably 2.25 to 9 mm, for example. The thickness T_1 of the first rubber layer being more than 1.5 mm (e.g., more than 2.25 mm) serves as an advantage in widening the nip width. On the other hand, since the thickness T_1 of the first rubber layer is less than 10 mm. (e.g., less than 9 mm), the first rubber layer can easily be attached to a common widely-used spinning machine, without any limit on the roller size.

[0035] The thickness T_2 of the second rubber layer is preferably 0.5 to 10 mm and further preferably 0.75 to 3 mm, for example. Since the thickness T_2 of the second rubber layer is more than 0.5 mm (e.g., more than 0.75 mm), it becomes easier to obtain a roller of uniform quality, and also, sharp decline in the apparent hardness associated with wear is unlikely to occur. Furthermore, the roller surface can be easily reground and the running cost for spinning can be reduced. On the other hand, since the thickness T_2 of the second rubber layer is less than 10 mm (e.g., less than 3 mm), it becomes easier to widen the nip width.

[0036] The apparent hardness of the surface of the spinning roller 1 satisfying the foregoing conditions is 50° to 80° and preferably 55° to 70°, for example.

[0037] Next, an example of a production method of the spinning roller 1 according to the present embodiment will be given.

[0038] First, an adhesive that is to become a first adhesive layer 3 is uniformly applied to the external surface of a pipe 2. Then, via the first adhesive layer 3, the external surface of the pipe 2 is coated with a first rubber composition that is unvulcanized and cylindrically extruded with use of an extruder. Thereafter, the first rubber composition is vulcanized to form a first rubber layer 4.

[0039] After the external surface of the first rubber layer 4 is ground, an adhesive that is to become a second adhesive layer 5 is uniformly applied to the external surface of the first rubber layer 4. Then, a second rubber composition (rubber tube), unvulcanized and cylindrically molded in advance, is fitted around the first rubber layer 4 so as to coat the ground external surface. Thereafter, the second rubber composition is vulcanized to form a second rubber layer 6. Lastly, the external surface of the second rubber layer is ground, thereby to complete a spinning roller 1.

[0040] An alternative production method may be used, the method using an extruder which has a function of sending out a pipe 2 at a predetermined speed; and a function of pushing out an unvulcanized first rubber composition (inner layer) and an unvulcanized second rubber composition (outer layer) together, such that the two rubber compositions become coaxial with the pipe 2. In that case, a preform of the roller is obtained, the preform comprising: the pipe 2; the unvulcanized first rubber composition (inner layer) that coats the external surface of the pipe 2; and the unvulcanized second rubber composition (outer layer) that coats the external surface of the inner layer. Note that an adhesive is preferably applied to the external surface of the pipe 2 before being coated with the inner layer. Thereafter, the inner layer and the outer layer are vulcanized together, thereby to form an elastic layer including the first rubber layer 4 and the second rubber layer 6. Lastly, the external surface of the second rubber layer is ground. In that case, the second adhesive layer 5 can be omitted.

[0041] Next, the present invention is specifically described by way of Examples and Comparative Examples. The following Examples, however, are not to be construed as limiting in any way the scope of the present invention.

[Example 1]

(1) Production of spinning roller

[0042] A spinning roller illustrated in Fig. 1 was produced by the following procedures.

(a) Formation of first rubber layer (inner layer)

[0043] An adhesive was applied to the external surface of a cylindrical pipe 2 (diameter: 21 mm, width: 1250 mm) made of aluminum, to form a first adhesive layer 3. Then, an unvulcanized NBR composition was extruded in layer form

onto the first adhesive layer 3, and then vulcanized, thereby to form a first rubber layer 4. The external surface of the first rubber layer 4 formed was ground. The thickness of the first rubber layer was 4.63 mm.

(b) Formation of second rubber layer (outer layer)

[0044] An adhesive was applied to the external surface of the first rubber layer 4 after the grinding in (a) above, to form a second adhesive layer 5. A rubber tube was formed separately with use of an unvulcanized NBR composition. The rubber tube obtained was attached onto the second adhesive layer 5 so as to coat the external surface of the second adhesive layer 5, and then vulcanized, thereby to form a second rubber layer 6. After the external surface of the second rubber layer 6 was ground, the elastic layer was cut together with the pipe to have a predetermined width, thereby to obtain a spinning roller 1. The thickness and hardness of the second rubber layer were 0.77 mm and 70°, respectively. The thickness of the whole rubber layer (elastic layer) including the first rubber layer and the second rubber layer was 5.4 mm. The ratio of a thickness T_2 of the second rubber layer to a thickness T_1 of the first rubber layer: T_2/T_1 was 1/6.
[0045] Here, the hardnesses of the first rubber layer and the second rubber layer were measured in the following manner.
[0046] First, with use of the respective NBR compositions used in the formations of the first and second rubber layers, 12.5 mm-thick test pieces were produced as defined in "Durometer hardness test" of JIS-K6253 "Rubber, vulcanized or thermoplastic - Determination of hardness". Then, the test pieces obtained were measured with a Type A durometer in compliance with "Durometer hardness test" as standardized in the above-mentioned JIS-K6253.

(2) Evaluation

[0047] The apparent hardness and nip width of the spinning roller obtained in (1) above were evaluated by the following procedures.

(a) Apparent hardness

[0048] The apparent hardness, corresponding to the hardness of the whole rubber layer (elastic layer) including the first and second rubber layers, was measured by pressing a Type A durometer against the surface of the second rubber layer of the spinning roller.

(b) Nip width

[0049] Two metal plates were used to hold the spinning roller therebetween, with the plates being parallel to each other; and a load of 16 kgf (□ 157 N) was applied to the roller. With the load applied to the roller, the width (nip width) of the contact face between one of the metal plates and the roller was measured.
[0050] Fig. 3 is a schematic illustration to describe a method of measuring the nip width. To describe the method in detail, first, a roller R is held between a metal plate P1 and a metal plate P2 that are disposed below and above the roller R, respectively, as illustrated in Fig. 3. Then, a load of 16 kgf (□ 157 N) is applied to the roller R from above, via the metal plate P2. as indicated by the arrow in Fig. 3. Due to applying the load, the roller R becomes slightly distorted in a horizontal direction, and this causes the respective contact faces between the roller R and the metal plates P1 and P2 to increase. A width W of the contact face between the distorted roller R and the metal plate P1 disposed below the roller R is measured, and then evaluated as the nip width.

[Example 2]

[0051] Except for changing the ratio of the thickness T_2 of the second rubber layer to the thickness T_1 of the first rubber layer: T_2/T_1 to 1/2, a spinning roller was produced as in Example 1, the thickness of the whole rubber layer therein being 5.4 mm.

[Example 3]

[0052] Except for changing the ratio of the thickness T_2 of the second rubber layer to the thickness T_1 of the first rubber layer: T_2/T_1 to 1/1, a spinning roller was produced as in Example 1, the thickness of the whole rubber layer therein being 5.4 mm.

[Comparative Example 1]

[0053] As in (a) in Example 1, a vulcanized rubber layer with a hardness of 70° was formed on the external surface of the cylindrical pipe via the first adhesive layer 3, followed by grinding of the external surface of the rubber layer formed, thereby to produce a spinning roller having a rubber layer with a single-layer structure and a thickness of 5.4 mm.

[Comparative Example 2]

[0054] As in (a) in Example 1, a vulcanized rubber layer with a hardness of 65° was formed on the external surface of the cylindrical pipe via the first adhesive layer 3, followed by grinding of the external surface of the rubber layer formed, thereby to produce a spinning roller having a rubber layer with a single-layer structure and a thickness of 5.4 mm.

[Comparative Example 3]

[0055] Except for changing the ratio of the thickness T_2 of the second rubber layer to the thickness T_1 of the first rubber layer: T_2/T_1 to 6/1, a spinning roller was produced as in Example 1, the thickness of the whole rubber layer therein being 5.4 mm.

[Comparative Example 4]

[0056] Except for changing the ratio of the thickness T_2 of the second rubber layer to the thickness T_1 of the first rubber layer: T_2/T_1 to 2/1, a spinning roller was produced as in Example 1, the thickness of the whole rubber layer therein being 5.4 mm.

[0057] For Examples 2 and 3 and Comparative Examples 1 to 4, the apparent hardnesses and the nip widths were measured as in Example 1. The results are shown in Table 1.

[Table 1]

	T_2/T_1	Hardness of inner layer (°)	Hardness of outer layer(°)	Apparent hardness(°)	Nip width(mm)
Ex.1	1:6	35	70	55	15.9
Ex.2	1:2	35	70	65	14.1
Ex.3	1:1	35	70	70	12.4
Comp.Ex.1	-	-	-	70	9.7
Comp.Ex.2	-	-	-	65	11.0
Comp.Ex.3	6:1	35	70	72	10.2
Comp.Ex.4	2:1	35	70	71	11.1

[0058] As shown in Table 1, the apparent hardnesses of the roller of Example 2 and the roller of Comparative Example 2 were both the same, being 65°. However, the nip width in Example 2 was longer than that in Comparative Example 2. and a widening of the nip width was observed.

[0059] Likewise, the apparent hardnesses of the roller of Example 3 and the roller of Comparative Example 1 were both the same, being 70°. However, the nip width in Example 3 was longer than that in Comparative Example 1, and a widening of the nip width was observed.

[0060] Moreover, comparing the roller of Example 3 with the rollers of Comparative Examples 3 and 4, despite the apparent hardnesses being close, a considerable difference was observed between the nip widths.

[0061] Although the present invention has been described in terms of the presently preferred embodiments, it is to be understood that such disclosure is not to be interpreted as limiting. Various alterations and modifications will no doubt become apparent to those skilled in the art to which the present invention pertains, after having read the above disclosure. Accordingly, it is intended that the appended claims be interpreted as covering all alterations and modifications as fall within the true spirit and scope of the invention.

[Industrial Applicability]

[0062] The spinning roller of the present invention can be used in processes in spinning such as combing, drawing, roving, and spinning; and is also expected to be used in a wide range of applications.

[Explanation of Reference Numerals]

[0063]

1 spinning roller
2 pipe
3 first adhesive layer
4 first rubber layer
5 second adhesive layer
6 second rubber layer
7 arbor

Claims

1. A spinning roller comprising:

a cylindrical pipe; and
a cylindrical elastic layer fixed to an external surface of the pipe,
the elastic layer including:

a first rubber layer on an inner side; and
a second rubber layer on an outer side, fixed to the first rubber layer,
a hardness of the first rubber layer being 48° or less,
a hardness of the second rubber layer being 60° or more,
a thickness of the elastic layer being 2 to 20 mm, and
a ratio of a thickness T_2 of the second rubber layer to a thickness T_1 of the first rubber layer: T_2/T_1 being 1/1 to 1/10.

2. The spinning roller in accordance with claim 1,
wherein the hardness of the first rubber layer is 30° to 45°, and the hardness of the second rubber layer is 65° to 95°.

3. The spinning roller in accordance with claim 2,
wherein the hardness of the first rubber layer is 30° to 38°, and the hardness of the second rubber layer is 65° to 73°.

4. The spinning roller in accordance with any one of claims 1 to 3, wherein the thickness T_1 of the first rubber layer is 1.5 to 10 mm.

5. The spinning roller in accordance with any one of claims 1 to 4, wherein the thickness of the elastic layer is 3 to 20 mm.

6. The spinning roller in accordance with any one of claims 1 to 5, wherein the ratio T_2/T_1 is 1/3 to 1/6.

FIG. 1

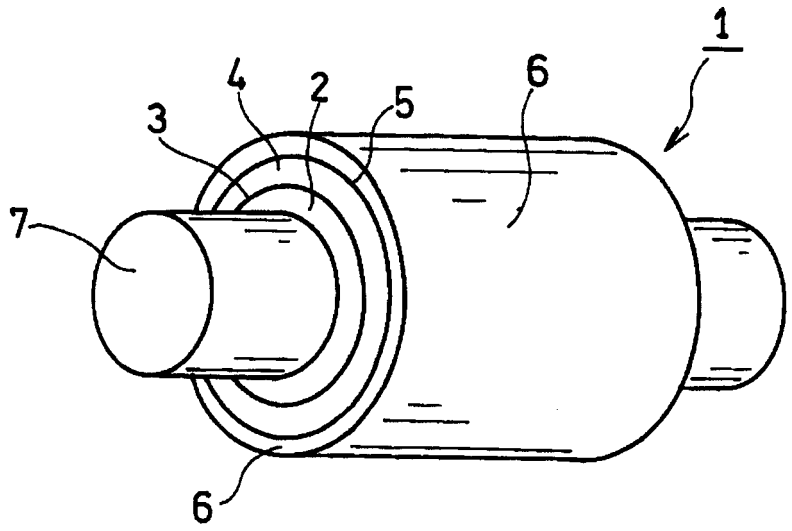


FIG. 2

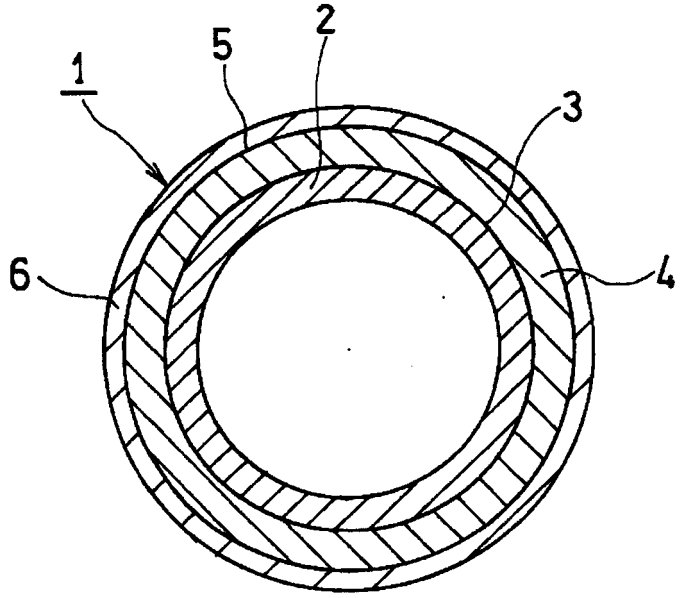
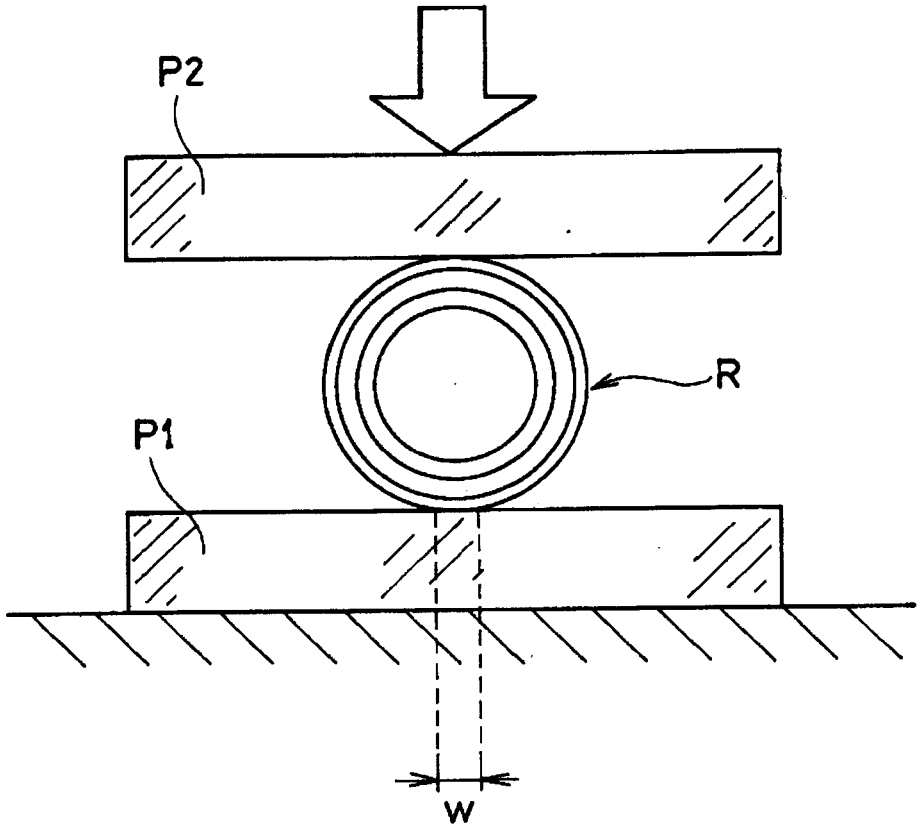


FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/004174

A. CLASSIFICATION OF SUBJECT MATTER
D01H5/80(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)
D01H1/00-17/02, D01G1/00-99/00

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 1996-2013
Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

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 2007-138342 A (Yamauchi Corp.), 07 June 2007 (07.06.2007), paragraphs [0013] to [0015], [0020] to [0023]; fig. 1 to 3 (Family: none)	1-6
A	JP 50-089644 A (Yamauchi Gum Kogyo Kabushiki Kaisha), 18 July 1975 (18.07.1975), page 1, lower right column, line 19 to page 2, upper right column, line 5 (Family: none)	1-6

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

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4550478 A (Armstrong World industries, Inc., Lancaster, Pa.), 05 November 1985 (05.11.1985), column 2, lines 16 to 29; drawings (Family: none)	1-6

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Patent documents cited in the description

- JP 2007138342 A **[0003]**
- JP 1685634 A **[0003]**