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(72) Inventor: **Imamura, Hisakatsu**
Kyoto, 612-8686 (JP)

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastraße 4
81925 München (DE)

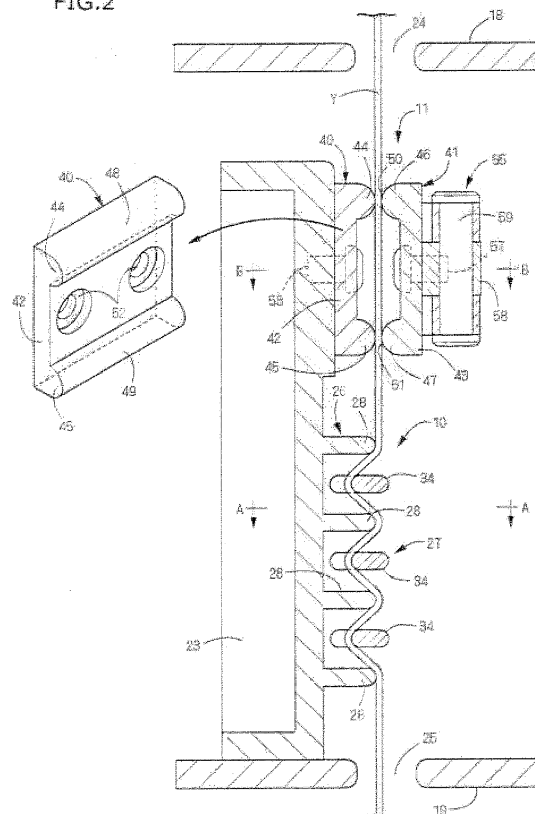
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(71) Applicant: **Murata Machinery, Ltd.**
Minami-ku
Kyoto-shi
Kyoto 601-8326 (JP)

(54) **Hairiness reducing device and yarn winding device**

(57) A hairiness reducing device includes multiple pairs of press-contact members arranged along a yarn path of a yarn being wound on the winding unit. Each pair of the press-contact members is formed by a first press-contact member that includes a first yarn contacting portion and a second press-contact member that includes a second yarn contacting portion arranged with the yarn path interposed therebetween. At least one of a set of first press-contact members and a set of second press-contact members includes a moving mechanism for moving one of the sets relative to the other set. The yarn contacting portions retain the yarn by sandwiching the yarn. In each pair of the press-contact members, the first yarn contacting portion is a protrusion arcuate along the yarn path, while the second yarn contacting portion is either a flat surface along the yarn path or a protrusion arcuate along the yarn path.

FIG.2



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a hairiness reducing device that removes hairs protruding out of a surface of the yarn when the yarn fed from a yarn feeding bobbin is wound on a winding unit, and to a yarn winding device that includes the hairiness reducing device.

2. Description of the Related Art

[0002] Generally, when a yarn winding device such as an automatic winder winds a yarn fed from a yarn feeding bobbin to form a package, because the yarn touches a guiding portion or the like while the yarn unwound from the yarn feeding bobbin is being wound, hairiness arising in the wound yarn cannot be avoided. Examples of conventional techniques for controlling occurrence of such hairiness include a hairiness suppressing device in an automatic winder disclosed in Japanese published unexamined application No. 2001-139231 and a hairiness control device disclosed in Japanese published unexamined application No. 2002-348042.

[0003] The hairiness suppressing device disclosed in Japanese published unexamined application No. 2001-139231 includes a yarn passage, through which a yarn passes, and a nozzle unit having holes, through which air is jetted to produce a swirl flow in the yarn passage. By jetting air into the yarn passage, the yarn is ballooned causing yarn hairs protruding from the yarn to be entangled with the yarn and suppressed. On the other hand, the hairiness control device disclosed in Japanese published unexamined application No. 2002-348042 includes a plurality of friction disks that is rotated to apply false twisting onto a running yarn, thereby causing yarn hairs protruding from a surface of the yarn to be entangled with fibers that form the yarn. Each of these devices is capable of suppressing hairiness that arises while a yarn unwound from a yarn feeding bobbin is wound in a package form.

[0004] Meanwhile, such yarn winding devices typically include, as a means that allows smooth running and winding of the yarn, a tension applying device (tension device) that applies a tension on a running yarn. Such a device is described in Japanese published unexamined application No. 2001-139231.

[0005] The hairiness suppressing device disclosed in Japanese published unexamined application No. 2001-139231 requires not only air and the nozzle unit for causing a yarn to swivel but also an air supply unit (including an air passage, and a compressor that serves as an air supply source). To obtain sufficient hairiness suppression effect, it is necessary to arrange at least near an inlet or an outlet of the yarn passage a twisting stopping unit that practically prevents twisting of the yarn

caused by the swirl flow from propagating at least towards the inlet or the outlet of the yarn passage. This arrangement inevitably results in more air consumption and an increase in complexity in device configuration and mechanism.

[0006] In the hairiness control device disclosed in Japanese published unexamined application No. 2002-348042, it is necessary to arrange the friction disks in a predetermined state to apply false twisting onto a running yarn. Additionally, it is necessary to arrange a plurality of driving shafts for driving the friction disks, and a rotation-driving device (such as a motor) that drives the disks by rotating the driving shafts. Hence, the hairiness control device disclosed in Japanese published unexamined application No. 2002-348042 is also disadvantageous in being complicated in device configuration and mechanism.

[0007] Meanwhile, when a yarn is wound as discussed above, protruding hairs of various lengths, from protruding hairs equal to or shorter than 1 millimeter (mm) to protruding hair equal to or longer than 10 mm, are produced. Some users demand yarns that particularly have less quantity of relatively longer hairs that are equal to or longer than 3 mm. However, conventional hairiness suppressing devices and the like are not configured to suppress the amount of such relatively longer protruding hairs that are equal to or longer than 3 mm with emphasis on such protruding hairs, and therefore have insufficiently responded to the user's demand.

SUMMARY OF THE INVENTION

[0008] It is an object of the present invention to provide a hairiness reducing device capable of removing protruding hairs (in particular, relatively longer protruding hairs that are equal to or longer than 3 mm; the same applies hereinafter), that are produced when a yarn fed from a yarn feeding bobbin is wound to form a package, with a relatively simple configuration and mechanism, and a yarn winding device (automatic winder or the like) including the hairiness reducing device. It is another object of the present invention to provide a yarn winding device or the like that is capable of removing protruding hairs, that are produced when a yarn fed from a yarn feeding bobbin is wound to form a package, with a relatively simple configuration and mechanism, and furthermore, capable of storing removed protruding hairs (fluff) at one location to facilitate fluff-removal operation to be performed later. It is still another object of the present invention to provide a yarn winding device or the like that is capable of removing protruding hairs, that are produced when a yarn fed from a yarn feeding bobbin is wound to form a package, with a relatively simple configuration and mechanism, and furthermore, that is easy to perform adjustment necessary for fluff removal. It is still another object of the present invention to provide a yarn winding device and the like capable of removing protruding hairs, that are produced when a yarn fed from a yarn feeding bobbin is

wound to form a package, with a relatively simple configuration and mechanism, and furthermore, capable of applying a tension of a magnitude appropriate for both removal of protruding hairs and winding of a running yarn. It is still another object of the present invention to provide a yarn winding device or the like that is capable of removing protruding hairs that are produced when a yarn fed from a yarn feeding bobbin is wound to form a package, with a relatively simple configuration and mechanism, and furthermore, that includes a smaller number of driving sources than that of an automatic winder or the like that includes a conventional hairiness suppressing device, thereby achieving cost reduction corresponding to the reduced number of the driving sources.

[0009] To accomplish the objects, hairiness reducing device and yarn winding device according to aspects of the present invention are configured as described below.

[0010] According to an aspect of the present invention, a hairiness reducing device includes a plurality of pairs of press-contact members that are arranged along a yarn path, along which a yarn that is wound on a winding unit runs. Each pair of the press-contact members is formed by a first press-contact member and a second press-contact member arranged with the yarn path interposed therebetween. At least one of a set of first press-contact members and a set of second press-contact members that form the pairs of press-contact members includes a moving mechanism for moving one of the set of first press-contact members and the set of second press-contact members relative to remaining one of the set of first press-contact members and the set of second press-contact members. Each of the first press-contact members includes a first yarn contacting portion, each of the second press-contact members includes a second yarn contacting portion, and the first yarn contacting portions and the second yarn contacting portions retain the yarn by sandwiching the yarn. The first yarn contacting portion in each pair of press-contact members is a protrusion that is arcuate along the yarn path. The second yarn contacting portion in each pair of press-contact members is a protrusion that is arcuate along the yarn path.

[0011] According to another aspect of the present invention, a hairiness reducing device includes a plurality of pairs of press-contact members that are arranged along a yarn path, along which a yarn that is wound on a winding unit runs. Each pair of the press-contact members is formed by a first press-contact member and a second press-contact member arranged with the yarn path interposed therebetween. At least one of a set of first press-contact members and a set of second press-contact members that form the pairs of press-contact members includes a moving mechanism for moving one of the set of first press-contact members and the set of second press-contact members relative to remaining one of the set of first press-contact members and the set of second press-contact members. Each of the first press-contact members includes a first yarn contacting portion, each of the second press-contact members includes a

second yarn contacting portion, and the first yarn contacting portions and the second yarn contacting portions retain the yarn by sandwiching the yarn. The first yarn contacting portion in each pair of press-contact members is a protrusion that is arcuate along the yarn path. The second yarn contacting portion in each pair of press-contact members is a flat surface along the yarn path.

[0012] Other features, elements, processes, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the present invention with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

FIG. 1 is an elevation view illustrating an overall configuration of a yarn winding device according to a first embodiment of the present invention;

FIG. 2 is a longitudinal cross-sectional view illustrating a configuration of and around a hairiness reducing device provided in the yarn winding device;

FIG. 3 is a plan view illustrating a state where a movable gate member and a movable press-contact element are at an operating position;

FIG. 4 is a plan view illustrating a state where the movable gate member and the movable press-contact element are at a standby position;

FIG. 5 is a side view as viewed along an arrow C of FIG. 4;

FIG. 6 is a cross-sectional view taken along a line A-A of FIG. 2;

FIG. 7 is a cross-sectional view taken along a line B-B of FIG. 2;

FIGS. 8A and 8B illustrate a pair of press-contact elements (press-contact members and the like) according to a second embodiment of the present invention where FIG. 8A is an elevation view as viewed from facing surfaces of the press-contact elements and FIG. 8B is a longitudinal cross-sectional view;

FIGS. 9A and 9B illustrate a pair of press-contact elements (press-contact members and the like) according to a third embodiment of the present invention where FIG. 9A is an elevation view as viewed from facing surfaces of the press-contact elements and FIG. 9B is a longitudinal cross-sectional view;

Each of FIGS. 10A to 10E illustrates a pair of press-contact elements according to Comparative Example of the present invention where FIG. 10A illustrates Comparative Example 1, FIG. 10B illustrates Comparative Example 2, FIG. 10C illustrates Comparative Example 3, FIG. 10D illustrates Comparative Example 4, and FIG. 10E illustrates Comparative Example 5; and

FIG. 11 is a table illustrating results of tests conducted to verify effects of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Exemplary embodiments of the present invention are explained below in detail with respect to the accompanying drawings.

First Embodiment

[0015] FIGS. 1 to 7 illustrate a yarn winding device 1 (automatic winder) according to a first embodiment of the present invention. As illustrated in FIG. 1, the yarn winding device 1 includes a rectangular-box-shaped main body frame 2. A bobbin support unit 3, an unwinding assisting device 4, a tension applying unit 5, a tension sensor 6, a yarn joining device 7, a slab catcher 8, a winding unit 9 and the like are arranged on a left-hand side, in FIG. 1, of the main body frame 2 along a yarn path, which extends vertically upward, of a yarn Y so that the yarn Y fed from a yarn feeding bobbin B supported by the bobbin support unit 3 is wound to form a package P. The tension applying unit 5 includes, in addition to a tension device 10, a hairiness reducing device 11 that is one feature of the present invention.

[0016] The unwinding assisting device 4 reduces an increase in tension, which increases as a remaining yarn amount on the yarn feeding bobbin B decreases, on the yarn Y, thereby assisting unwinding of the yarn Y from the yarn feeding bobbin B. The tension device 10 of the tension applying unit 5 applies a predetermined tension (which will be described later) on the yarn Y fed and delivered from the yarn feeding bobbin B. The tension sensor 6, provided in the yarn path of the yarn Y at a position downstream of the tension applying unit 5, measures a tension on the yarn Y and outputs a measured value. As the tension sensor 6, a sensor that measures a tension on the yarn Y laid across two fixed rods and a movable rod could be used. The movable rod is located between the fixed rods and the yarn Y exerts a force on the movable rod.

[0017] When the slab catcher 8 detects a yarn defect, the yarn joining device 7 cuts the yarn Y to remove a defective portion of the yarn Y and splices a lower yarn coming from the yarn feeding bobbin B to an upper yarn going to the package P. For this splicing, a relay pipe 12 that catches the lower yarn and passes the caught lower yarn to the yarn joining device 7 and a suction mouth 13 that catches the upper yarn and passes the caught upper yarn to the yarn joining device 7 are assembled onto the main body frame 2 in a manner that allows each of the relay pipe 12 and the suction mouth 13 to swing. The yarn Y is introduced into the tension device 10 in a process where the relay pipe 12 passes the lower yarn to the yarn joining device 7. The winding unit 9 includes a traversing drum 14 that causes the yarn Y to travel across (traverse) a predetermined width range and a cradle 16 that supports a winding core 15 of the package P.

[0018] As illustrated in FIGS. 2 and 3, a pair of an upper

plate-like bracket 18 and a lower plate-like bracket 19 is attached to the tension applying unit 5, on one side of an auxiliary frame 17 fixed to the main body frame 2. The upper plate-like bracket 18 and the lower plate-like bracket 19 are separated by a predetermined distance. In addition to the tension device (tension applying device) 10 and the hairiness reducing device 11 that is the feature of the present invention, a pair of an upper swinging member 20 and a lower swinging member 21, a driving mechanism (moving mechanism) 22, and a box-shaped casing 23, which has an opening in its back surface, that belong to the tension device 10 and the hairiness reducing device 11 are arranged between the brackets 18 and 19. An introducing groove 24 and an introducing groove 25 elongated in a front-to-rear direction of FIG. 3 are formed in the bracket 18 and the bracket 19, respectively, with openings of the introducing grooves 24 and 25 at front edges of the brackets 18 and 19. The lower yarn caught by the relay pipe 12 is guided from a frontward position relative to the tension device 10 by the introducing grooves 24 and 25 and introduced into a gap between a movable gate member 27 and a fixed gate member 26 situated at a standby position that will be described later. Thus, an upper end of the lower yarn is passed on to the yarn joining device 7.

[0019] As illustrated in FIGS. 2 to 4, the tension device 10 includes the comb-like fixed gate member 26, the comb-like movable gate member 27, the lower swinging member 21 discussed above, the driving mechanism 22 discussed above, and the casing 23. The driving mechanism 22 can move the movable gate member 27 to switch its positions between an operating position (the position illustrated in FIG. 3) and the standby position (the position illustrated in FIG. 4). When the movable gate member 27 is at the operating position, the movable gate member 27 cooperates with the fixed gate member 26 to pinch the yarn Y therebetween, thereby applying tension on the yarn Y, whereas, when the movable gate member 27 is at the standby position, the movable gate member 27 is separated from the fixed gate member 26 to be ready for receiving the yarn Y introduced into the gap between the movable gate member 27 and the fixed gate member 26. Meanwhile, the tension device 10 includes an open-close sensor (not shown) that detects the current position of the movable gate member 27. Specifically, the open-close sensor detects whether the movable gate member 27 is at the operating position or at the standby position.

[0020] As illustrated in FIGS. 2 to 4, 6, and 7, the fixed gate member 26 fixed to an outer surface of a right side wall (on the right-hand side in FIGS. 2 to 4, 6, and 7) of the casing 23 includes a plurality of (in the illustrated example, four) horizontal fixed comb teeth 28 that are horizontally arranged. Each of the fixed comb teeth 28 includes a rounded front-end portion for smooth introduction of the yarn Y, and at a rear portion, a semicircular projecting portion 29 for preventing the yarn Y from moving rearward.

[0021] As illustrated in FIG. 6, the lower swinging member 21 is substantially L-shaped as viewed from above. The lower swinging member 21 includes a central boss 31 that is pivotally supported on a spindle 30. The spindle 30 is fixed to the lower bracket 19. This configuration allows the lower swinging member 21 to pivot about the spindle 30. A first end of the lower swinging member 21 is configured as an attaching portion 32 for attaching the movable gate member 27. A second end, or the other end, of the lower swinging member 21 is configured as an operated portion 33 that is swung by a first lever 67 or a second lever 68. The first lever 67 and the second lever 68 will be described later.

[0022] The movable gate member 27 includes a plurality of (in the illustrated example, three) horizontal movable comb teeth 34 provided on the attaching portion 32 of the lower swinging member 21. The movable comb teeth 34 and the fixed comb teeth 28 are arranged in a staggered manner. Each of the movable comb teeth 34 includes a curved portion at a position lateral to the projecting portion 29 of a corresponding one of the fixed comb teeth 28. When the curved portions of the movable comb teeth 34 and the curved portions of the fixed comb teeth 28 cooperate with each other to pinch the yarn Y therebetween, the curved shape of the movable comb teeth 34 prevents the yarn Y from moving forward. When the movable gate member 27 is at the operating position, the movable gate member 27 cooperates with the fixed gate member 26 to pinch the yarn Y therebetween and apply tension on the yarn Y, whereas when the movable gate member 27 is at the standby position, the movable gate member 27 is separated from the fixed gate member 26 to be ready for receiving the yarn Y introduced into the gap between the movable gate member 27 and the fixed gate member 26.

[0023] The hairiness reducing device 11 provided in the tension applying unit 5 is discussed below.

[0024] As illustrated in FIGS. 2, 3, and 7, the hairiness reducing device 11 includes a pair of press-contact elements 40 and 41 arranged to face each other across the yarn path of the yarn Y that is wound on the winding unit 9, the upper swinging member 20, and the driving mechanism 22. The driving mechanism 22 is shared by the hairiness reducing device 11 and the tension device 10 discussed above.

[0025] In the first embodiment, each of the press-contact elements 40 and 41 is made of ceramics and is rectangular as viewed from the side of facing surfaces (the side where the yarn Y is pinched) of the press-contact elements 40 and 41 as illustrated in FIG. 2. Each of the press-contact elements 40 and 41 includes a plate-like portion. The plate-like portion of the press-contact element 40 is referred to as a first plate member 42, while the plate-like portion of the press-contact element 41 is referred to as a second plate member 43. Two pairs of press-contact portions 44, 45, 46, and 47 are provided on the facing surfaces of the press-contact elements 40 and 41. Specifically, the press-contact portions 44 and

46, which form an upper pair, are provided along upper edges of the facing surfaces, while the press-contact portions 45 and 47, which form a lower pair, are provided along lower edges of the facing surfaces. The upper and lower pairs of press-contact portions 44, 45, 46, and 47 extend in a direction orthogonal to the yarn path of the yarn Y. The upper and the lower pairs of press-contact portions are separated from each other by a predetermined distance in a direction along the yarn path (a vertical direction in FIG. 2). Yarn contacting portions 48, 49, 50, and 51 are formed on facing surfaces of the press-contact portions 44, 45, 46, and 47, respectively. In the first embodiment, each of the yarn contacting portions 48, 49, 50, and 51 is a protrusion that is arcuate along the yarn path of the yarn Y as viewed in a direction orthogonal to the sheet plane of FIG. 2. The protrusions are identical in shape. Screw through holes 52 for fixing the press-contact element 40 to the casing 23 illustrated in FIG. 2 and screwing the press-contact element 41 to a connecting unit 55 illustrated in FIG. 7 are defined in the plate members 42 and 43. The screw through holes 52 in the plate member 42 are located between the press-contact portions (first press-contact members) 44 and 45, while the screw through holes 52 in the plate member 43 are located between the press-contact portions (second press-contact members) 46 and 47. In the first embodiment, the plate member 42 provided in the press-contact element 40 and the press-contact portions 44 and 45 are made of the same material (in the first embodiment, ceramics) in one piece, while the plate member 43 provided in the press-contact element 41 and the press-contact portions 46 and 47 are made of the same material (in the first embodiment, ceramics) in one piece. These elements can be formed as separate members and/or of material other than ceramics.

[0026] In the first embodiment, among the press-contact elements 40 and 41, the press-contact element 40 functions as a fixed press-contact element 40, while the press-contact element 41 functions as a movable press-contact element 41. The fixed press-contact element 40 is fixed with screws 53 to an upper portion of the outer surface of the right side wall of the casing 23, on which the fixed gate member 26 is provided, with the first plate member 42 therebetween. As illustrated in FIGS. 2, 3, and 7, the movable press-contact element 41 is attached to the connecting unit 55 that is attached to an attaching portion 54 of the upper swinging member 20. The connecting unit 55 includes a first connecting member 56 fixed to the attaching portion 54 of the upper swinging member 20, a second connecting member 58 swingably coupled to the first connecting member 56, and a connecting shaft 59 that connects the first connecting member 56 and the second connecting member 58 together. The movable press-contact element 41 is fixed to the second connecting member 58 with screws 57. The connecting shaft 59 extends parallel to the spindle 30 that supports the swinging members 20 and 21 and the like discussed above. The second connecting member 58

and the movable press-contact element 41 attached to the second connecting member 58 are pivotable in one piece about the connecting shaft 59.

[0027] The upper swinging member 20 has a configuration similar to that of the lower swinging member 21. As illustrated in FIGS. 3 and 7, the upper swinging member 20 is substantially L-shaped as viewed from above. The upper swinging member 20 includes a central boss 60 that is pivotally supported on the spindle 30 that is fixed to the lower bracket 19. This configuration allows the upper swinging member 20 to pivot about the spindle 30. A first end of the upper swinging member 20 is formed as the attaching portion 54 for the first connecting member 56, while a second end, or the other end, of the upper swinging member 20 is formed as an operated portion 61 to be swung by the first lever 67 or the second lever 68 similar to the lower swinging member 21.

[0028] The driving mechanism 22 drives the movable gate member 27 and the movable press-contact element 41 with a single driving source. As illustrated in FIG. 3, the driving mechanism 22 includes a first actuator (driving source) 65 for opening/closing the movable gate member 27 and the movable press-contact element 41 to thereby effect switching between an open position and a closed position (the standby position and the operating position), a second actuator (driving source) 66 for adjusting torques of the upper and lower swinging members 20 and 21 and also torques at the movable gate member 27 and the movable press-contact element 41, the first lever 67 and the second lever 68 each pivotally supported on the spindle 30, a first tie rod 70 that is coupled at a first end to a first end of the first lever 67 and coupled at a second end to a rotary shaft 69 of the first actuator 65, and a second tie rod 72 that is coupled at a first end to a first end (pivot end) of the second lever 68 and coupled at a second end to a rotary shaft 71 of the second actuator 66. For example, each of the first actuator 65 and the second actuator 66 is a rotary solenoid.

[0029] As illustrated in FIGS. 3 and 5 to 7, first operating portions 73 causing the upper and lower swinging members 20 and 21 to pivot for switching between the open position and the closed position of the movable gate member 27 and the movable press-contact element 41 are provided at an upper portion and a lower portion of the first lever 67 on a first-end side of the first lever 67. A second operating portion 74 is provided at a bottom portion of the first lever 67 on a second-end side of the first lever 67. When the first lever 67 is pivoted about the spindle 30 counterclockwise in FIG. 4 to move the movable gate member 27 and the movable press-contact element 41 from the standby position illustrated in FIG. 4 to the operating position illustrated in FIGS. 3 and 6, the second operating portion 74 abuts on a second end of the second lever 68, causing the second lever 68 to also pivot counterclockwise in FIG. 4 about the spindle 30.

[0030] The second lever 68, which is forged in a substantial L-shape as viewed from above, includes a boss 75, which is supported on the spindle 30 at a portion on

a third-end side. An upper operating portion 76 and a lower operating portion 77 that correspond to the upper swinging member 20 and the lower swinging member 21, respectively, are provided at an upper portion and a lower portion, respectively, of the second lever 68 on the second-end side (see FIG. 5). The upper and lower operating portions 76 and 77 are arranged at vertical positions so that the upper and lower operating portions 76 and 77 face the operated portions 61 and 33 of the upper and lower swinging members 20 and 21, respectively. Elastic members (in the illustrated example, rubber) 78 and 79 are attached, respectively, to a facing surface of the operating portion 76 and a facing surface of the operating portion 77, the facing surfaces facing each other. A coupling unit 80 extending parallel to the operating portions 76 and 77 as viewed from above is provided on the second lever 68 at a position between the upper and lower operating portions 76 and 77. The first end of the second tie rod 72 is coupled to a distal end portion of the coupling unit 80. In a state where the movable gate member 27 and the movable press-contact element 41 are at the operating position illustrated in FIG. 3, when the second actuator 66 causes the second lever 68 to pivot counterclockwise in FIG. 3 about the spindle 30 via the second tie rod 72, the upper and lower operating portions 76 and 77 press the operated portions 61 and 33 on the upper and lower swinging members 20 and 21 with the elastic members therebetween. In contrast, when the second lever 68 is pivoted clockwise in FIG. 3, pressure exerted by the operating portions 76 and 77 is eased or released. Thus, the second actuator 66 can adjust torques of the upper and lower swinging members 20 and 21, and also a tension on the yarn Y and a force (nip force on the yarn Y) exerted by the press-contact element 41 on the yarn Y.

[0031] As each of the elastic members 78 and 79 attached to the upper and lower operating portions 76 and 77 of the second lever 68, it is desirable to use a member that appropriately achieves its purpose. More specifically, when the operated portions 61 and 33 are pressed against the upper and lower swinging members 20 and 21 with the elastic members 78 and 79 therebetween, the elastic member 78 should preferably achieve, at the upper swinging member 20, a torque appropriate for tension application performed by the movable gate member 27, while the elastic member 79 should preferably achieve, at the lower swinging member 21, a torque appropriate for removal of protruding hairs performed by the press-contact element 41.

[0032] The first actuator 65 and the second actuator 66 are driven under control by a control device 83 (see FIG. 1) that controls various units in the yarn winding device (automatic winder) 1. To open the movable gate member 27 and the movable press-contact element 41, rotary motive power of the first actuator 65 is transmitted to the movable press-contact element 41 and the movable gate member 27 via the movable press-contact element 41, the movable gate member 27, the upper and lower swinging members 20 and 21, and the like. When

the first actuator 65 is actuated from the state illustrated in FIGS. 3, 6, and 7, the first lever 67 pivots about the spindle 30 clockwise in FIGS. 3, 6, and 7, thereby moving the movable press-contact element 41 and movable gate member 27 for switching from the operating position illustrated in FIGS. 3, 6, and 7 to the standby position illustrated in FIG. 4.

[0033] To close the movable gate member 27 and the movable press-contact element 41, rotary motive power exerted by the first actuator 65 is transmitted to the movable press-contact element 41 and the movable gate member 27 via the first tie rod 70, the first lever 67, the second lever 68, the upper and lower swinging members 20 and 21, and the like. When the first actuator 65 is actuated from the state illustrated in FIG. 4, the first lever 67 pivots about the spindle 30 counterclockwise in FIG. 4. This causes the second operating portion 74 of the first lever 67 to abut on the second end of the second lever 68, which in turn pivots about the spindle 30. When the second lever 68 has pivoted in this way, the elastic members 79 and 78 arranged on the second lever 68 abut on the operated portions 61 and 33 of the upper and lower swinging members 20 and 21, causing the swinging members 20 and 21 to also pivot about the spindle 30. Thus, the movable press-contact element 41 and the movable gate member 27 move to switch from the standby position to the operating position.

[0034] When the movable press-contact element 41 and the movable gate member 27 have reached the operating position, the second actuator 66 is driven. Rotary motive power of the second actuator 66 is transmitted to the movable press-contact element 41 and the movable gate member 27 via the second tie rod 72, the second lever 68, the upper and lower swinging members 20 and 21, and the like to perform more subtle adjustment of the operating position of the movable press-contact element 41 and the movable gate member 27. As a result, as illustrated in FIGS. 2 and 6, the movable comb teeth 34 and the fixed comb teeth 28 are staggered in a predetermined arrangement. The yarn Y is pinched between the comb teeth 28 and 34 producing zigzag bent portions in the yarn Y. A tension is applied on the yarn Y by a frictional force produced at the bent portions of the yarn Y. As illustrated in FIGS. 2 and 7, the yarn Y is also pinched between the yarn contacting portion (first yarn contacting portion) 49, which is the arcuate protrusion of the fixed press-contact element 40, and the yarn contacting portion (second yarn contacting portion) 51, which is the arcuate protrusion of the movable press-contact element 41. Protruding hairs are plucked from a surface of the yarn Y because the surface of the running yarn Y is rubbed against the yarn contacting portions 49 and 51 where the yarn Y has been pinched.

[0035] The control device 83 adjusts a voltage (electric current) applied on the second actuator 66 depending on the tension value output from the tension sensor 6 to control the torques at the movable press-contact element 41 and the movable gate member 27 so that an appro-

priate tension is applied on the yarn Y, and an appropriate force, or pressure, is exerted by the first and second yarn contacting portions 49 and 51 on the yarn Y. The control device 83 adjusts the tension on the yarn Y by controlling driving of the second actuator 66 depending on the tension value output from the tension sensor 6.

[0036] In the yarn winding device 1 configured as discussed above, when the yarn Y is run upward as shown in FIG. 1, in a state where the movable gate member 27 and the movable press-contact element 41 are at the operating position, in order that the yarn Y fed from the yarn feeding bobbin B supported by the bobbin support unit 3 is wound on the winding unit 9 to form the package P, the yarn Y is wound on the winding unit 9 under a tension of a predetermined magnitude that is applied by the tension device 10. While the yarn Y is being wound in this way, the yarn Y contacts a guiding portion and the like. Accordingly, protruding hairs of various lengths, from short protruding hairs equal to or shorter than 1 mm to long protruding hairs equal to or longer than 10 mm, are produced on the surface of the yarn Y that has passed through the tension device 10.

[0037] After passing through the tension device 10, the yarn Y with the protruding hairs passes through the hairiness reducing device 11 arranged above the tension device 10. While the yarn Y passes through the hairiness reducing device 11, relatively longer protruding hairs equal to or longer than 3 mm are removed from the yarn Y as discussed below. The yarn Y that runs along the yarn path is pinched between the yarn contacting portions 49 and 51 of the pair of the press-contact elements 40 and 41 provided in the hairiness reducing device 11. When the yarn Y in the pinched state passes through a nip between the yarn contacting portions 49 and 51, a frictional force is applied to the protruding hairs on the surface of the yarn Y to remove the protruding hairs by plucking the protruding hairs.

[0038] In this removal, if the force (nip force) exerted on the yarn Y in the nip between the yarn contacting portions 49 and 51 is too strong, the surface of the yarn Y is roughened, which adversely produces the protruding hairs. Moreover, if the contact area with the yarn Y is larger, a distance, over which the surface of the yarn Y is rubbed, increases, which also adversely produces the protruding hairs. Tensions of the same magnitude are applied on the yarn Y by the first actuator 65 via the lower swinging member 21 and the movable gate member 27. Moreover, forces of the same magnitude are exerted on the yarn Y via the upper swinging member 20 and the movable press-contact element 41 for removal of protruding hairs.

[0039] However, if the yarn Y is pinched between pointed protrusions, a contact area where contact with the yarn Y to be made is considerably small, causing the pressure (nip force) to be concentrated on the contact area. The thus-concentrated strong force roughens the yarn and adversely produces the protruding hairs. When an increase in an amount of the protruding hairs resulting

from such production of protruding hairs is greater than a decrease in an amount of the protruding hairs resulting from protruding-hair plucking, a total amount of the protruding hairs disadvantageously increases. If the contact area with the yarn is too large, concentration of the pressure (nip force) will not occur. In such a case, a force of a magnitude necessary for plucking the protruding hairs cannot be obtained. Furthermore, the larger the contact area where contact with the yarn Y is to be made, the longer the distance, over which the surface of the yarn Y is rubbed. This results in an increase in the amount of protruding hairs. A difference between the decrease in the amount of the protruding hairs due to the protruding-hair plucking and the increase in the amount due to the production of the protruding hairs is measured as a resultant amount of the protruding hairs. However, when a hairiness reducing unit has a flat contact area where contact with a yarn is to be made, sufficient hairiness reducing effect will not be obtained.

[0040] In contrast, in the hairiness reducing device 11 configured as discussed above, each of the upper first and second yarn contacting portions 48 and 50 and the lower first and second yarn contacting portions 49 and 51 of the pair of press-contact elements 40 and 41 that are arranged with the yarn path interposed therebetween is the arcuate protrusion extending orthogonal to the yarn path of the yarn Y and configured to pinch the yarn Y between the facing protrusions. With this configuration, although a direct contact between the facing arcuate protrusions is a curved-surface-to-curved-surface contact, a contact between the protrusions and the yarn Y that passes through the nip, in the state of being pinched between the protrusions in the direction orthogonal to the protrusions, is a line contact that is close to a point contact. When the yarn Y is pinched between the arcuate protrusions that are placed at the two, or upper and lower, positions separated by a predetermined distance is run in such a line-contact state close to a point-contact state, in spite that the contact area where contact with the yarn Y is to be made is relatively small, concentration of the pressure (nip force) does not occur in contrast to a configuration where a yarn is pinched between the pointed protrusions. The relatively small contact area where a contact with the yarn Y is to be made not only provides a plucking force of a required magnitude but also prevents an increase in the amount of the protruding hairs, which can occur when the distance, over which the surface of the yarn Y is rubbed, is elongated. In addition, long protruding hairs are more readily plucked off from a yarn than short protruding hairs because a larger frictional force is applied on the long protruding hairs when the yarn passes through the nip between the arcuate protrusions. Thus, the hairiness reducing device 11 discussed above and the yarn winding device 1 including the hairiness reducing device 11 are each capable of removing or suppressing relatively longer protruding hairs (protruding hairs equal to or longer than 3 mm) produced on the yarn Y being wound to form the package P.

[0041] The pair of press-contact elements 40 and 41 of the first embodiment is simple in configuration and configured such that the two pairs, or the upper and lower pairs, of the press-contact portions (press-contact members) 44, 45, 46, and 47 extending in the direction orthogonal to the yarn path are provided on and along the upper edges and the lower edges of the plate members 42 and 43, which are rectangular as viewed from the facing surfaces of the plate members 42 and 43. Hence, the press-contact elements 40 and 41 can be manufactured relatively easily. The hairiness reducing device 11 can be configured to temporarily store fluff in space between the two pairs, or the upper and lower pairs, of the press-contact portions (press-contact members) 44, 45, 46, and 47 so that the fluff is sucked by a suction device or the like provided in the yarn winding device 1.

Second Embodiment

[0042] FIGS. 8A and 8B are diagrams illustrating a pair of press-contact elements 85 and 86 according to a second embodiment of the present invention. Each of the press-contact elements 85 and 86 includes a plate-like portion that is circular as viewed from a side of facing surfaces (the side where the press-contact elements 85 and 86 contact a yarn) of the press-contact elements 85 and 86. The plate-like portion of the press-contact element 85 is referred to as a first plate member 87, while the plate-like portion of the press-contact element 86 is referred to as a second plate member 88. A ring-shaped press-contact portion (press-contact member) 89 and a ring-shaped press-contact portion (press-contact member) 90 are provided facing each other on the press-contact element 85 and the press-contact element 86, respectively, along rims of the facing surfaces. Yarn contacting portions 91 and 92 that come into contact with a yarn to retain the yarn are formed on the facing surfaces of the press-contact portions 89 and 90. Each of yarn contacting portions 91 and 92 includes a protrusion that is arcuate in a cross section of the press-contact element 85 or the press-contact element 86 taken along a radial direction. The screw through holes 52 for fixing the press-contact element 85 to the casing 23 illustrated in FIG. 2 and the press-contact element 86 to the connecting unit 55 illustrated in FIG. 7 are formed in central portions of the plate members 87 and 88 of the press-contact elements 85 and 86.

[0043] With this configuration, a running yarn can be pinched between the yarn contacting portion 91, which is the arcuate protrusion of the press-contact element 85, and the yarn contacting portion 92, which is also the arcuate protrusion of the press-contact element 86; furthermore, the yarn is pinched at two positions, or upper and lower positions, separated by a predetermined distance. Hence, similar to the first embodiment, it is possible to run a yarn in a state where the yarn makes a point contact against the yarn contacting portions 91 and 92. This leads to effective removal or suppression of rela-

tively longer protruding hairs (protruding hairs equal to or longer than 3 mm) produced on a yarn being wound to form a package. The press-contact elements 85 and 86 can be fabricated easily because they are simple in configuration. It is also possible to store fluff in a space S between the pair of press-contact elements 85 and 86.

Third Embodiment

[0044] FIGS. 9A and 9B are diagrams illustrating a pair of press-contact elements 93 and 94 according to a third embodiment of the present invention. In the third embodiment, the press-contact element 93, which is one of the pair of press-contact elements 93 and 94, is identical with the press-contact element 85 according to the second embodiment in configuration. Corresponding parts and elements are denoted by like reference numerals. Note that the configuration of the other one, or the press-contact element 94, differs from that according to the second embodiment. Specifically, although the press-contact element 94 of the third embodiment includes a press-contact portion (second press-contact member) 95 that faces the yarn path, a yarn contacting portion (second yarn contacting portion) 96 provided on the press-contact portion 95 is a flat surface along the yarn path. More specifically, a rim of an end surface, on a side of the yarn contacting portion 96, of the press-contact portion (second press-contact member) 95 that faces the yarn path is chamfered, by which an arcuate chamfered portion 97 is formed. A surface of the portion surrounded by the chamfered portion 97 is flat. The flat surface portion immediately inside the chamfered portion 97 is the second yarn contacting portion 96. The press-contact elements 93 and 94 are configured to pinch a yarn between the second yarn contacting portion 96, which is the flat surface, and the yarn contacting portion (first yarn contacting portion) 91, which is the arcuate protrusion on the press-contact element 93. Also in the third embodiment, the screw through holes 52 for fixing the press-contact element 93 to the casing 23 illustrated in FIG. 2 and the press-contact element 94 to the connecting unit 55 illustrated in FIG. 7 are defined in central portions of the plate member 87 and a plate member 98 of the press-contact elements 93 and 94.

[0045] With this configuration, it is possible to pinch a running yarn between the yarn contacting portion (first yarn contacting portion) 91, which is the arcuate protrusion, and the yarn contacting portion (second yarn contacting portion) 96, which is the flat surface. Therefore, it is possible to run a yarn in a state where the yarn is making a point contact relative to the first yarn contacting portion 91. In this state, the yarn is making a surface contact relative to the second yarn contacting portion 96; however, the yarn is in a point-contact state relative to the first yarn contacting portion 91. Accordingly, a frictional force at a portion where the point contact is made plucks and removes protruding hairs from the surface of the yarn. Furthermore, the press-contact elements 93

and 94 can be fabricated easily because of simple configuration.

[0046] Each of FIGS. 10A to 10E illustrates a pair of press-contact elements 100 and 101 according to Comparative Examples 1 to 5 of the present invention. In Comparative Example 1 illustrated in FIG. 10A, each of yarn contacting portions 102 of the pair of press-contact elements 100 and 101 is a flat surface. In Comparative Example 2 illustrated in FIG. 10B, a press-contact portion (press-contact member) 104 of the press-contact element 100, which is one of the pair of press-contact elements 100 and 101, includes, as does the press-contact element 86 of the second embodiment, upper and lower yarn contacting portions 105, which are arcuate protrusions, while yarn contacting portions 106, which correspond to the yarn contacting portions 105, of the other press-contact element 101 are formed as arcuate recesses conforming to the arcuate protrusions. In Comparative Example 3 illustrated in FIG. 10C, yarn contacting portions 107, which are arcuate protrusions, are provided at upper two positions and lower two positions (four positions in total) on each of facing surfaces of the pair of press-contact elements 100 and 101 so as to face each other. In Comparative Example 4 illustrated in FIG. 10D, a yarn contacting portion 108 of the press-contact element 100, which is one of the pair of press-contact elements 100 and 101, is a flat surface, while yarn contacting portions 109 of the other press-contact element 101 are saw-teeth-like protrusions having flat distal ends. In Comparative Example 5 illustrated in FIG. 10E, yarn contacting portions 109 of each of the pair of press-contact elements 100 and 101 are saw-teeth-like recesses having flat distal ends. Any one of the press-contact elements 100 and 101 illustrated in FIGS. 10A to 10E is circular (round) as viewed from facing surfaces of the press-contact elements 100 and 101.

Experiment

[0047] To verify the advantages of the present invention, a protruding-hair removal experiment was conducted on the first to third embodiments and Comparative Examples 1 to 5. FIG. 11 presents a result of the test. The test was carried out by using, as a press-contact element, the press-contact element according to each of the embodiments and Comparative Examples, and the yarn winding device according to the first embodiment other than the press-contact element. Under such a condition as discussed above, the yarn fed from a yarn feeding bobbin was wound to form a package. An amount of protruding hairs on a yarn on the yarn feeding bobbin and an amount of protruding hairs on a yarn wound on the package were measured to determine hairiness-increase suppression ratio. FIG. 11 is a table of a result of the test. The greater the numerical values (ratio by which an increase in hairiness is suppressed) in the table, the more effectively the hairiness is suppressed.

[0048] FIG. 11 demonstrates that when any one of the

press-contact elements according to the first to third embodiments is used, production of protruding hairs of each one of the lengths is suppressed as compared to a configuration where the press-contact element according to any one of Comparative Examples 1 to 5 is used. This hairiness suppression effect is remarkable for protruding hairs of which lengths are 2 mm to 15 mm.

[0049] Each of the first press-contact members includes a first yarn contacting portion, each of the second press-contact members includes a second yarn contacting portion, and the first yarn contacting portions and the second yarn contacting portions retain the yarn by sandwiching the yarn. In each pair of the press-contact members, the first yarn contacting portion is a protrusion that is arcuate along the yarn path, while the second yarn contacting portion is a protrusion arcuate along the yarn path or a flat surface extending along the yarn path. The second yarn contacting portion is preferably an arcuate protrusion and is identical with the first yarn contacting portion in shape. The "protrusion that is arcuate along the yarn path" means such a protrusion whose outline on a cross section of the press-contact member, including the yarn contacting portions and the yarn path, taken along the yarn path is arcuate on a side facing the yarn path.

[0050] More specifically, the hairiness reducing device could further include a first plate member and a second plate member that are arranged with the yarn path interposed therebetween, and the first press-contact members are arranged on a plate surface of the first plate member, while the second press-contact members are arranged on a plate surface of the second plate member. At least one of the first plate member and the second plate member should preferably be swingably supported on a side of a plate surface opposite from the plate surface where corresponding ones of the first press-contact members and the second press-contact members are arranged.

[0051] The number of positions where the pairs of press-contact members are arranged can be two, three, or four. It is preferable to arrange the pairs of press-contact members at two positions to achieve particularly effective hairiness reduction. If the number of positions is one, the hairiness reduction effect may be insufficient, whereas if the number of positions is equal to or greater than five, protruding hairs can adversely increase.

[0052] It is preferable to arrange the first press-contact members extending in a direction orthogonal to the yarn path on the first plate member at two positions separated by a predetermined distance in a direction along the yarn path, and to arrange the second press-contact members extending in the direction orthogonal to the yarn path on the second plate member at two positions separated by a predetermined distance in the direction along the yarn path.

[0053] The press-contact members could be ring shaped as viewed from the yarn path.

[0054] A shape of the first plate member on which the

first press-contact members are arranged and the second plate member on which the second press-contact members are arranged could be identical. The term "identical in shape" means that, for example, as viewed from the yarn path that is pinched between the press-contact members, external shapes (outlines) of the plate members are identical (e.g., same rectangles, same circles, or the like).

[0055] According to another aspect of the present invention, a yarn winding device includes a bobbin support unit that supports a yarn feeding bobbin; a winding unit that winds a yarn fed from the yarn feeding bobbin supported on the bobbin support unit to form a package; and any one of the hairiness reducing devices discussed above.

[0056] The yarn winding device according to the present invention further includes a tension applying device, which applies a tension on the yarn that is wound on the winding unit, and a control device that controls the tension applied by the tension applying device and the hairiness reducing device. It is desirable that the yarn winding device includes a driving mechanism that drives with a single driving source the tension applying device and the hairiness reducing device mounted on a one-piece frame.

[0057] The hairiness reducing device according to still another aspect of the present invention includes the pairs of press-contact members, on which the yarn contacting portions are formed, that are arranged along the yarn path, along which a yarn that is wound on the winding unit runs. Each of the pairs of press-contact members includes the first press-contact member and the second press-contact member that are arranged with the yarn path interposed therebetween. At least one of the set of first press-contact members and the set of second press-contact members that form the pairs of press-contact members includes the moving mechanism for moving one of the sets relative to remaining one of the sets. This makes it possible to pinch a running yarn between the yarn contacting portions on the pairs of press-contact members. Accordingly, it is possible to apply a frictional force to protruding hairs on a surface of the yarn, thereby removing the protruding hairs by plucking the protruding hairs.

[0058] When applying the frictional force, if the force, or pressure, or the nip force, exerted on the yarn pinched between the yarn contacting portions is too strong, the surface of the yarn is roughened, which adversely produces protruding hairs; if a contact area where a contact with the yarn is to be made is large, the distance, over which the surface of the yarn is rubbed, increases, which also adversely produces protruding hairs. The tension applied on the yarn is constant. The force exerted on the yarn to remove protruding hairs is also constant. However, for example, when the yarn is nipped between pointed protrusions, a contact area where contact with the yarn is to be made is considerably small, causing a pressure (nip force) to concentrate onto the contact area. This

strong force concentrated on a small area roughens the yarn and disadvantageously produces protruding hairs. When an increase in an amount of the protruding hairs resulting from such production of protruding hairs is greater than a decrease in an amount of the protruding hairs resulting from protruding-hair plucking, a total amount of the protruding hairs disadvantageously increases. If the contact area where a contact with the yarn is to be made is too large, concentration of the pressure (nip force) will not occur. In such a case, a force with a magnitude necessary for plucking the protruding hairs cannot be obtained. Furthermore, the larger the contact area where a contact with the yarn is to be made, the longer the distance, over which the surface of the yarn is rubbed. This leads to an increase in the amount of the protruding hairs. A difference between the decrease in the amount of the protruding hairs due to the protruding-hair plucking and the increase in the amount of the protruding hairs due to the production of the protruding hairs is measured as a resultant amount of the protruding hairs. However, when a hairiness reducing unit has a flat contact area where a contact with a yarn is to be made, sufficient hairiness reducing effect will not be obtained.

[0059] In contrast, in the hairiness reducing device according to still another aspect of the present invention, each of the first yarn contacting portions formed on the first press-contact members of the pairs of press-contact members is a protrusion that is arcuate along the yarn path, while each of the second yarn contacting portions formed on the second press-contact members of the pairs of press-contact members is a flat surface along the yarn path or a protrusion that is arcuate along the yarn path. Accordingly, at least the first yarn contacting portions (and the second yarn contacting portions in a configuration where the second yarn contacting portions are the protrusions that are arcuate along the yarn path) make a point contact with a running yarn. When the yarn is caused to run through a nip between the yarn contacting portions, at least in the yarn contacting portions that are arcuate protrusions, in spite that a contact area where a contact with the yarn Y is to be made is relatively small, concentration of the pressure (nip force) does not occur in contrast to a configuration where a yarn is pinched between the pointed protrusions. The relatively small contact area where a contact with the yarn Y is to be made not only provides a plucking force of a required magnitude but also prevents an increase in the amount of the protruding hairs, which can occur when the distance, over which the surface of the yarn is rubbed, is elongated. Furthermore, long protruding hairs are more readily plucked off from a yarn than short protruding hairs because a larger frictional force is applied on the long protruding hairs when the yarn passes through the nip between the arcuate protrusions.

[0060] Thus, the hairiness reducing device according to still another aspect of the present invention is capable of removing or suppressing relatively longer protruding hairs (protruding hairs equal to or longer than 3 mm) pro-

duced on the yarn being wound to form a package.

[0061] In a yarn winding device including the hairiness reducing device, in which the second yarn contacting portions are also arcuate protrusions, a running yarn is to be pinched between the arcuate protrusions and the protrusions on the yarn path. This makes it possible to appropriately concentrate pressure on surfaces of the arcuate protrusions, thereby removing relatively longer protruding hairs without further producing protruding hairs. When the second yarn contacting portions are arcuate protrusions that are identical in shape with the first yarn contacting portions, a yarn is to be pinched between the identical protrusions. This facilitates finding a portion on which nip stress concentrates, thereby making an adjustment of the nip force and the like for optimum hairiness reduction (suppression) easy.

[0062] The hairiness reducing device according to still another aspect of the present invention includes the first plate member, on which the first press-contact members are arranged, and the second plate member, on which the second press-contact members are arranged, arranged with the yarn path interposed therebetween. At least one of the first plate member and the second plate member is swingably supported on a side of a plate surface opposite from the plate surface where corresponding one of the first press-contact members and the second press-contact members are provided. In this hairiness reducing device, the press-contact members are provided on the plate member that swings. Accordingly, a stress exerted for removal of the protruding hairs is equally distributed to the press-contact members. This causes the press-contact members to exert an equal effect for removal of the protruding hairs.

[0063] When the hairiness reducing device is configured such that the first press-contact members extending in the direction orthogonal to the yarn path are arranged on the first plate member at two positions separated by a predetermined distance in the direction along the yarn path, and the second press-contact members extending in the direction orthogonal to the yarn path are arranged on the second plate member at two positions separated by a predetermined distance in the direction along the yarn path, fluff can be stored in a space between the press-contact members. Furthermore, the press-contact members can be fabricated easily because of simple configuration.

[0064] Shaping each of the press-contact members as a portion of a ring-shaped member is also advantageous in terms of manufacturing because this makes the press-contact members simple in configuration.

[0065] When the first plate member on which the first press-contact members are arranged, and the second plate member on which the second press-contact members are arranged, are identical in shape, a yarn is pinched between the identical protrusions. This facilitates finding a portion on which nip stress concentrates, thereby making the adjustment easy.

[0066] The yarn winding device according to still an-

other aspect of the present invention includes the bobbin support unit that supports the yarn feeding bobbin, the winding unit that winds a yarn fed from the yarn feeding bobbin supported on the bobbin support unit to form a package, the tension applying device that applies a tension on the yarn that is wound on the winding unit, and the control device that controls tension application, which is performed by the tension applying device, and the hairiness reducing device. This makes it possible for the control unit to control tension application by the tension applying device, application of force or pressure by the hairiness reducing device for removal of protruding hairs, and tension application by the tension applying device and the hairiness reducing device. Accordingly, tension application appropriate for hairiness reduction and yarn winding can be achieved.

[0067] When the yarn winding device is configured such that the tension applying device and the hairiness reducing device are mounted on the one-piece frame, attachment and detachment of the tension applying device and the hairiness reducing device to and from the yarn winding device are facilitated because attachment and detachment can be performed integrally with the frame member as a unit. Driving the tension applying device and the hairiness reducing device with the single driving source in a sharing manner reduces the number of driving sources as compared to a configuration where the tension applying device and the hairiness reducing device are driven individually by different driving sources. Hence, cost reduction by the reduced number of driving sources can be achieved.

[0068] While the present invention has been described with respect to preferred, embodiments thereof, it will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many embodiments other than those specifically set out and described above. Accordingly, it is intended by the appended claims to cover all modifications of the present invention that fall within the true spirit and scope of the present invention.

Claims

1. A hairiness reducing device for removing protruding hairs that are produced on a surface of a yarn when the yarn fed from a yarn feeding bobbin is wound on a winding unit, the hairiness reducing device comprising:

a plurality of pairs of press-contact members arranged along a yarn path, along which the yarn that is wound on the winding unit runs, each of the pairs of press-contact members being formed by a first press-contact member and a second press-contact member arranged along the yarn path with the yarn path interposed therebetween, wherein

at least one of a set of first press-contact members and a set of second press-contact members that form the pairs of press-contact members includes a moving mechanism for moving one of the set of first press-contact members and the set of second press-contact members relative to remaining one of the set of first press-contact members and the set of second press-contact members,

each of the first press-contact members includes a first yarn contacting portion, each of the second press-contact members includes a second yarn contacting portion, and the first yarn contacting portions and the second yarn contacting portions retain the yarn by sandwiching the yarn,

the first yarn contacting portion in each pair of press-contact members is a protrusion that is arcuate along the yarn path, and

the second yarn contacting portion in each pair of press-contact members is a protrusion that is arcuate along the yarn path.

2. A hairiness reducing device for removing protruding hairs that are produced on a surface of a yarn when the yarn fed from a yarn feeding bobbin is wound on a winding unit, the hairiness reducing device comprising:

a plurality of pairs of press-contact members arranged along a yarn path, along which the yarn that is wound on the winding unit runs, each of the pairs of press-contact members being formed by a first press-contact member and a second press-contact member arranged along the yarn path with the yarn path interposed therebetween, wherein

at least one of a set of first press-contact members and a set of second press-contact members that form the pairs of press-contact members includes a moving mechanism for moving one of the set of first press-contact members and the set of second press-contact members relative to remaining one of the set of first press-contact members and the set of second press-contact members,

each of the first press-contact members includes a first yarn contacting portion, each of the second press-contact members includes a second yarn contacting portion, and the first yarn contacting portions and the second yarn contacting portions retain the yarn by sandwiching the yarn,

the first yarn contacting portion in each pair of press-contact members is a protrusion that is arcuate along the yarn path, and

the second yarn contacting portion in each pair of press-contact members is a flat surface along

the yarn path.

3. The hairiness reducing device according to Claim 1, wherein the second yarn contacting portion is identical with the first yarn contacting portion in shape. 5
4. The hairiness reducing device according to any one of Claims 1 to 3, further comprising:
 - a first plate member and a second plate member that are arranged with the yarn path interposed therebetween, wherein the first press-contact members are arranged on a plate surface of the first plate member, the second press-contact members are arranged on a plate surface of the second plate member, and at least one of the first plate member and the second plate member is swingably supported on a side of a plate surface of one of the first plate member and the second plate member opposite from the plate surface where corresponding ones of the first press-contact members and the second press-contact members are arranged. 10 15 20 25
5. The hairiness reducing device according to Claim 4, wherein number of positions where the pairs of press-contact members are arranged is any one of two, three, and four. 30
6. The hairiness reducing device according to Claim 4, wherein
 - the first press-contact members extending in a direction orthogonal to the yarn path are arranged on the first plate member at two positions separated by a predetermined distance in a direction along the yarn path, and 35
 - the second press-contact members extending in the direction orthogonal to the yarn path are provided on the second plate member at two positions separated by the predetermined distance in the direction along the yarn path. 40
7. The hairiness reducing device according to Claim 4, wherein each press-contact member is a portion of a ring-shaped member. 45
8. The hairiness reducing device according to Claim 6 or 7, wherein the first plate member on which the first press-contact members are arranged and the second plate member on which the second press-contact members are arranged are identical in shape. 50 55
9. A yarn winding device comprising:

a bobbin support unit that supports a yarn feed-

ing bobbin;

a winding unit that winds a yarn fed from the yarn feeding bobbin supported on the bobbin support unit to form a package; and the hairiness reducing device according to any one of Claims 1 to 8.

10. The yarn winding device according to Claim 9, further comprising
 - a tension applying device that applies a tension on the yarn that is wound on the winding unit; and a control device that controls the tension applied by the tension applying device, and the hairiness reducing device.
11. The yarn winding device according to Claim 10, further comprising:
 - a frame member that supports the tension applying device and the hairiness reducing device; and
 - a driving mechanism that drives the tension applying device and the hairiness reducing device with a single driving source.

FIG.1

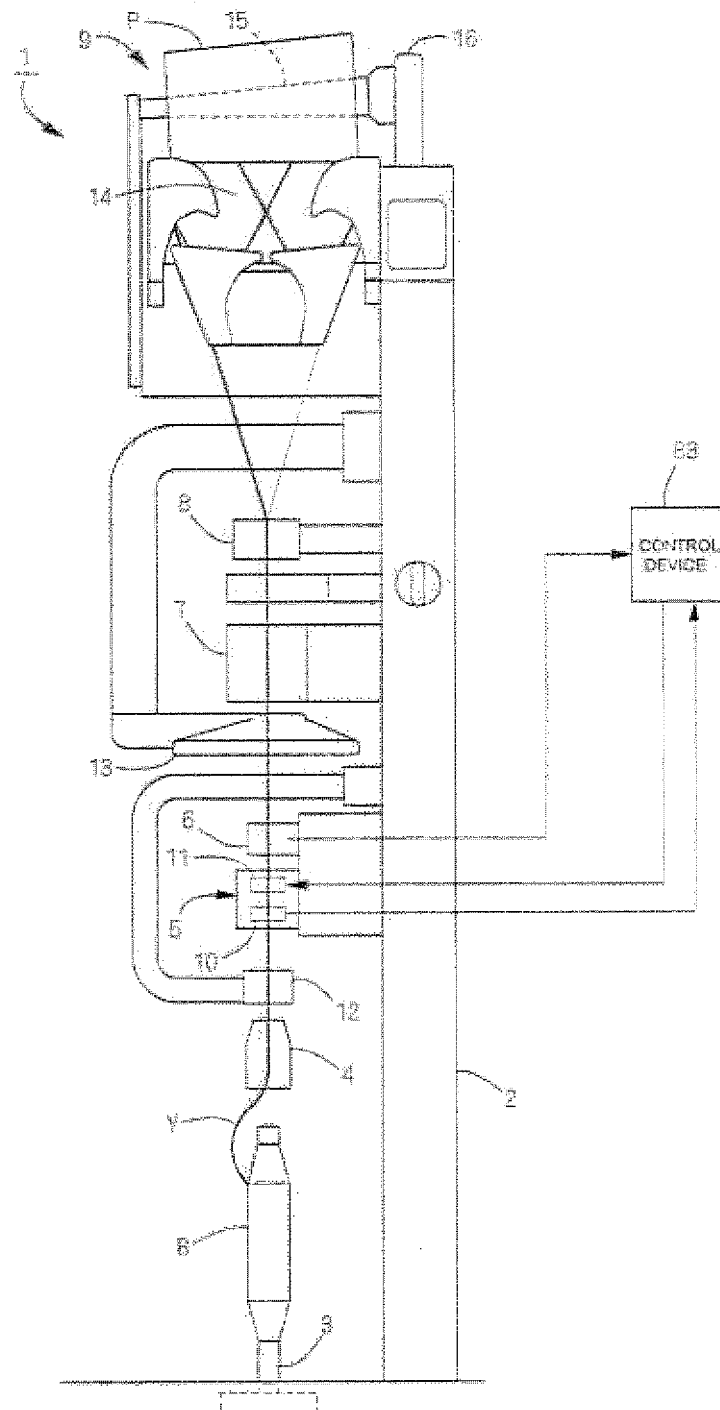


FIG.2

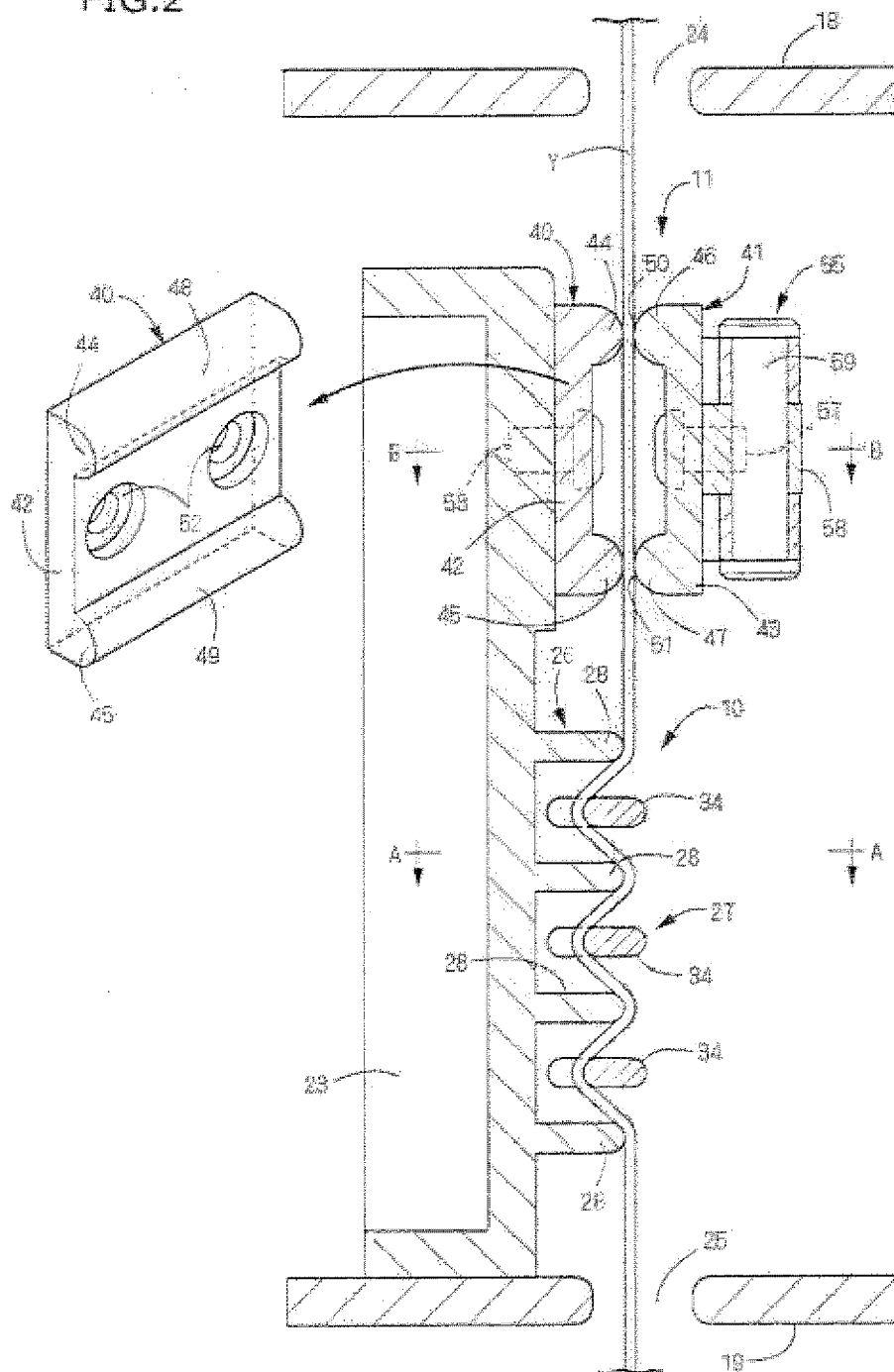


FIG.3

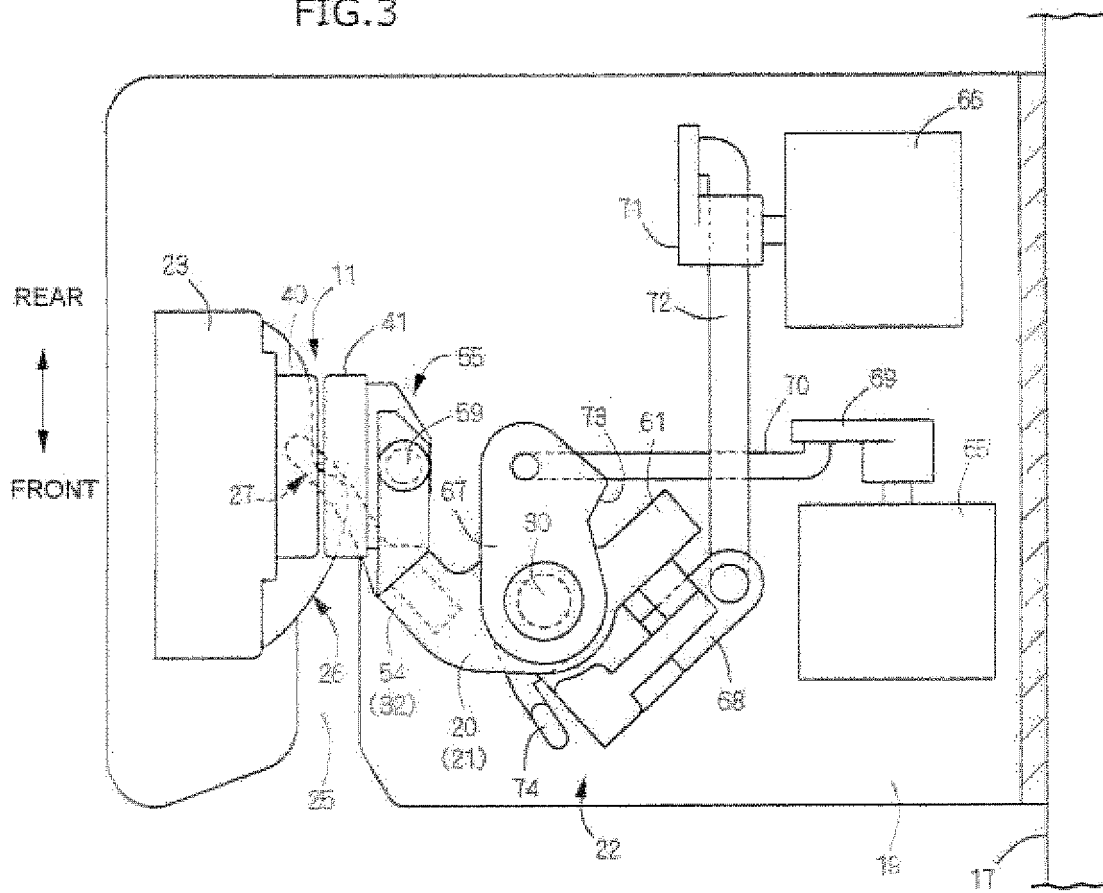


FIG.4

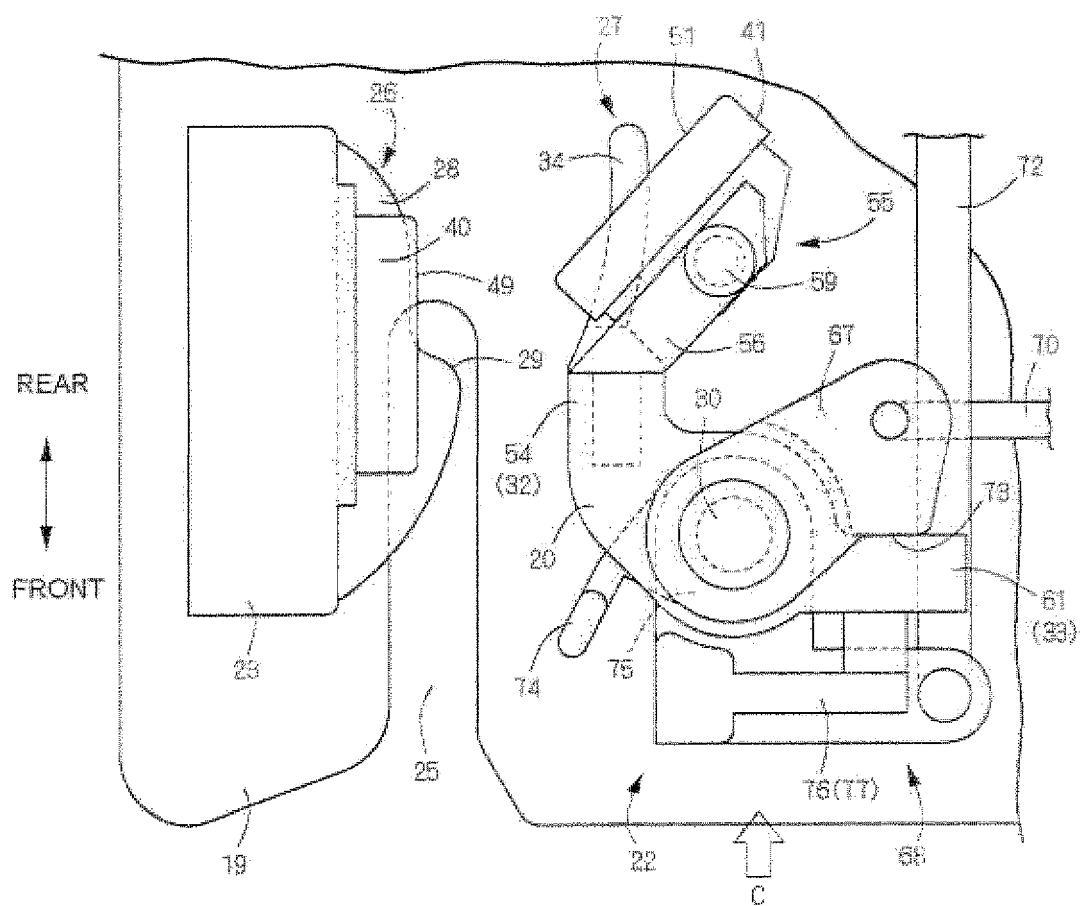
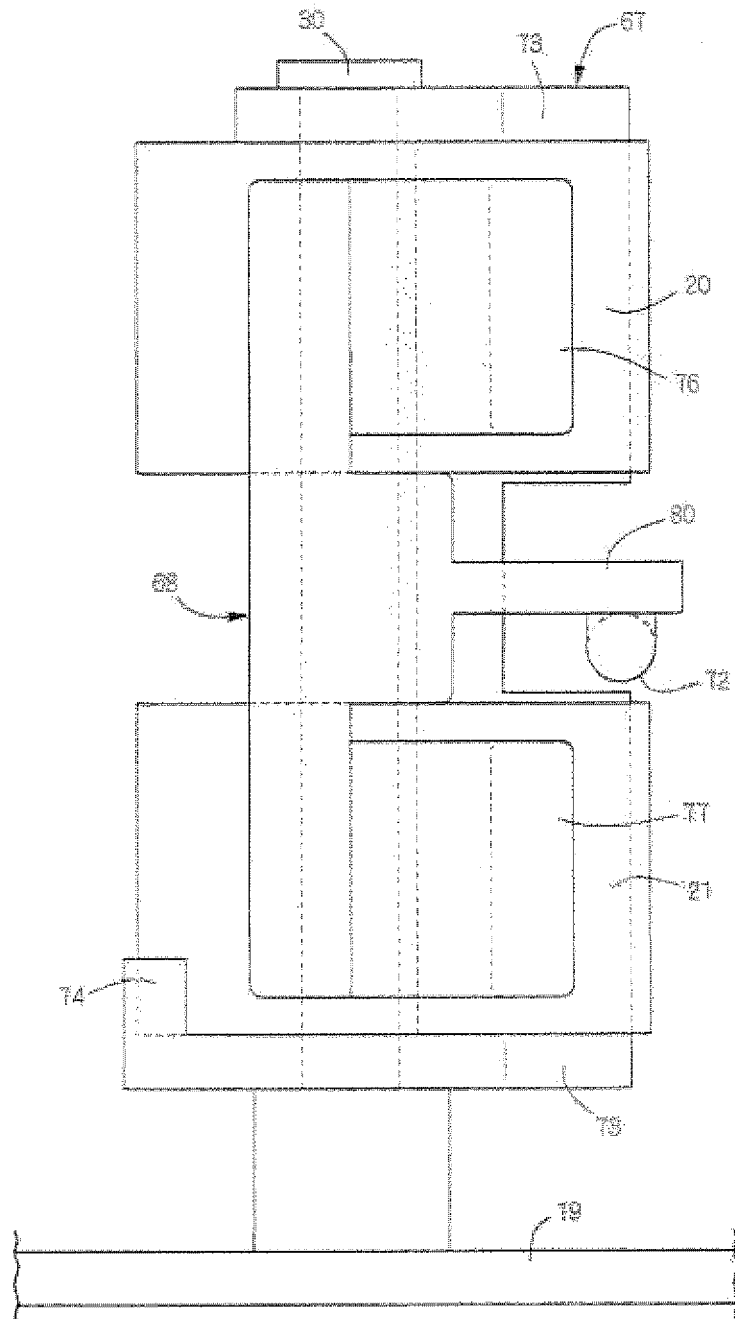
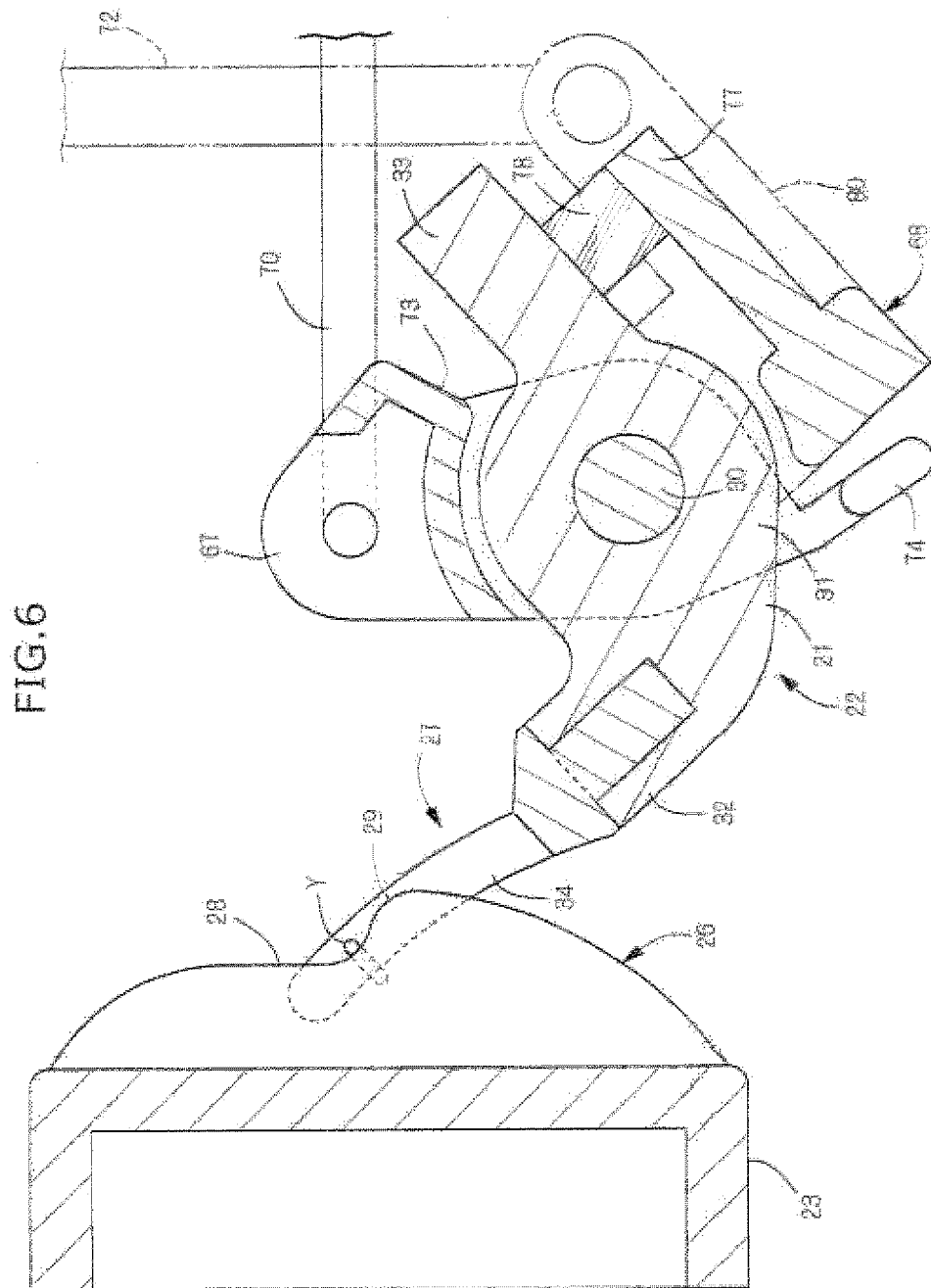


FIG. 5





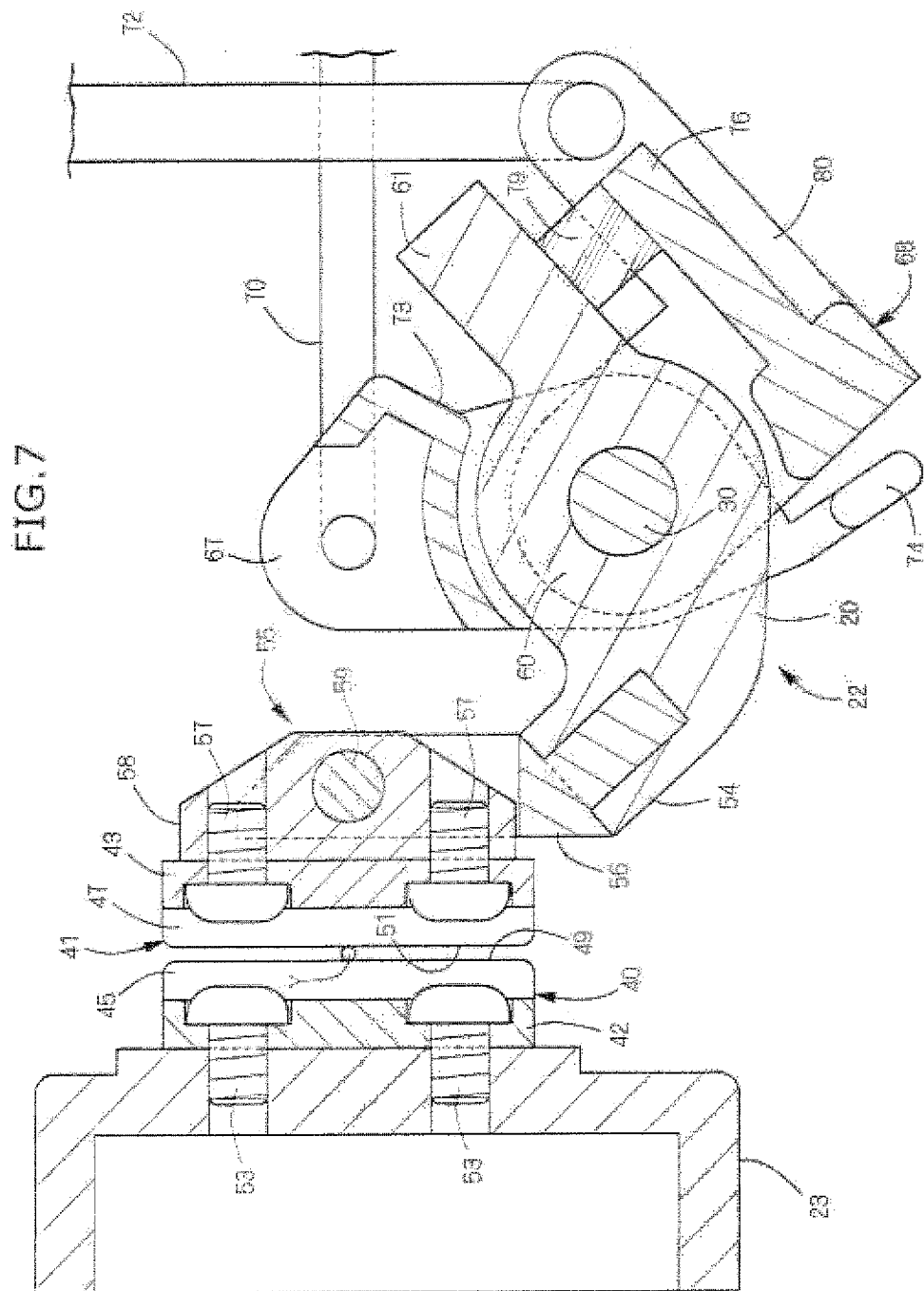


FIG. 8A

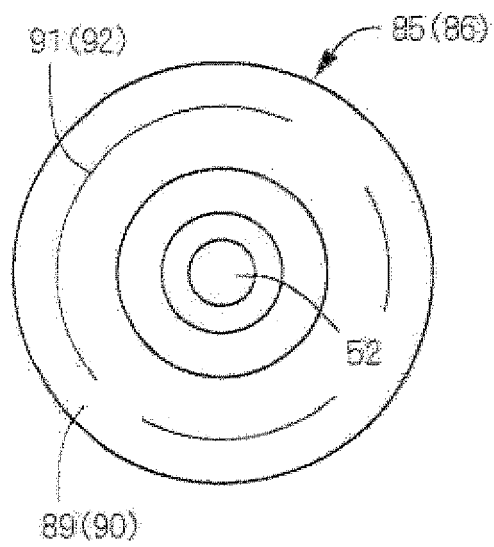


FIG. 8B

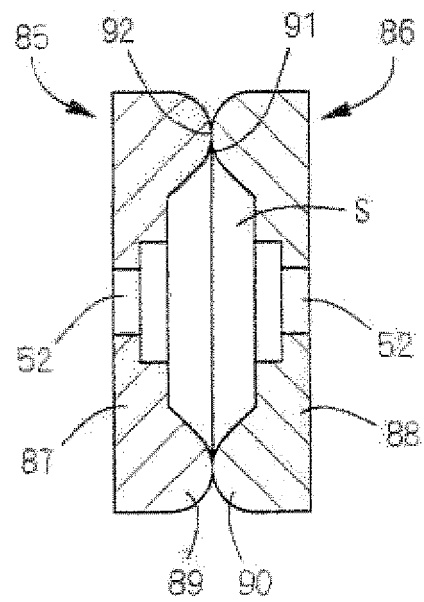


FIG. 9A

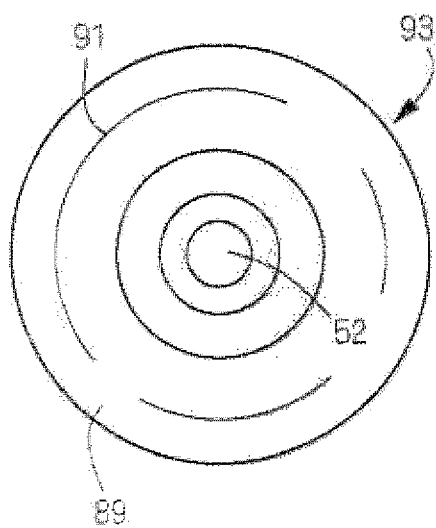
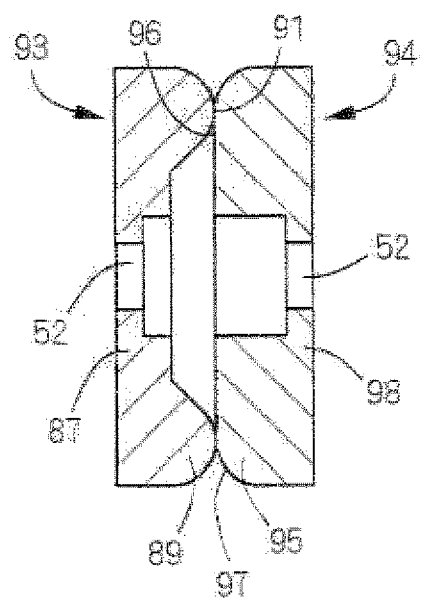


FIG. 9B



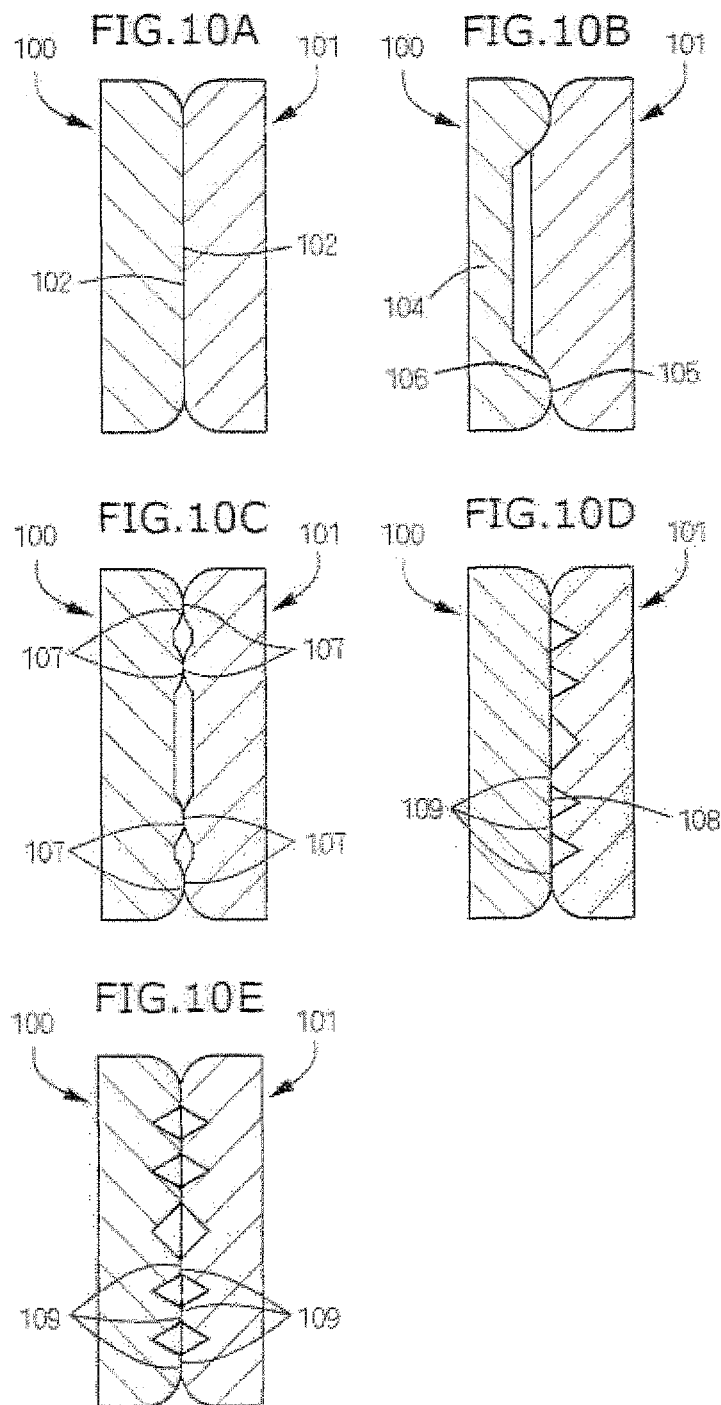


FIG. 11

HAIRNESS-INCREASE SUPPRESSION RATIO (%)

	1 mm HAIR	2 mm to 3 mm HAIR	2 mm TO 15 mm HAIR
EMBODIMENT 1	18.0	32.0	31.0
EMBODIMENT 2	10.0	24.0	29.0
EMBODIMENT 3	5.6	19.0	21.0
COMPARATIVE EXAMPLE 1	-1.7	-4.0	-5.1
COMPARATIVE EXAMPLE 2	1.9	1.5	-1.5
COMPARATIVE EXAMPLE 3	—	1.5	9.0
COMPARATIVE EXAMPLE 4	-4.8	4.8	0.8
COMPARATIVE EXAMPLE 5	-6.8	-3.3	-7.6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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