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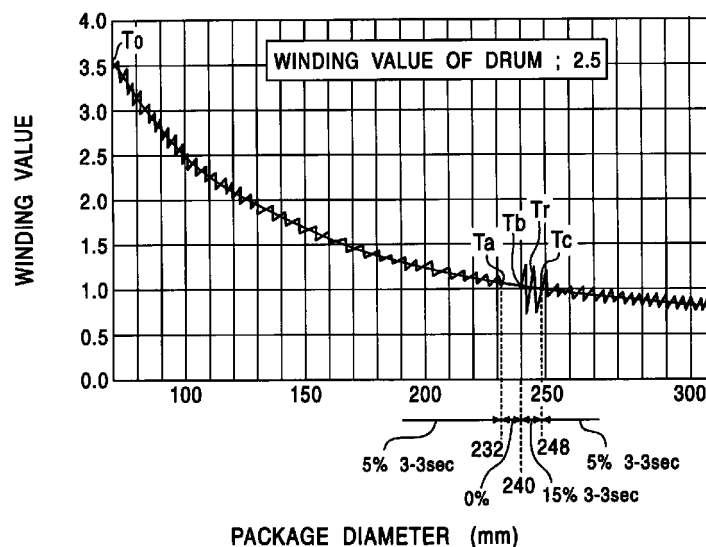
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(54) **Ribbon winding prevention method and apparatus**

(57) A ribbon winding prevention method used when winding a yarn into a package P wound on a traverse drum 11 in which (1) disturb control such that the speed of the traverse drum 11 is varied slightly is performed from the start of winding (To) until a point (Ta) before the package reaches a diameter at which it tends to induce the formation of large ribbons (Tr), (2) disturb control is discontinued from that point (Ta) until another

point (Tb) just before the package reaches the ribbon inducing diameter (Tr), and (3) disturb control such that the speed of the traverse drum 11 is varied greatly is performed from just before that point (Tb) until another point (Tc) after the package diameter has exceeded the point at which it induces large ribbons.

FIG. 1



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Description

Field of the Invention

[0001] The present invention relates to a method of preventing ribbon winding in an automatic winding machine or similar apparatus, and to an apparatus that utilizes such method.

Background of the Invention

[0002] An automatic winder is a kind of machine that winds spin yarn from a bobbin (generally a bobbin delivered directly from a spinning frame) into a package rotated by a traverse drum. The yarn is traversed back and forth along the package by grooves in the traverse drum as it is wound into the package. The wound package is formed to a predetermined shape having a predetermined amount of yarn.

[0003] One problem faced by automatic winders is known as "ribbon winding." Ribbon winding occurs when the ratio of the package winding speed to the traverse speed approaches an integer or ratio of an integer. When this happens, the yarn wound onto the package ends up wound in layers over the same path along the package, creating a "ribbon" of layered yarn.

[0004] The yarns in the ribbon tend to become entangled, and later, when the package is unwound, the yarns of the ribbon may come off the package together all at once, a problem known as "sloughing."

[0005] The package winding value P_w (the number of times the yarn circles the package for each time the yarn traverses the package in one direction) is a function of the winding value of the traverse drum D_w (the number of times the traverse grooves on the drum circle the drum in a single traverse direction), the drum diameter D_d , and the package diameter P_d :

$$P_w = D_w \times D_d / P_d \quad (\text{Function 1})$$

[0006] If the drum rotation speed is called N_d , and the package rotation speed is called N_p , the package winding value can be seen as the following function:

$$P_w = D_w \times N_p / N_d \quad (\text{Function 2})$$

[0007] When, for example, the drum diameter D_d is 98mm, and the drum winding value D_w is 2.5, ribbon winding tends to occur when the diameter of the package reaches sizes of 81mm (approximately 3W), 98mm (2.5W), 163mm (approximately 1.5W), and 245mm (1W). (Note that "W" indicates the number of times the yarn circles the package in a single traverse direction.)

[0008] Japanese patent application publication (Tokko-Hei) No. 2-40577 discloses a ribbon winding prevention method using "disturb control." As the package diameter approaches the size at which it tends to induce ribbon winding, the rotation speed of the traverse

drum is varied, and a slip is induced between the package and the drum, thereby altering the yarn path on the package, and breaking the ribbon.

[0009] Since the inertia of the package is relatively large, the package continues rotating at a constant rotary speed N_p even if the rotary speed of the drum N_d is varied, thus creating the change in package winding value (see function 2), thereby changing the path of the yarn over the package, and preventing creation of the ribbon.

[0010] However, this change in package winding value when the drum rotation speed is varied as the package approaches a diameter at which ribbon winding is likely to occur may actually induce formation of a small ribbon before the package actually reaches the diameter at which ribboning is expected. When the package is then unwound, the ribboned yarns become entangled (a process called "latching"), leading to yarn breakage.

[0011] After further observation of this latching phenomenon in the unwinding of many packages, it was then determined that latching tended not to occur so much at the 2W and 3W package diameters, as at the approach of the 1W diameter.

[0012] It is thus object of the present invention to provide a more effective ribbon winding prevention method and ribbon winding prevention apparatus.

Summary of the Invention

[0013] In order to accomplish this object, in a first aspect of the present invention, a method of preventing the ribboning of a winding package rotated on a traverse drum includes the steps of (1) beginning disturb control at the start of winding, and (2) discontinuing disturb control for a period of time before the diameter of the winding package reaches a diameter at which it induces ribboning.

[0014] According to a second aspect of the present invention, a ribbon winding prevention method includes the steps of (1) performing disturb control such that the amount of variation in the speed of the traverse drum is small from the start of winding until a point in time slightly before the diameter of the package reaches a diameter that induces formation of large ribbons, (2) discontinuing disturb control from said point slightly before the package reaches said large ribbon forming diameter until a point just before the diameter of the package reaches said large ribbon forming diameter, and (3) performing disturb control such that the amount of variation in the speed of the traverse drum is large starting at said point just before the package reaches said large ribbon forming diameter until a point after the package has reached said large ribbon forming diameter.

[0015] In a third aspect of the present invention, a ribbon winding prevention apparatus that winds yarn into a package rotated in contact with a traverse drum comprises:

an inverter that controls the rotation of the traverse drum;

a package diameter sensor that detects the diameter of the package from a point slightly before the package reaches a large ribbon forming diameter; and

a logic circuit that receives the detection value of the package diameter sensor, outputs a disturb command signal to the inverter, performs disturb control such the amount of variation in the speed of the traverse drum is small from the start of winding until a point in time slightly before the package reaches a diameter that induces formation of large ribbons, does not perform disturb control from said point slightly before the package reaches said large ribbon forming diameter until a point just before the diameter of the package reaches said large ribbon forming diameter, and performs disturb control such that the amount of variation in the speed of the traverse drum is large starting at said point just before the package reaches said large ribbon forming diameter until a point after the package has reached said large ribbon forming diameter.

Brief Description of the Drawing

[0016]

Figure 1 shows how disturb control affects the relationship between the package winding value and the package diameter to prevent ribbon winding.

Figure 2 is an outline view of an embodiment of a device that prevents ribbon winding according to the present invention.

Figure 3 shows the path of yarn along a winding package.

Figure 4 shows the relationship between the number of reciprocations of the yarn (the "turn number") and the separation amount when the package diameter is 242mm.

Figure 5 shows the relationship between turn number and separation amount when disturb control is activated when the package reaches a diameter of 238mm.

Figure 6 shows the relationship between turn number and separation amount when disturb control is discontinued when the package reaches a diameter of 238mm.

Detailed Description of the Preferred Embodiment

[0017] A detailed description of the present invention will now be explained in reference to the accompanying drawings.

[0018] Figure 2 shows one winding unit of an automatic winding machine employing the ribbon winding prevention method and apparatus of the present invention.

[0019] The drawing shows a cross-section of a single winding unit 10 of an automatic winder. The winding unit 10 includes a traverse drum 11 and a cradle 13, which can rotate freely around the axis of a shaft 12. Package P is held in the cradle 13, and is freely rotatable therein. The package P rotates in contact with the traverse drum 11. A spun yarn Y, drawn from a supplying package produced by the spinning frame, is led through a groove 14 in the traverse drum 11, and thereby traversed as it is wound into the package P.

[0020] The traverse drum is coupled with a driving motor 16 via a transmission 15. The motor 16 can be driven at variable rotary speeds by an inverter 18.

[0021] A package diameter indicating lever 19 is attached to the shaft 12 of the cradle 13, and pivots around the axis of the shaft 12 with the cradle 13. The diameter of the package P is detected by a package diameter sensor 20, which reads the position of the package diameter indicating lever 19. The sensor 20 is arranged in the winding unit 10 and may, for example, be set to begin detecting the diameter at some time before the package reaches its 1W diameter. The detection result detected by the sensor 20 is then output to a programmable logic circuit 21.

[0022] The inverter 18 converts the AC current from a commercial power source to DC current, and converts DC to AC by switching a transistor on and off.

[0023] During package winding, the logic circuit 21 outputs a signal 23 instructing the inverter 18 to operate at a cycle that is specified based on a program that controls the rotation speed of the traverse drum 11.

[0024] This control program performs disturb control such that the amount by which the speed of the traverse drum 11 is varied is small from the start of winding until a point in time slightly before the package reaches a diameter that tends to induce the formation of large ribbons (a "large ribbon forming diameter"). Next, from this point slightly before the package reaches a large ribbon forming diameter until a point in time just before the package reaches a large ribbon forming diameter, the control program rotates does not perform disturb control (i.e. the traverse drum 11 is rotated at a constant speed). Next, from the point just before the package reaches a large ribbon forming diameter until a point after the package reaches a large ribbon forming diameter, disturb control is performed such that the amount by which the speed of the drum 11 is varied is large.

[0025] Figure 1 shows the change in the package

winding value (achieved through disturb control performed by the logic circuit 21) as the diameter of the package grows larger.

[0026] In this case, the winding value D_w of the traverse drum 11 is $2.5W$, and the drum diameter D_d is 98mm. Thus, as can be seen in function 1, the package diameter D_p at which the biggest ribbons occur ($1W$), is 244mm.

[0027] In this embodiment of the present invention, large ribbon formation is eliminated by performing the disturb control as follows.

[0028] First, the disturb ratio (variation in the speed of the traverse drum) is set to a small value of $\pm 5\%$, $3/3$ sec. (a 3 second speed increase followed by a 3 second speed decrease) from the start of winding (T_o) until the package diameter reaches 232mm (T_a). This is indicated by the jagged line in the graph of Figure 1 from T_o to T_a . When the package diameter is between 232mm (T_a) and 240mm (T_b), disturb control is not performed (i.e. the disturb ratio is 0%). This is indicated by the non-jagged curve from T_a to T_b . When the package diameter D_p is between 240mm (T_b) and 248mm (T_c), the disturb ratio is set very high, to $\pm 15\%$, $3/3$ sec. This is indicated by the sharp jagged line in the graph, from T_b to T_c . From a point at which the package diameter D_p exceeds 248mm (T_c) until the package is completely wound, disturb ratio is once again set at a small value, $\pm 5\%$, $3/3$ sec. This is indicated by the jagged line in the graph extending from T_c . Such control almost completely eliminates the problem of ribbon winding in the wound package P.

[0029] As described hereinbelow, the inventors of the present invention were able to determine through experimentation at what diameters latching tends to occur when conventional disturb control is performed from before the package diameter reaches the $1W$ large ribboning point (i.e. T_r in Figure 1, or specifically 244mm in the present embodiment). Testing revealed that latching tends to occur even when disturb control is performed before the package reaches its $1W$ point; at package diameters even below 240mm. Further examination of latching at diameters between 230mm and 250mm revealed that the peak latching diameter was 238mm.

[0030] In order to understand the cause of the problem, the inventors analyzed the amount of yarn path separation created when disturb control was performed. The graphs of Figures 4 ~ 6 show the observed results, indicating the effect of disturb control on ribbon winding.

[0031] Figures 4 ~ 6 are graphs of data indicating the amount of separation generated for each "yarn turn" (one reciprocal traverse of the yarn across the package).

[0032] The relationship between the separation and the turn value will now be explained in reference to Figure 3.

[0033] Figure 3 shows the yarn path on the large diameter side of cone-shaped wound package P after

the package P has reached a given diameter. On the first turn, the yarn follows the dotted line of yarn path 26, reversing direction at the end of the package. On the second turn (after one reciprocal traverse), the yarn follows the straight line of yarn path 27, again reversing direction at the edge of the package. The reversal of direction at the edge of the package for each yarn path 26, 27, form angles 26a, 27a, respectively. The distance between the center points of the two angles 26d, 27d yields the amount of separation between the yarn paths. The separation value is positive if the center point of the second angle is farther forward in the direction of package rotation than that of the first, and negative if the center point of the second angle is in back of that of the first, relative to the direction of package rotation.

[0034] The turn values and separation amounts of packages that had not yet reached their $1W$ diameters were calculated for repeated large disturb rates comprised of 3 seconds $+15\%$ speed increases followed by 3 seconds of -15% speed decreases. Results of these experiments are shown in Figure 4 and Figure 5.

[0035] Figure 4 shows the results when disturb control was performed starting from package diameters of 244mm, while Figure 5 shows the results when disturb control was performed starting from package diameters of 238mm.

[0036] In both Figure 4 and Figure 5, ribbon winding takes place when the separation amount is 0mm, and ribbon winding does not take place when the separation amount does not cross the 0mm area.

[0037] In Figure 4, the median separation per turn (the median line of the graph) is 0mm, while in Figure 5, the median separation amount per turn is -80mm.

[0038] When disturb control was initiated from just before the package reaches its 244mm $1W$ ribbon winding diameter (i.e. from 242mm), and only slight disturb control (for example $\pm 3\%$, $3/3$ sec.) was performed, there were numerous instances of 0mm separation, meaning that ribbon winding occurred, and that ribbon winding prevention was ineffective. But when a large disturb control value of $\pm 15\%$ was used, as indicated in Figure 4, occurrences of 0mm separation were drastically reduced.

[0039] As shown in Figure 5, initiating large $\pm 15\%$ disturb control from further before the package reaches its $1W$ ribbon winding diameter (in this case, from 238mm) does not completely eliminate instances of 0mm separation, meaning that there are still places on the package that will cause latching.

[0040] But when disturb control was not performed between package diameters of 238mm and 240mm, meaning that drum rotation speed was constant, the separation amount is held roughly constant at 80mm, as seen in Figure 6, and ribbon winding is avoided.

[0041] In other words, this data indicates that performing disturb control of $\pm 15\%$ from a package diameter of 238mm in Figure 6 actually ended up causing ribbon winding instead of preventing it, and that conse-

quently disturb control during this period is useless for preventing ribbon formation.

[0042] Nonetheless, small ribbons may still be formed before the package diameter reaches 238mm, and so disturb control is still required from the start of winding until some point in time before the package reaches the 1W large ribboning zone (i.e. until the 238mm package diameter).

[0043] The present invention therefore performs disturb control using a small disturb rate is performed from the start of winding (To) until a point in time slightly before the package reaches its 244mm 1W winding diameter (i.e., until 232mm, Ta), as shown in Figure 1. From that point until a point in time only just before the package reaches its 244mm 1W winding diameter (i.e. from 232mm, Ta until 240mm, Tb), disturb control is not performed, meaning that the drum is rotated at a constant speed, and no slip is created between the drum and the package. Next, from that point just before the package reaches its 1W winding diameter, continuing through a point in time after the package exceeds its 1W diameter at which it induces formation of large ribbons, and extending until a point in time where the separation amount grows large (i.e. from Tb at 240mm, past 244mm, until Tc at 248mm), disturb control using a large disturb rate is performed, thus greatly reducing the number of ribbons that might occur in the package. From then on (i.e. from after the package reaches 248mm in diameter), only slight disturb control is performed (or disturb control is not performed at all), permitting almost complete prevention of ribbon winding.

[0044] The ribbon winding prevention control shown in Figure 1 is programmed into the logic circuit 21 of Figure 2 as a pattern of disturb instruction signals changing the cycle of the cycle instruction signals 23 sent to the inverter 18. The timing of the control is determined based on the package diameter detected by the package diameter sensor 20.

[0045] The embodiment of the present invention described herein has disclosed a disturb rate of $\pm 5\%$, with 2 seconds increase and 2 seconds decrease, as the disturb control employed from the start of winding (To) until the before the package reaches the 1W ribbon winding diameter (Ta), but it should be understood by those skilled in the art that the present invention is not limited to these values, and that the range of values that can be used includes any values suitable for breaking small ribbons that may be formed during this period. Additionally, although the embodiment disclosed herein describes a disturb rate of $\pm 15\%$, with 2 seconds increase and 2 seconds as the disturb control employed from just before the package reaches its 1W diameter (Tb), through the time when the package passes its 1W ribbon winding diameter (Tr), until the package reaches a diameter where the separation amount becomes large (Tc), it should be understood by those skilled in the art that any value appropriate for breaking the 1W ribbon may be used.

[0046] Additionally, the present embodiment has described the winding value of the drum 11 as 2.5W, but of course, drums of different winding values, such as 3W, 2W, and 1.5W may also be employed. If the drum diameter is 100mm, for example, the 1W ribbon package is approximately 300mm with a 3W drum, 200mm with a 2 W drum, and 150mm with a 1.5W drum. It should be noted that the disturb ratio switching points Ta, Tb, and Tc also change depending upon the winding value of the drum. The Ta point before the diameter of the package reaches its 1W winding size (Tr) should merely be set at a safe point where the separation amount is significantly more or less than 0mm, and the Tb point just before the yarn package enters the ribbon winding zone should preferably be set to a point at which the separation amount is within 20mm. The Tc point may be set at a point where disturb control is useless.

[0047] The present specification has indicated that at the very least the package diameter giving the package a winding value of 1, although sometimes package diameters giving the package a winding value of 1.5, are the diameters that cause large ribbons. Consequently, in the preferred embodiment of the present invention, disturb control is not performed starting from some point before the 1W package diameter is reached, until immediately before the 1W package diameter is reached. From this point until the package diameter passes the 1W point, large disturb control is employed. It should be noted that disturb control may be discontinued as necessary from some point prior to when the winding value of the package reaches 1.5W and 1W until just before the winding value reaches 1.5W and 1W, and then large disturb control may be resumed from that point until after it has passed the 1.5W and 1W point.

[0048] As described hereinbefore, by discontinuing disturb control prior to reaching a point where the package would induce formation of large ribbons, and thereby rotating the drum at a constant speed and preventing ribbon winding where one would not expect it, and by resuming large disturb control just prior to the actual point at which the package would create large ribbons, large ribbons can be reliably broken, allowing relatively ribbon-free packages to be wound.

Claims

1. A ribbon winding prevention method in which a yarn is wound into a package rotating on a traverse drum, the method including the steps of:

from the start of package winding, winding the yarn while disturb control is performed, and from before the package reaches a diameter that induces formation of large ribbons, winding the yarn while disturb control is not performed.

2. The ribbon winding prevention method of claim 1

further comprising the steps of:

from the start of package winding until a point in time slightly before the package reaches a diameter that induces formation of large ribbons, performing disturb control such that amount of variation in the speed of the traverse drum is small, from said point slightly before the package reaches said large ribbon forming diameter until a point in time just before the package reaches said large ribbon forming diameter, not performing disturb control, and then, from said point just before the package reaches said large ribbon forming diameter until a point after the package has reached said large ribbon forming diameter, performing disturb control such that the amount of variation in the speed of the traverse drum is large.

3. The ribbon winding prevention method of claim 1 or claim 2 wherein the package diameter at which large ribbons can be formed is a diameter at which the winding value of the package is 1.
4. The ribbon winding prevention method of claim 3 wherein the package diameter at which large ribbons can be formed includes a diameter at which the winding value of the package is 1.5
5. A ribbon winding prevention apparatus that winds yarn into a package rotated in contact with a traverse drum comprising:

an inverter that controls the rotation of the traverse drum;

a package diameter sensor that detects the diameter of the package from a point slightly before the package reaches a large ribbon forming diameter; and

a logic circuit that receives the detection value of the package diameter sensor, outputs a disturb command signal to the inverter, performs disturb control such that the speed of the traverse drum is varied slightly from the start of winding until a point slightly before the package reaches a diameter that induces formation of large ribbons, does not perform disturb control from said point slightly before the package reaches said large ribbon forming diameter until a point just before the package reaches said large ribbon forming diameter, and performs disturb control such that the speed of the traverse drum is varied greatly from said point just before the package reaches said large ribbon forming diameter until a point after the package reaches said large ribbon forming diameter.

FIG. 1

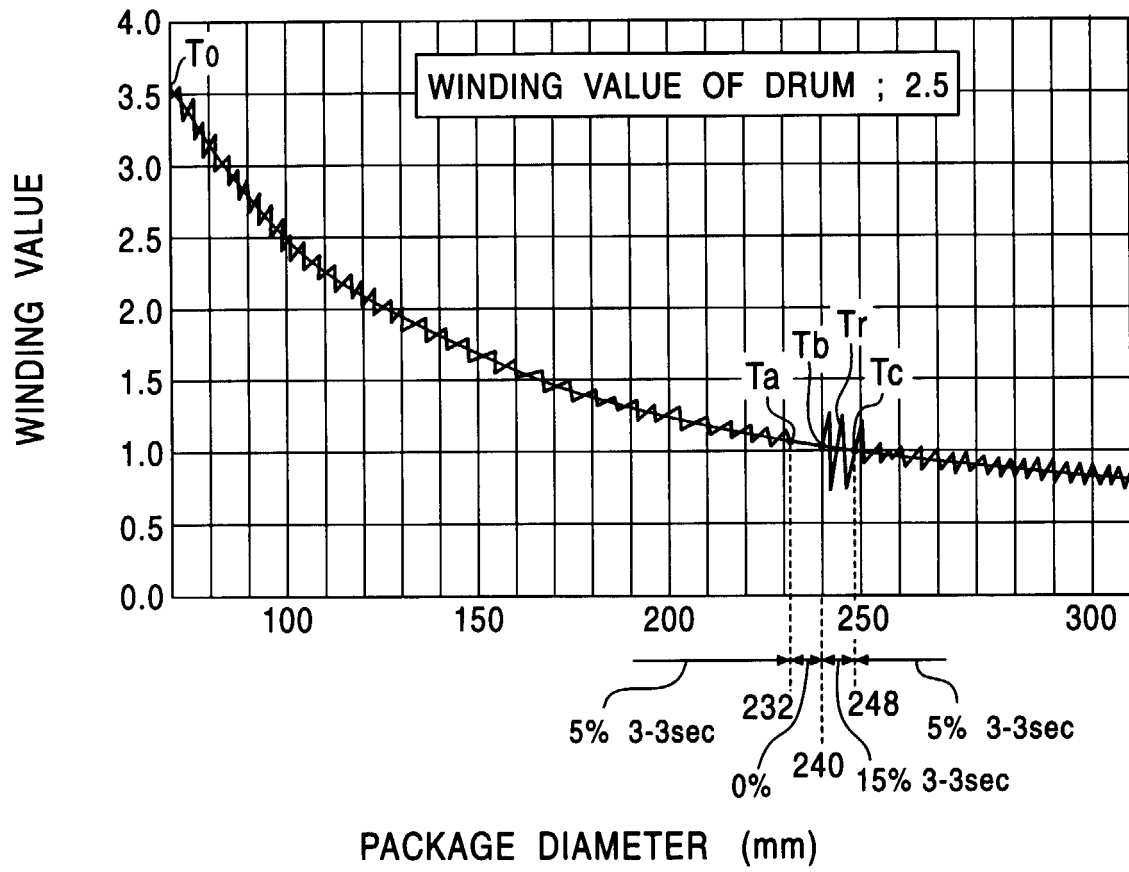


FIG. 2

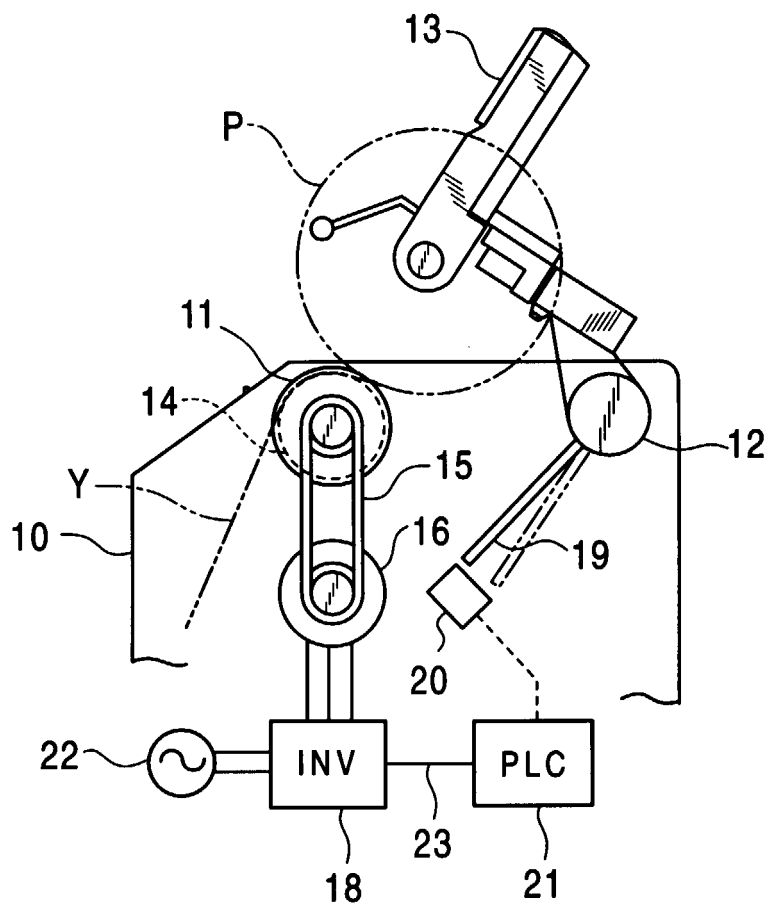


FIG. 3

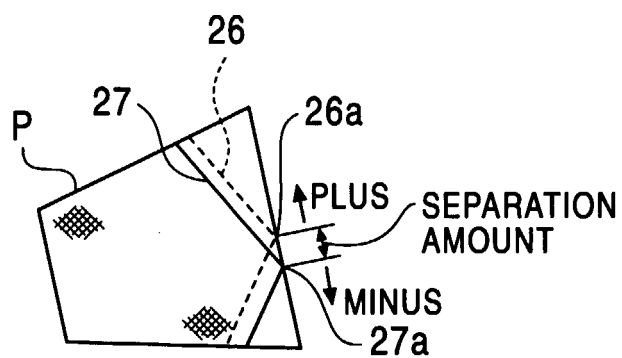


FIG. 4

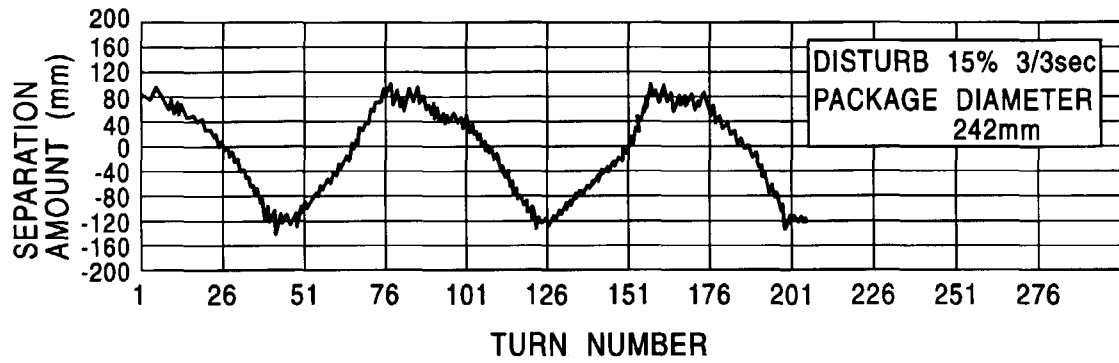


FIG. 5

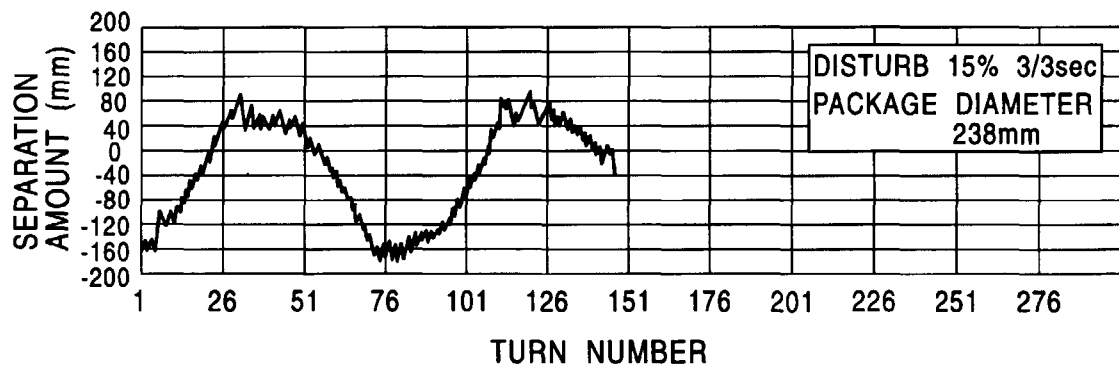


FIG. 6

