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(71) Applicant: **MURATA KIKAI KABUSHIKI KAISHA**
Minami-ku
Kyoto-shi
Kyoto 601 (JP)

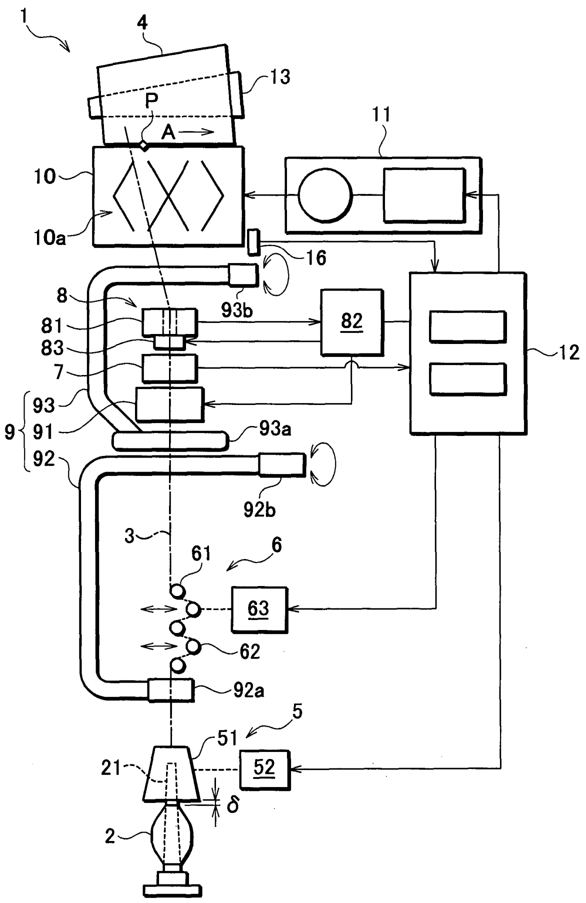
(72) Inventor: **Kawamoto, Kenji**
Fushimi-ku
Kyoto-shi
Kyoto (JP)

(74) Representative: **Liedl, Christine et al**
c/o Hansmann & Vogeser,
Albert-Rosshaupter-Strasse 65
81369 München (DE)

(54) **Textile machine**

(57) The present invention relates to a textile machine that eliminates yarn defects present in a traveling yarn. When configured to determine a yarn speed utilizing a speed such as a drum rotation speed which is not proportional to the real yarn speed, the textile machine may determine a value deviating from the actual yarn speed to be the correct yarn speed. When determining a yarn length on the basis of this yarn speed information, a yarn defect detecting device erroneously determines for a yarn defect. A winding unit 1 includes a yarn speed sensor 7 that directly detects the yarn speed of a traveling yarn 3, a yarn defect detecting device 8 that detects a yarn defect in the traveling yarn 3, and a traverse drum 10 that winds the yarn 3 having passed through the yarn sensor 7 and yarn defect detecting device 8. The yarn defect detecting device 8 includes a data converting section 82b that converts yarn thickness time varying data DT obtained in a time-oriented manner into yarn thickness length varying data DL on the basis of the detected value of the yarn speed and a yarn defect determining section 82b that determines for a yarn defect on the basis of the yarn thickness length varying data DL

FIGURE 1



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Description

Field of the Invention

[0001] The present invention relates to a textile machine comprising a yarn defect detecting device that determines for a yarn defect in a traveling yarn and a winding device that winds the yarn having passed through the yarn defect detecting device.

Background of the Invention

[0002] In the prior art, textile machines such as a winder (winding machine) for a spun yarn comprise a yarn defect detecting device that detects and eliminates yarn defects which are included in a yarn. Examples of the yarn defect detecting device include a photoelectric sensor that detects yarn thickness on the basis of an image of a yarn obtained by light irradiation, and a capacitance sensor that passes a yarn through electric fields to detect the capacitance of passing cross section of the yarn to determine the yarn thickness.

[0003] The yarn defect refers to the abnormal thickness of a yarn and includes a nep or slab in which the yarn forms a mass over a portion of about several millimeters, and too thick or thin a yarn having a yarn thickness different from the average one over a portion of several centimeters or more. Determination criteria are set according to the yarn defect level such as a nep or slab.

[0004] For example, where a yarn thickness equal to at least 150% of the average one extends at least 3 mm, the yarn is determined to have a slab. In this case, even when the yarn thickness detected by the yarn defect detecting device is at least 150% of the average one, where the defective portion extends less than 3 mm, the yarn is not determined to have a slab.

[0005] The determination of a yarn defect requires yarn length information. Here, the yarn length is equal to yarn traveling speed multiplied by time. Thus, information on the yarn traveling speed is provided to a yarn defect detecting device not having means for directly detecting the yarn length so that the yarn defect detecting device can calculate the length of a yarn defect portion having passed through the device.

[0006] The Unexamined Japanese Patent Application Publication Tokkai-Hei) No. 62-255366 discloses a winder having a rotation number detecting device (pulse generating device) in a traverse drum that winds a yarn into a package, so as to calculate the yarn speed from the rotation number of the traverse drum. With cheese (cylindrical) winding packages, the yarn speed is proportional to the rotation speed of the drum. This enables the yarn speed to be appropriately calculated from the rotation speed of the drum, and the calculated yarn speed is transmitted to the yarn defect detecting device, which can then correctly determine the yarn length in spite of a change in yarn speed.

[0007] Figure 4 shows the relationship between the peripheral speed (rotation speed) of a traverse drum and winding diameter (line (a)) and the relationship between the yarn speed and package winding diameter (line (b)) in connection with winding of cone winding packages carried out by a winder.

[0008] This winder, like the winder disclosed in the Unexamined Japanese Patent Application Publication (Tokkai-Hei) No. 62-255366, uses a traverse drum to wind a yarn into a package. In this winder, the rotation speed of the traverse drum is kept fixed except for the start of driving, when the speed is increased, and the end of driving, when the speed is decreased. The line (b) in Figure 4 shows the peripheral speed of the traverse drum instead of its rotation speed. This is because the peripheral speed of the traverse drum corresponds to the yarn speed.

[0009] However, for cone (truncated cone-like cylinder) winding packages, the yarn speed of the yarn being wound into a package is not always equal to the peripheral speed of the traverse drum. The yarn speed decreases gradually with increasing package winding diameter.

[0010] A variation in yarn speed is caused by the displacement of a substantial contact point (driving point) between a cone winding package and the traverse drum toward a larger diameter side, which displacement occurs in keeping with increasing winding diameter of the cone winding package. The rotation speed of the traverse drum is applied to the package at the driving point. Consequently, the driving point is displaced in the axial direction of the package. Thus, even with the fixed rotation speed of the traverse drum, the rotation speed of the package varies to vary the yarn speed of the yarn being wound into a package. The displacement of the driving point toward the larger diameter side is caused by the movement of center of gravity of the package toward the larger diameter side, which movement occurs in keeping with increasing winding diameter.

[0011] The mismatch between the drum rotation speed and the yarn speed is not limited to winders forming cone winding packages. Where wax is applied to the yarn that is to be wound into a cheese winding package, the yarn speed may be varied by slippage of the yarn in spite of the fixed drum rotation speed.

[0012] As described above, the yarn speed (drum peripheral speed) determined from the drum rotation speed may deviate from the actual one. Where the drum peripheral speed is different from the actual yarn speed, the yarn defect detecting device cannot appropriately determine the yarn length.

[0013] Figure 4 shows areas RA, RB in which the peripheral speed of the traverse drum 10 deviates from the actual yarn speed. In the area RA, in which the actual yarn speed is higher than the peripheral speed of the traverse drum 10, the yarn defect detecting device is too insensitive. In this case, the yarn defect detecting device may obtain a yarn length smaller than the actual one; the yarn defect detecting device may not determine that 3 mm of yarn has passed until 5 mm of yarn has passed. A determination criterion for a yarn defect is set for a yarn thickness (average yarn thickness) determined to correspond to the yarn defect and the length of a yarn defect portion. For example, the presence of a slab is determined where a portion with a yarn thickness equal to at least 150% of a reference value extends at least 3 mm. Then, the yarn defect detecting device determines a 3 mm slab to be a 1.8 mm (5/3 mm) abnormal-thickness portion; the yarn defect detecting device may fail to determine it to be a slab. In other words, a portion to be determined to be a yarn defect may be overlooked by the yarn defect detecting device.

[0014] On the contrary, in the area RB, in which the actual yarn speed is lower than the peripheral speed of the traverse drum 10, the yarn defect detecting device is too sensitive. Specifically, the yarn defect detecting device may obtain a yarn length larger than the actual one; the yarn defect detecting device may erroneously determine that 7 mm of yarn has passed though 5 mm of yarn has actually passed. This causes the yarn length of the yarn defect portion to be recognized to correspond to a yarn defect more serious than the actual one. In other words, the yarn defect detecting device may recognize a portion not to be determined to be a yarn defect as a yarn defect.

[0015] That is, the problem to be solved is that when the textile machine eliminating yarn defects in a traveling yarn is configured to determine the yarn speed by utilizing the speed such as the drum rotation speed which is not proportional to the real yarn speed, it may obtain a yarn speed that deviates from the actual one, so that when determining the yarn length on the basis of this yarn speed information, the yarn defect detecting device may erroneously determine for a yarn defect.

Summary of the Invention

[0016] A description has been given of the problem to be solved by the present invention. A description will be given of means for solving the problem.

[0017] A textile machine according to claim 1 comprises:

a yarn speed detecting device that directly detects a yarn speed of a traveling yarn or indirectly detects the yarn speed by detecting a rotation speed of a rotor rotating in direct proportion to the yarn speed, to output the detected value;

a yarn defect detecting device that detects a yarn defect in the traveling yarn; and

a winding device that winds the yarn having passed through the yarn speed detecting device and the yarn defect detecting device;

the yarn defect detecting device converts yarn thickness time varying data obtained in a time-oriented manner into yarn thickness length varying data on the basis of the detected value of the yarn speed, to determine for a yarn defect on the basis of the yarn thickness length varying data.

[0018] The above configuration has the following advantage.

[0019] The yarn length information required for the yarn defect detecting device can be accurately calculated on the basis of the time information obtained by the yarn defect detecting device 8 and the yarn speed transmitted by the yarn speed detecting device.

[0020] Claim 2 provides the textile machine according to claim 1, wherein the yarn speed detecting device utilizes a variation in the yarn thickness of the yarn to detect the moving speed of varying portion of the yarn by means of a spatial filter method to determine the moving speed of the varying portion to be the detected value of the yarn speed.

[0021] The above configuration has the following advantage.

[0022] The yarn speed is detected in a non-contact manner.

[0023] The present invention exerts the following effects.

[0024] According to claim 1, even with a change in yarn speed, the yarn defect detecting device does not determine the value deviating from the actual yarn speed to be the correct yarn speed. This allows the yarn length to be accurately determined, preventing yarn defects from being erroneously determined for.

[0025] Claim 2 not only exerts the same effect of claim 1 but also prevents the yarn from being subjected to a load in detecting the yarn speed.

Brief Description of the Drawings

[0026]

Figure 1 is a diagram showing the configuration of a winding unit.
Figure 2 is a diagram showing the configuration of a yarn defect detecting device.
Figure 3 is a graph showing yarn thickness length varying data.
Figure 4 is a graph showing the relationship between a drum and winding diameter (a) and the relationship between yarn speed and the winding diameter (b) which relationships are observed where the rotation speed of the drum is controlled to a fixed value.

Detailed Description of the Preferred Embodiments

[0027] An embodiment of the present invention will be described.
[0028] An automatic winder will be described with reference to Figure 1.
[0029] This automatic winder is a device that rewinds a yarn from a supplying package 2 produced by a spinning machine or the like to form a winding package 4 of a predetermined shape. The automatic winder comprises a large number of winding units 1 each responsible for rewinding.
[0030] As shown in Figure 1, the supplying package 2 is placed at the bottom of the winding unit 1, and a winding package 4 is placed at the top of the winding unit 1. The winding unit 1 has an unwinding assisting device 5, a variable tension device 6, a yarn splicing device 9, a yarn speed sensor 7, a yarn defect detecting device 8, and a traverse drum 10 arranged along a route for a yarn 3 which extends from the supplying package 2 to the winding package 4.
[0031] The winding unit 1 also comprises a drum driver 11 that rotationally drives the traverse drum 10, an encoder 16 that detects the rotation speed of the traverse drum 10, and a sequencer 12 that instructs the drum driver 11 to control rotational driving of the traverse drum 10.
[0032] The unwinding assisting device 5 controls an unwinding balloon that is generated when the yarn 3 is unwound from the supplying package 2 in its axial direction.
[0033] The unwinding assisting device 5 comprises an umbrella-shaped cylinder member 51 that covers a bobbin 21 of the supplying package 2, and a driving mechanism 52 that lowers the cylinder member 51 with a substantially fixed gap δ maintained between the cylinder member 51 and the chess portion of the supplying package 2. The cylinder member 51 is controlled to maintain a substantially fixed balloon diameter during unwinding, preventing an increase in balloon diameter in spite of progress of unwinding.
[0034] The variable tension device 6 applies a variable winding tension to the yarn 3 being unwound from the supplying package 2.
[0035] The variable tension device 6 comprises fixed comb teeth 61 and movable comb teeth 62 alternately arranged opposite one another across the route for the yarn 3, and a driving mechanism 63 such as a solenoid which increases or decreases the amount of engagement between the sets of fixed comb teeth 61 and movable comb teeth 62.
[0036] In accordance with a control signal from the sequencer 12, the variable tension device 6 controls the amount of engagement of the movable comb teeth 62 with the fixed comb teeth 61, that is, the degree of zigzag bend of the route. This make it possible to sequentially control the winding tension applied to the yarn 3.
[0037] The yarn speed sensor 7 is a device that detects the traveling speed (yarn speed) of the yarn 3 in a non-contact manner.
[0038] According to the present embodiment, the yarn speed sensor 7 utilizes a variation in yarn thickness to detect the moving speed of varying portion of the yarn by a spatial filter method, and the yarn speed sensor 7 then outputs the detected value.
[0039] More specifically, the yarn speed sensor 7 comprises a plurality of optical yarn thickness detecting devices arranged along the yarn traveling direction. The yarn speed sensor 7 detects the traveling speed of the yarn 3 using the spatial filter method on the basis of output signals from the yarn thickness detecting means, arranged at the different positions in the yarn traveling direction.
[0040] Each of the optical yarn thickness detecting devices comprises a light receiving element and a light source. The quality of light received by the light receiving element varies depending on the yarn thickness of the yarn 3 passing by the detection position of the yarn thickness detecting means. The yarn thickness detecting device then outputs an electric signal corresponding to the yarn thickness.
[0041] In the present embodiment, the yarn 3 is a spun yarn. Thus, fluffs may vary the yarn thickness in the length direction of the yarn 3. A fluffy portion of the yarn 3 in its length direction has an apparently larger thickness. Further, in this portion, the yarn thickness varies from average value through larger value to average value. Detecting the moving speed of the yarn thickness varying portion by the spatial filter method allows the yarn speed to be detected. This is because the moving speed is equal to the yarn speed.
[0042] To indirectly detect the yarn speed of the yarn 3, a roller (rotor) is placed so as to move in contact with and in conjunction with the yarn 3, and the rotation speed of the roller is then detected to determine the yarn speed. The yarn speed can be calculated from the rotation speed of the roller because it is proportional to the peripheral speed of the roller. In particular, the roller rotates in conjunction with traveling of the yarn 3 and in direct proportion to the yarn speed,

the rotation speed of the roller accurately reflects information on the yarn speed.

[0043] Where the roller in contact with the yarn 3 is used to indirectly detect the yarn speed, it is necessary to prevent possible slippage between the roller and the yarn 3. Thus, the roller for indirect yarn speed detection is placed on the route for the yarn 3 upstream of a waxing device (which applies wax) and an oiling device (which applies oil) in the yarn traveling direction.

[0044] Upon detecting a yarn defect such as a slab on the yarn 3, the yarn defect detecting device 8 cuts the yarn 3.

[0045] The yarn defect detecting device 8 comprises a yarn thickness detecting device 81 that detects the yarn thickness of the passing yarn 3, a yarn defect determining device 82 that determines whether or not the yarn thickness corresponds to a yarn defect, and a yarn cutting device 83 that cuts the yarn 3 when the yarn thickness is determined to correspond to a yarn defect.

[0046] The yarn thickness detecting device 81 and yarn defect determining device 82 will be described below in detail. During winding, the yarn defect determining device 82 determines for a yarn defect on the basis of information on the yarn thickness of the yarn 3 detected by the yarn thickness detecting device 81. When a yarn defect is detected, the yarn defect determining device 82 immediately instructs the yarn cutting device 83 to cut the yarn 3. This actuates the yarn cutting device 83, which forcibly cuts the yarn 3.

[0047] Simultaneously with the yarn cutting, a yarn traveling signal from the yarn thickness detecting device 81 is turned off, and the yarn defect determining device 82 senses the yarn breakage. The yarn defect determining device 82 then transmits a stop signal for the traverse drum 10 to the drum driver 11 via the sequencer 12 to stop the rotation of the traverse drum 10.

[0048] The yarn thickness detecting device 81 provided in the yarn defect detecting device 8 is in principle similar to the yarn thickness detecting device provided in the yarn speed sensor 7, and the yarn thickness detecting device 81 thus comprises a light receiving element and a light source. The yarn thickness detecting device 81 outputs an electric signal corresponding to the yarn thickness.

[0049] The yarn splicing device 9 splices a lower yarn of the supplying package 2 side and an upper yarn of the winding package 4. When a yarn breakage results from yarn cutting or the like carried out by yarn defect detecting device 8, the yarn 3 is separated into an upper yarn and a lower yarn. Thus, the yarn splicing device 9 carries out splicing to resume rewinding the yarn around the winding package 4. When the yarn traveling signal from the yarn thickness detecting device 81 is turned off, the yarn defect determining device 82 transmits a yarn splicing instruction signal to the yarn splicing device 9 via the sequencer 12 in order to actuate the yarn splicing device 9.

[0050] The yarn splicing device 9 comprises an air nozzle device 91 that uses an air current to entangle fibers of the upper yarn and lower yarn with one another for splicing, a lower yarn sucking device 92 that sucks, catches, and guides the lower yarn to the air nozzle device 91, and an upper yarn sucking device 93 that sucks, catches, and guides the upper yarn to the air nozzle device 91.

[0051] The lower yarn sucking device 92 comprises a main body composed of a suction pipe that sucks and catches the yarn 3, and a suction port 92a at the leading end of the suction pipe is pivotable around an axis 92b at the trailing end of the suction pipe. Vertical pivoting of the suction pipe moves the suction port 92a between the air nozzle device 91 and a position above the unwinding assisting device 5. The upper yarn sucking device 93 is similarly configured. The upper yarn sucking device 93 comprises a main body composed of a suction pipe that sucks and catches the yarn 3. A suction port 93a at the leading end of the suction pipe is pivotable around an axis 93b at the trailing end of the suction pipe. Vertical pivoting of the suction pipe moves the suction port 93a between the air nozzle device 91 and a peripheral surface of the winding package 4.

[0052] When the yarn defect detecting device 8 forcibly cuts the yarn 3 on the basis of detection of a yarn defect by the yarn defect detecting device 8, the upper yarn is wound around the winding package 4, and on the basis of the yarn splicing instruction signal, the lower yarn is caught by the lower yarn sucking device 92 having the suction port 92a standing by above the unwinding assisting device 5.

[0053] Then, on the basis of the yarn splicing instruction signal, the upper yarn is caught by the upper yarn sucking device 93 having the suction port 93a standing by over the peripheral surface of the winding package 4.

[0054] The lower yarn sucking device 92 subsequently moves the suction port 92a upward to guide the lower yarn to the air nozzle device 91, and the upper yarn sucking device 93 moves the suction port 93a downward to guide the upper yarn to the air nozzle device 91. The air nozzle device 91 splices the upper yarn and lower yarn together.

[0055] After the yarn splicing operation, the rotational driving of the traverse drum 10 is resumed in accordance with an instruction from the sequencer 12, and winding is then carried out again.

[0056] The traverse drum 10 is a device that transversely wounds the yarn 3 into the winding package 4.

[0057] More specifically, the traverse drum 10 has a function (traverse means) for swinging the yarn 3 in the axial direction of the winding package 4 and a function (winding means) for rotating the winding package 4 to wind the yarn 3 on the winding package 4.

[0058] The function serving as winding means is implemented by forming the traverse drum 10 into a cylindrical rotating member. The traverse drum 10 is placed so that its outer peripheral surface contacts with the outer peripheral surface of the winding package 4. In this state, rotation of the traverse drum 10 rotates the winding package 4 in conjunction with the traverse drum 10.

[0059] The function serving as traverse means is implemented by a groove (traverse groove) 10a which is formed in the outer peripheral surface of the traverse drum 10 and through which the yarn 3 is guided. This groove is formed so as to be displaced in the axial direction of the traverse drum 10 along its circumferential direction. The yarn 3 guided through the groove 10a is swung in the axial direction of the traverse drum 10 in conjunction with rotation of the traverse drum 10.

[0060] The device that transversely wounds the yarn 3 into the winding package 4 is not limited to the traverse drum 10 integrally comprising the traverse means and winding means. The device serving as the traverse means may be separated from the device serving as the winding means. For example, the traverse means may be a device that swings the yarn guide in the axial direction of the winding package 4, whereas the winding means may be a simple cylindrical rotating member (drum) without any yarn guide groove.

[0061] Now, with reference to Table 1, a description will be given of determination criteria for yarn defects will be described.

[0062] On data (yarn thickness time varying data DT described below) on the yarn thickness of the yarn 3 obtained in a time-oriented manner and the determination criteria for yarn defects shown in Table 1, the yarn defect detecting device 8 determines whether or not there is a yarn defect on the yarn 3 passing by the detection position of the yarn defect detecting device 8.

[Table 1]

		Corresponding thickness	Monitored length
Yarn defect level	Nep	At least Pn (200%)	Ln (0mm)
	Slab	At least Ps (150%)	Ls (3mm)
	thick yarn	At least Pl (110%)	Ll (100cm)
	thin yarn	At most Pt (90%)	Lt (100cm)

[0063] As shown in Table 1, the determination criteria for yarn defects are classified according to the yarn defect level. The following are set for each yarn defect level: the length (monitored length) over which the yarn length is monitored and a thickness boundary value (corresponding thickness) at which the average yarn thickness within the monitored length is determined to correspond to a yarn defect. The thickness boundary value means a lower limit value at which the thickness is determined to a yarn defect in case of thick a yarn, a slab, or the like, or an upper limit value at which the thickness is determined to correspond to a yarn defect in case of thin a yarn.

[0064] Each of the percentages (%) shown in the level column indicates the ratio of the thickness to the reference value (hereinafter referred to as a reference yarn thickness). The reference yarn thickness is such a value as obtained by averaging yarn thicknesses over a sufficiently long distance (for example, 100 m) and as considered to be the average of the yarn thickness over the entire yarn 3.

[0065] For example, the determination criteria in Table 1 show that the yarn is determined to have a slab where the monitored length is 3 mm and where the average yarn thickness is at least 150% of the reference yarn thickness. Here, even if the yarn thickness is less than 150%, for example, 120%, of the reference value in any portion, the yarn 3 is determined to have a slab as long as the average yarn thickness exceeds 150% over the 3 mm portion. On the other hand, where the average yarn th i ckness is less than 150% within the 3 mm port i on, the yarn is not determined to have a slab.

[0066] With reference to Figure 2, a detailed description will be given of configuration of the yarn defect detecting device 8 for detection of yarn detects.

[0067] The yarn defect detecting device 8 requires yarn length information to determine for a yarn defect in accordance with the determination criteria (Table 1) set for the yarn thicknesses corresponding to the abnormal portions and the yarn lengths for the abnormal portions. The yarn defect detecting device 8 comprises no means for directly detecting the yarn length itself. Accordingly, the yarn defect detecting device 8 calculates the yarn length on the basis of time information obtained by the yarn defect detecting device 8 and information on the yarn speed transmitted by the yarn speed sensor 7, serving as an external device.

[0068] The yarn defect detecting device 8 comprises the yarn thickness detecting device 81 and the yarn defect determining device 82. The yarn defect determining device 82 further comprises a yarn thickness storing section 82a, a data converting section 82b, a determination criteria storing section 82c, and a yarn defect determining section 82d.

[0069] The yarn defect detecting device 8 converts yarn thickness time varying data DT obtained in a time-oriented manner into yarn thickness length varying data DL on the basis of the detected value of the yarn speed detected by the yarn speed sensor 7. The yarn defect determining device 8 then determines for a yarn defect on the basis of the yarn thickness length varying data DL.

[0070] The yarn thickness time varying data DT is created by the yarn thickness storing section 82a by arranging instantaneous values of the yarn thickness in a time-oriented manner; the yarn thickness storing section 82a stores the instantaneous values of the yarn thickness detected by the yarn thickness detecting device 81.

[0071] The data converting section 82b converts the yarn thickness time varying data DT into the yarn thickness length varying data DL on the basis of the detected value of the yarn speed detected by the yarn speed sensor 7, that is, utilizing the fact that the product of time and speed is distance.

[0072] The yarn defect determining section 82d determines for a yarn defect on the basis of the yarn thickness length varying data DL and the determination criteria for the yarn defects. Information (yarn defect determination reference data DS) corresponding to the determination criteria for the yarn defects is stored in the determination criteria storing section 82c.

[0073] A further detailed description will be given of the process of determining for a yarn defect which process is executed by the yarn defect detecting device 8.

[0074] First, while the yarn 3 is traveling, the yarn thickness detecting device 81 constantly detects the instantaneous value of the yarn thickness and outputs the detected value (instantaneous value of the yarn thickness).

[0075] The instantaneous values of the yarn thickness output by the yarn thickness detecting device 81 are stored in the yarn thickness storing section 82a in a time-oriented manner. The yarn thickness storing section 82a stores the yarn thickness time varying data DT as created, which comprises the instantaneous values of the yarn thickness arranged in a time-oriented manner. The yarn thickness time varying data DT in principle indicates the relationship between the detection continuation time having elapsed since the start of detection of the yarn 3 by the yarn thickness detecting device 81 and the yarn thickness varying depending on the detection continuation time. In the present embodiment, the origin of a time axis in the yarn thickness time varying data DT is not the detection continuation time but the time when the formation of a winding package 4 is started.

[0076] Then, the data converting section 82b converts the yarn thickness time varying data DT into yarn thickness length varying data DL, which is then output. The yarn thickness length varying data DL in principle indicates the relationship between the yarn length over which the yarn 3 travels from the start of detecting of the yarn 3 by the yarn thickness detecting device 81 until the passage of the yarn 3 through the yarn thickness detecting device 81, and the yarn thickness varying depending on the yarn length. In the present embodiment, the yarn length in the yarn thickness length varying data DL is not the length of the yarn having passed through the yarn thickness detecting device 81 but the length of the yarn wound into the winding package 4. This conversion is possible because the distance from the yarn thickness detecting device 81 to the position where the yarn 3 is wound around the winding package 4 is clear owing to the configuration of the winding unit 1.

[0077] The data converting section 82b converts the data DT into the data DL on the basis of the value of the yarn speed detected by the yarn speed sensor 7. The conversion utilizes the fact that the product of yarn speed and time is equal to distance (yarn length).

[0078] The determination criteria storing section 82c pre-stores the data (yarn defect determination criteria data DS in Figure 2) corresponding to such determination criteria for the yarn defects as shown in Table 1. The setting contents (monitored lengths and corresponding lengths) in the yarn defect determination criteria data DS can be rewritten by operating an external input device connected to the yarn defect determining device 82.

[0079] Then, the yarn defect determining section 82d determines for a yarn defect on the yarn 3 on the basis of the yarn thickness length varying data DL and the yarn defect determination criteria.

[0080] The yarn defect determination criteria include a plurality of yarn defect levels, and a monitored length and a thickness corresponding to the monitored length which are set for each of the yarn defect levels, as described above with reference to Table 1.

[0081] Accordingly, the yarn defect determining section 82d determines whether or not the average yarn thickness detected value (average yarn thickness) over each monitored length falls under the thickness corresponding to that monitored length, so as to enable the different levels of yarn defects to be simultaneously detected. This will be described below in detail.

[0082] Thus, the yarn defect determining section 82d comprises an average yarn thickness calculating section 82dl that averages the yarn thickness detected values over the monitored length and a comparative determining section 82d2 that compares the average yarn thickness with the corresponding thickness to determine that a yarn defect has occurred where the average yarn thickness exceeds the corresponding thickness.

[0083] With reference to Figure 3, a detailed description will be given of the determination for a yarn defect executed by the yarn defect determining section 82d.

[0084] Figure 3 shows the yarn thickness length varying data DL. The axis of ordinate corresponds to yarn thickness, and the axis of abscissa in Figure 3 corresponds to yarn length. The yarn length on the axis of abscissa corresponds to the entire length of the yarn 3 wound into the winding package 4 as previously described.

[0085] For the latest part of the yarn thickness length varying data DL, the average yarn thickness calculating section 82dl constantly averages the yarn thicknesses detected over the monitored length corresponding to each yarn defect level to calculate the average yarn thickness. Here, the latest part means that the part for which the time when the yarn 3 passes through the yarn thickness detecting device 81 is latest.

[0086] For example, to determine for the presence of a slab, the average yarn thickness calculating section 82d1 constantly averages, for the latest part of the yarn thickness length varying data DL, the yarn thickness values detected over the monitored length Ls (for example, 3 mm) corresponding to a slab to calculate an average yarn thickness for determining slab As. The average yarn thickness for determining slab As is utilized by the comparative determining section 82d2 to determine a slab.

[0087] To determine for the presence of a thick yarn, the average yarn thickness calculating section 82dl constantly averages, for the latest part of the yarn thickness length varying data DL, the yarn thickness values detected over the monitored length Ll (for example, 100 cm) corresponding to the thick yarn to calculate an average yarn thickness for determining thick yarn Al. The average yarn thickness for determining thick yarn Al is utilized by the comparative determining section 82d2 to determine for the thick yarn.

[0088] For each yarn defect level such as a slab, the comparative determining section 82d2 compares the average yarn thickness calculated by the average yarn thickness calculating section 82dl with the thickness corresponding to that level. Where the average yarn thickness exceeds the corresponding thickness, the comparative determining section 82d2 determines that a yarn defect has occurred.

[0089] For example, to determine for the presence of a slab, the comparative determining section 82d2 compares the average yarn thickness for determining slab As calculated by the average yarn thickness calculating section 82dl with a thickness Ps corresponding to a slab. Where the average yarn thickness for determining slab As exceeds the corresponding thickness Ps, the comparative determining section 82d2 determines that a slab has occurred. To determine for the presence of a nep, the comparative determining section 82d2 compares an average yarn thickness for determining nep An calculated by the average yarn thickness calculating section 82dl with a thickness Pn corresponding to a nep. Where the average yarn thickness for determining nep An exceeds the corresponding thickness Pn, the comparative determining section 82d2 determines that a nep has occurred. For a nep, the monitored length Ln corresponding to a nep is set at, for example, 0. Consequently, immediately after the yarn thickness detecting device 81 detects a yarn thickness exceeding the corresponding thickness An, the comparative determining section 82d2 determines that a nep has occurred.

[0090] Upon determining that a yarn defect has occurred, the yarn defect determining device (comparative determining section 82d2) instructs the yarn cutting device 83 to cut the traveling yarn 3.

[0091] Now, a description will be given of the relationship between the yarn speed and the rotation speed of the traverse drum 10.

[0092] The rotation speed of the traverse drum 10 is to be controlled by the sequencer 12. Accordingly, provided that the yarn speed can be correctly calculated on the basis of the rotation speed, the yarn speed sensor 7 need not detect the yarn speed.

[0093] However, where the yarn 3 is wound into the cone winding package 4, there is a complicated relationship between the rotation speed of the traverse drum 10 and the yarn speed of the yarn 3 in connection with the winding of the yarn 3. It is thus very difficult to correctly calculate the yarn speed on the basis of the rotation speed.

[0094] Thus, the yarn speed sensor 7 that can appropriately detect the yarn speed can be effectively provided in each winding unit 1.

[0095] A description will be given of the actual relationship between the rotation speed of the traverse drum 10 and the yarn speed.

[0096] With reference to Figure 4, a description will be given of a variation in yarn speed which occurs where the rotation speed of the traverse drum 10 is fixed.

[0097] A line (a) in Figure 4 shows the relationship between the peripheral speed of the traverse drum 10 and the winding diameter. The peripheral speed Vd is indicated by a thick solid line. The peripheral speed Vd has a fixed value.

[0098] A line (b) in Figure 4 shows the relationship between the traveling speed (yarn speed) of the yarn 3 and the winding diameter. The traverse average value of the yarn speed is indicated by a thick broken line. The upper and lower limits of instantaneous value of yarn speed, which varies across the average value, are indicated by thin broken lines. Here, the instantaneous value of the yarn speed varies at a traverse period under the effect of traversing. This is because during traversing, the yarn 3 is swung in the axial direction of the winding package 4 to vary the path length of the yarn 3 extending from the traverse drum 10 to the winding package 4, thus expanding or contracting the yarn 3.

[0099] The yarn speed sensor 7 detects the instantaneous value of the yarn speed.

[0100] In Figure 4, the axis of abscissa is a magnitude axis indicating the winding diameter of the winding package 4, and the axis of ordinate is a speed axis indicating the yarn speed or peripheral speed.

[0101] In the line (a) in Figure 4 shows the peripheral speed of the traverse drum 10 instead of its rotation speed. This is because the speed corresponding to the yarn speed is not the rotation speed of the traverse drum 10 but its peripheral speed. This will be described below in further detail. The peripheral speed of the traverse drum 10 is determined by the rotation speed of the traverse drum 10 and its diameter.

[0102] Further, the winding diameter of the winding package 4 increases as the time passes. Accordingly, the axis of abscissa in Figure 4 is generally a time axis.

[0103] As the line (a) shown in Figure 4, with the fixed peripheral speed (rotation speed) of the traverse drum 10, the yarn speed decreases gradually with increasing winding diameter of the winding package 4 as the line (b) in Figure 4.

[0104] In the present embodiment, the yarn speed is higher than the peripheral speed of the traverse drum 10, which is fixed, at the beginning of winding (smaller winding diameter), and is lower than the peripheral speed of the traverse drum 10 at the end of winding (larger winding diameter).

[0105] That is, the yarn speed varies depending on the winding diameter of the winding package 4.

[0106] Now, factors determining the yarn speed will be described.

[0107] The yarn speed is generally proportional to the rotation speed of the winding package 4. This is because the yarn 3 is wound into the winding package 4 and thus pulled to travel on the yarn traveling path in the winding unit 1. The only driving means for running the yarn 3 is the traverse drum 10, which rotates the winding package 4.

[0108] However, where the yarn 3 is wound into the cone winding package 4, then with the fixed rotation speed of the traverse drum 10, the displacement of a driving point P described below varies the rotation speed of the winding package 4.

[0109] First, the cone winding package 4 will be described.

[0110] The bobbin 13 for the winding package 4 is shaped like a cone (truncated cone-like cylinder). The yarn 3 is wound around an outer peripheral surface of the bobbin 13 while being traversed. This makes the winding diameter of the yarn 3 uniform in the axial direction of the bobbin 13. Thus, winding the yarn around the bobbin 13 results in the cone winding package 4.

[0111] The bobbin 13 is supported by a cradle arm (not shown in the drawings) so that the outer peripheral surface of the winding package 4 (bobbin 13) is always in contact with the outer peripheral surface of the traverse drum 10. The position where the bobbin 13 is supported by the cradle arm varies with increasing winding diameter of the winding package 4 formed on the bobbin 13.

[0112] Since the winding package 4 and bobbin 13 are each shaped like a cone, the bobbin 13 is supported by the cradle arm so that the lower end of outer peripheral surface of the winding package 4 (bobbin 13) is parallel to the upperend of outer peripheral surface of the traverse drum 10. This makes it possible to keep the entire lower end of outer peripheral surface of the winding package 4 (bobbin 13) in contact with the entire upper end of outer peripheral surface of the traverse drum 10. In this case, the bobbin 13 is located above the traverse drum 10.

[0113] The driving point P (substantial contact point between the winding package 4 and the traverse drum 10) will be described.

[0114] While the traverse drum 10 is stationary, the entire lower end of outer peripheral surface of the winding package 4 (bobbin 13) is in contact with the entire upper end of outer peripheral surface of the traverse drum 10. In other words, the outer peripheral surfaces of the winding package 4 and traverse drum 10 are in line contact with each other.

[0115] In contrast, while the traverse drum 10 is being rotationally driven, the outer peripheral surfaces of the winding package 4 and traverse drum 10 are substantially in point contact with each other at one point. The position of the point contact corresponds to the driving point P. That is, the winding package 4 (bobbin 13) is provided with the rotating force of the traverse drum 10 only at the driving point P.

[0116] The winding package 4 (bobbin 13) is provided with the rotating force only at the driving point P for the following reason.

[0117] Since the winding package 4 (bobbin 13) is conical, its outer peripheral length varies in its axial direction. On the other hand, the peripheral speed provided by the traverse drum 10 is the same regardless of the axial position on the winding package 4 (bobbin 13). When the winding package 4 (bobbin 13) is provided with the same peripheral speed at its different axial positions, this means that the winding package 4 (bobbin 13) is provided with different rotation speeds owing to its varying outer peripheral length. Where the winding package 4 (bobbin 13) has a stable shape, it is impossible that the rotation speed of the winding package 4 varies at different axial positions. Consequently, the rotating force of the traverse drum 10 is substantially transmitted to the winding package 4 (bobbin 13) only at one axial point (driving point P) on the winding package 4 (bobbin 13).

[0118] The driving point P serves as a balancing center position of the winding package 4 (bobbin 13) in contact with the traverse drum 10. This balancing center position is determined by a position of the center of gravity of the winding package 4 (bobbin 13) and the magnitude of the supporting force exerted by the cradle arm that exerts to support the opposite axial ends of the bobbin 13.

[0119] The position of the center of gravity of the winding package 4 (bobbin 13) is displaced toward a larger diameter side in response to an increase in winding diameter resulting from the progress of winding of the yarn 3.

[0120] Thus, the driving point P moves toward the larger diameter side of the winding package 4 as the winding diameter of the winding package 4 increases, as shown by arrow A (Figure 1).

[0121] The rotation speed of the winding package 4 decreases as the driving point P is displaced toward the larger diameter side in keeping with increasing winding diameter. The reason is as follows.

[0122] At a fixed rotation speed of the traverse drum 10, the traverse drum 10 has a fixed peripheral speed. Further, as previously described, the traverse drum 10 and the winding package 4 are in contact with each other substantially only at the driving point P. The fixed peripheral speed is applied to the winding package 4 at the driving point P. When the driving point P moves toward the larger diameter side of the winding package 4 with the peripheral speed of the traverse drum 10 fixed, the outer peripheral length of the winding package 4 increases at the driving point P. This increases the time required to allow the winding package 4 to make one rotation. In other words, the displacement of the driving point P toward the larger diameter side decreases the rotation speed of the winding package 4. Moreover, an increase in winding diameter itself uniformly increases the outer peripheral length of the winding package 4.

[0123] Thus, with an increase in the winding diameter of the winding package 4, the displacement of the driving point P toward the larger diameter side and the increase in winding diameter itself are combined with the increase in outer peripheral length to contribute to decreasing the rotation speed of the winding package 4. The line (b) in Figure 4 reflects this situation.

[0124] As described above, the yarn speed (drum peripheral speed) determined from the rotation speed of the traverse drum 10 may deviate from the actual one. Where the drum peripheral speed is different from the actual yarn speed, the yarn defect detecting device cannot appropriately determine the yarn length.

[0125] Figure 4 shows areas RA, RB in which the peripheral speed of the traverse drum 10 deviates from the actual yarn speed. In the area RA, in which the actual yarn speed is higher than the peripheral speed of the traverse drum 10, the yarn defect detecting device is too insensitive. In this case, the yarn defect detecting device 8 may obtain a yarn length smaller than the actual one; the yarn defect detecting device 8 may not determine that 3 mm of yarn has passed until 5 mm of yarn has passed. The determination criterion for a yarn defect is set for the yarn thickness (average yarn thickness) determined to correspond to the yarn defect and the length of the yarn defect portion. For example, the presence of a slab is determined when a portion with a yarn thickness equal to at least 150% of a reference value extends at least 3 mm. Then, the yarn defect detecting device 8 determines a 3 mm slab to be a 1.8 mm (5/3 mm) abnormal-thickness portion; the yarn defect detecting device 8 may fail to determine it to be a slab. In other words, a portion to be determined to be a yarn defect may be overlooked by the yarn defect detecting device 8.

[0126] On the contrary, in the area RB, in which the actual yarn speed is lower than the peripheral speed of the traverse drum 10, the yarn defect detecting device 8 is too sensitive. Specifically, the yarn defect detecting device 8 may obtain a yarn length larger than the actual one; the yarn defect detecting device 8 may erroneously determine that 7 mm of yarn has passed though 5 mm of yarn has actually passed. This causes the yarn length of the yarn defect portion to be recognized to correspond to a yarn defect more serious than the actual one. In other words, the yarn defect detecting device 8 may determine the portion which should not be determined as a yarn defect to be a yarn defect.

[0127] As described above, the yarn defect detecting device 8 obtains yarn length information (yarn thickness length varying data DL) on the basis of the yarn speed detected by the yarn speed sensor 7, which serves as a yarn speed detecting device.

[0128] Thus, even with a change in yarn speed, the yarn defect detecting device 8 does not determine the value deviating from the actual yarn speed to be the correct yarn speed. This allows the yarn length to be accurately determined, preventing yarn defects from being erroneously determined for.

[0129] In traversing, the yarn speed varies depending on the traverse period. However, this variation in yarn speed can be sensed by the yarn speed sensor 7, which detects the instantaneous value of the yarn speed. Thus, the yarn thickness length varying data DL reflects the variation in yarn speed caused by traversing; the yarn thickness length varying data DL is obtained by converting the yarn thickness time varying data DT on the basis of the yarn speed.

[0130] Where the corresponding length in the yarn defect determination criteria is shorter than the length required for one winding of the winding package 4, the variation in yarn speed caused by traversing affects the yarn defect determination. For example, it is assumed that the length Ls corresponding to a slab is 3 mm and that the length required for one winding of the winding package 4 (length over which the yarn travels during one traverse period) is 20 cm. For a portion with a higher yarn speed within the traverse period, the slab determination is lax. For a portion with a lower yarn speed within the traverse period, the slab determination is stringent.

[0131] The yarn defect detecting device 8 uses the instantaneous value of the yarn speed to convert the yarn thickness time varying data DT into the yarn thickness length varying data DL. The yarn defect detecting device 8 thus deals with the variation in yarn speed caused by traversing and is prevented from incorrectly determining for a yarn defect.

[0132] Strictly speaking, the instantaneous value of the yarn speed cannot be determined using the yarn speed sensor 7. This is because the time width required to detect the yarn speed varies depending on the yarn speed.

[0133] With the spatial filter scheme, frequency, on the basis of which the yarn speed is determined, varies depending on the yarn speed. This varies the time required to detect the yarn speed. Further, with an encoder, pulsing interval, on the basis of which the yarn speed is determined, varies depending on the yarn speed. This varies the time required to detect the yarn speed.

[0134] However, the time width required to detect the yarn speed corresponds to the time required for a given point on the yarn 3 to have passed by the yarn speed sensor 7. The time width is thus much shorter than the traverse period. Consequently, in connection with the traverse period, the yarn speed detected by the yarn speed sensor 7 can be considered to be the instantaneous value of the yarn speed.

Claims

1. A textile machine comprising:

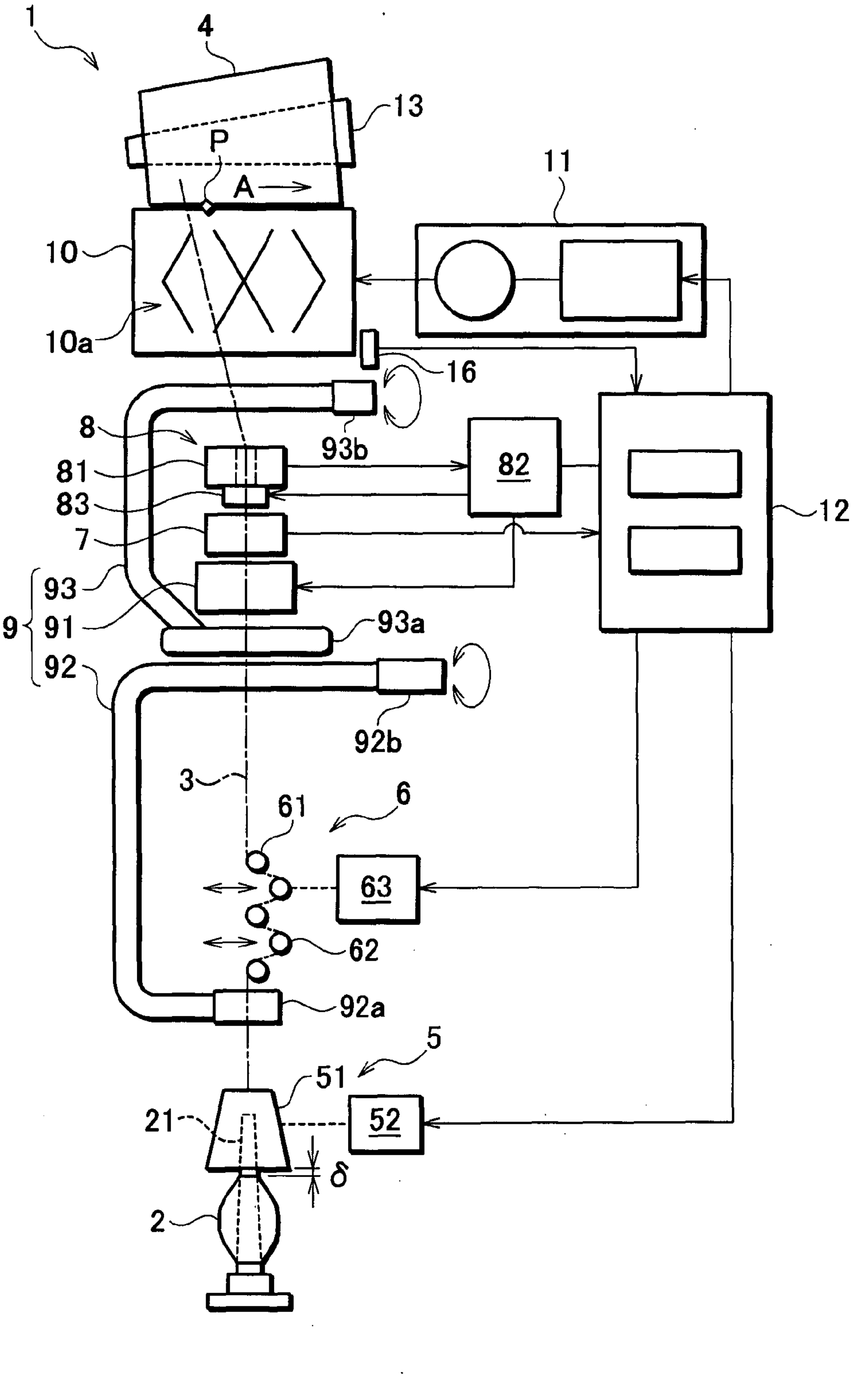
a yarn speed detecting device that directly detects a yarn speed of a traveling yarn or indirectly detects the yarn speed by detecting a rotation speed of a rotor rotating in direct proportion to the yarn speed, to output the detected value,
a yarn defect detecting device that detects a yarn defect in the traveling yarn, and
a winding device that winds the yarn having passed through the yarn speed detecting device and the yarn defect detecting device, the textile machine being

characterized in that:

the yarn defect detecting device converts yarn thickness time varying data obtained in a time-oriented manner into yarn thickness length varying data on the basis of the detected value of the yarn speed, to determine for a yarn defect on the basis of the yarn thickness length varying data.

2. A textile machine according to Claim 1, **characterized in that** the yarn speed detecting device utilizes a variation in the yarn thickness of the yarn to detect the moving speed of varying portion of the yarn by means of a spatial filter method to determine the moving speed of the varying portion to be the detected value of the yarn speed.

FIGURE 1


1
4
13
P
A
11
10
10a
16
8
93b
81
82
83
12
7
93
9
91
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92b
3
6
61
63
62
92a
5
51
21
52
δ
2

FIGURE 2

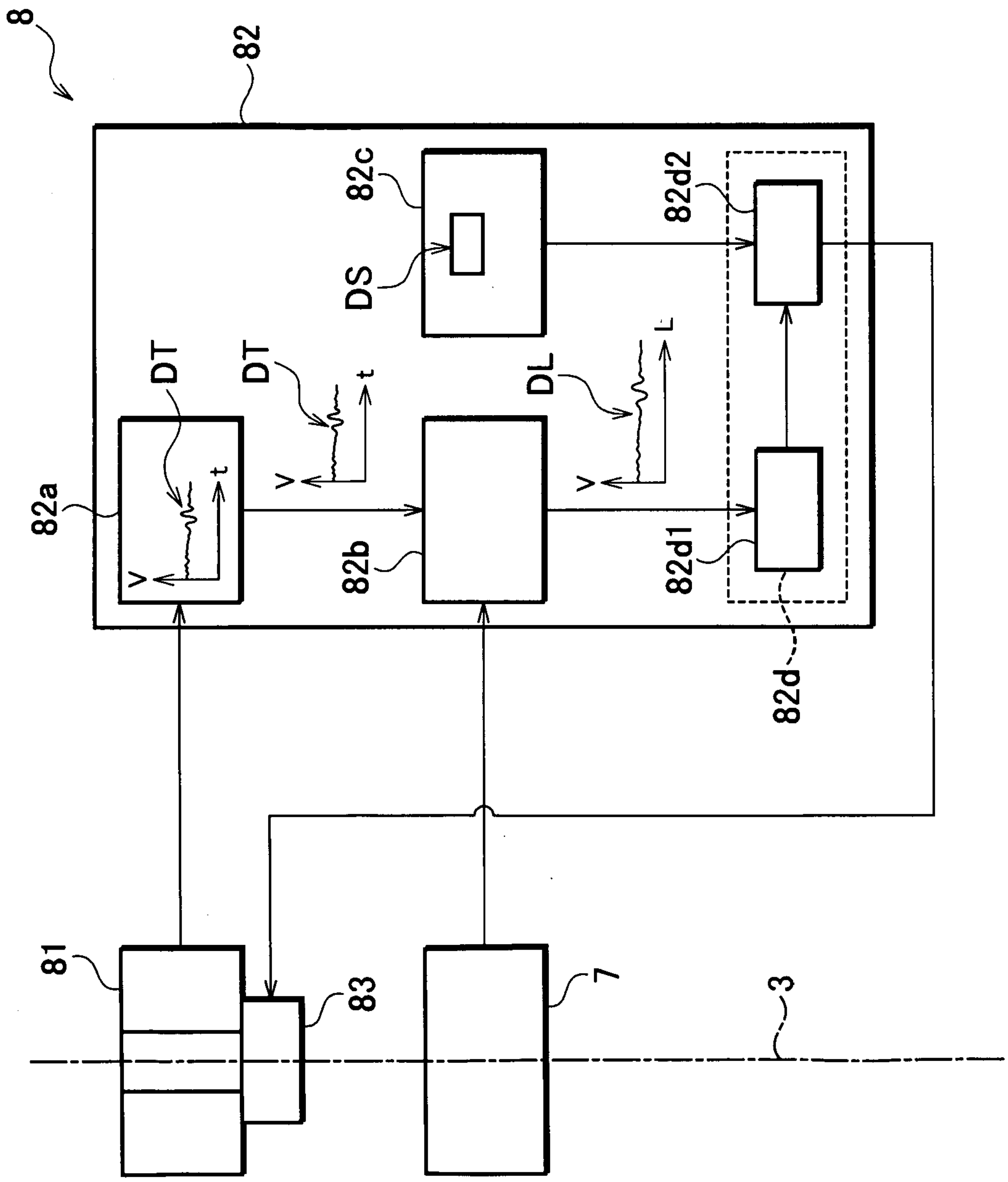


FIGURE 3

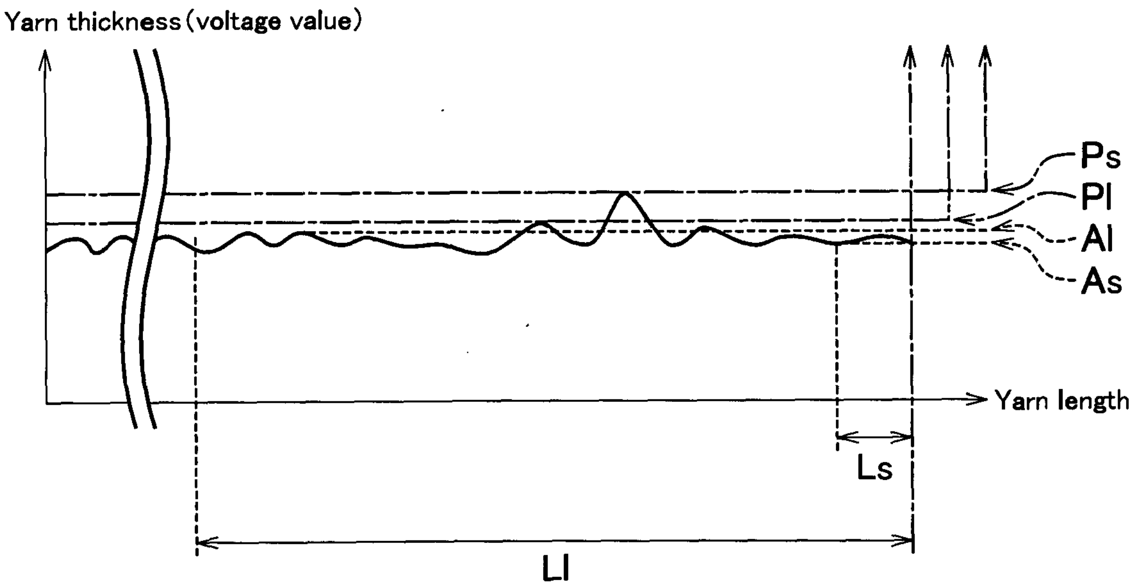
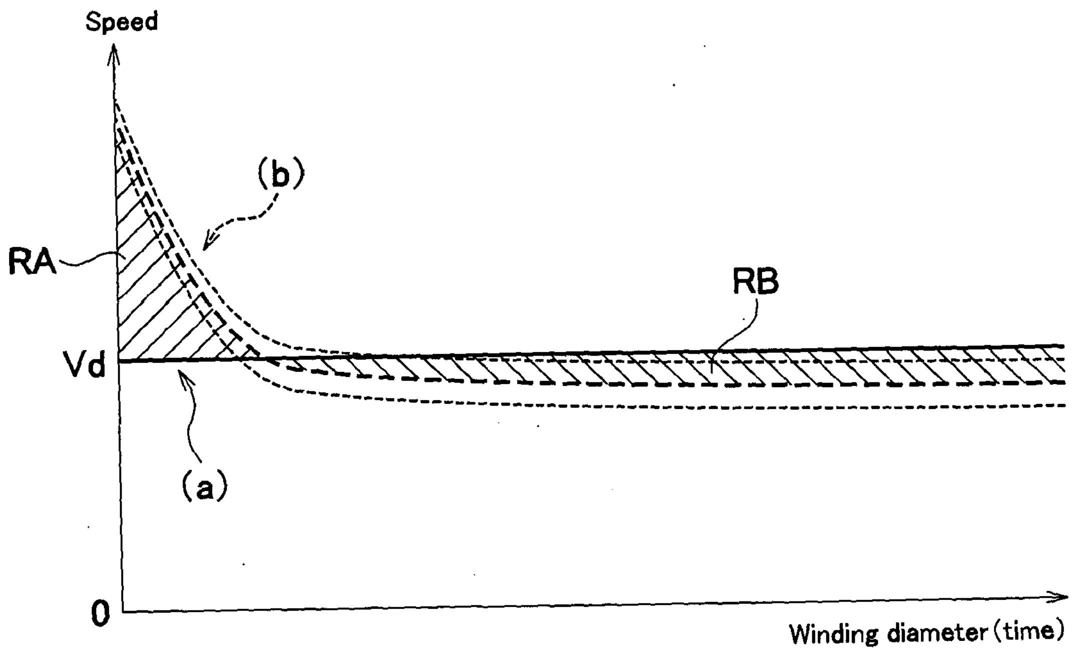


FIGURE 4



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EUROPEAN SEARCH REPORT

Application Number
EP 06 02 4231

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