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

(11) EP 3 327 186 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
24.07.2019 Bulletin 2019/30

(21) Application number: **15901887.8**

(22) Date of filing: **30.10.2015**

(51) Int Cl.:
D01H 4/08 (2006.01) ***D02G 3/04*** (2006.01)
D02G 3/34 (2006.01) ***D01H 4/32*** (2006.01)
D01H 4/44 (2006.01)

(86) International application number:
PCT/CN2015/000738

(87) International publication number:
WO 2017/031613 (02.03.2017 Gazette 2017/09)

(54) **ROTOR SPINNING METHOD AND APPARATUS USING TWO-COTTON-SLIVER ASYNCHRONOUS INPUT AND THREE-STAGE CARDING**

ROTORSPINNVERFAHREN UND -VORRICHTUNG MIT ASYNCHRONER EINFÜHRUNG VON ZWEI BAUMWOLLBÄNDERN UND DREISTUFIGER KARDIERUNG

PROCÉDÉ ET APPAREIL DE FILATURE À ROTOR UTILISANT L'INTRODUCTION ASYNCHRONE DE DEUX RUBANS DE FIBRES DE COTON ET UN CARDAGE À TROIS ÉTAGES

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

(30) Priority: **21.08.2015 CN 201510516137**

(43) Date of publication of application:
30.05.2018 Bulletin 2018/22

(73) Proprietor: **Jiangnan University**
Wuxi, Jiangsu 214122 (CN)

(72) Inventors:
- **XUE, Yuan**
  Wuxi
  Jiangsu 214122 (CN)
- **GAO, Weidong**
  Wuxi
  Jiangsu 214122 (CN)
- **YANG, Ruihua**
  Wuxi
  Jiangsu 214122 (CN)
- **GUO, Mingrui**
  Wuxi
  Jiangsu 214122 (CN)

(74) Representative: **Berkkam, Ayfer**
Berkkam Patent Consulting
Büklüm Sokak, No. 5/16-3
06680 Kavaklidere Ankara (TR)

(56) References cited:
EP-A2- 1 352 998 **EP-A2- 1 564 318**
CN-A- 1 298 969 **CN-A- 103 911 697**
CN-A- 103 938 322 **CN-A- 103 938 322**
CN-A- 104 711 730 **CN-U- 203 795 057**
CN-U- 205 133 850 **JP-B1- S4 819 567**

EP 3 327 186 B1

Description

TECHNICAL FIELD

[0001] The present invention relates the field of rotor spinning in the textile industry.

BACKGROUND

[0002] The basic principle of the rotor spinning yarn is that the sliver is fed through the trumpet and is held by a feeding plate and a feeding roller. The feeding roller rotates to feed the sliver to the carding area. The sliver is opened and stripped, carded separately and mixed by the carding roller, which rotates at a high speed in the carding area, so that the sliver becomes single fibers which are separated and arranged in parallel to each other. The single fibers enter into a fiber transport channel. Under the action of air flow, the fiber flows into the rotor through the fiber transport channel. With the centrifugal force of the rapidly rotating rotor, the fibers in the collection groove are further piled up and mixed, and then the fibers are jointed with the mother-yarn and twisted by a navel to form a yarn.

[0003] In the Patent "Rotor spinning melange yarn forming method and device and product (Application No. CN201410190891.1)" and "Device of spinning rotor spun melange yarn (CN201420229715.X)", the speed of the feeding roller is controlled to keep feeding in an invariable amount, or two or more drawn slivers are fed in segments in different amounts, resulting in a blending ratio that has a monochromatic or a multi-color fiber mixture, so as to achieve an effect that the blending ratio can be adjusted while the density of the spun yarn is invariable. However, these two inventions have two problems. First, in those inventions, only the concept of realizing the blending and segment-color spinning process with invariable linear density through the proposed coupling and drafting method, and no indication is given to show how to change the mixing ratio or color blending ratio under the condition that the coupling and drafting achieves an invariable linear density. In the meantime, no specific embodiments and examples are disclosed. Second, a conventional single carding roller is still used in those patent applications. When three slivers are fed at the same time, the original carding and drafting system cannot adequately strip, card, mix, break down and draft a plurality of slivers, which will cause inadequate break down of fiber plexus, resulting in blocking the carding roller and rotor, and will be prone to yarn broken and slub, nep and other defects. At the same time, although the total amount of each sliver by coupling and feeding is invariable, there is still a difference in the feeding amount of each sliver, and the short carding area causes little chance of horizontal fiber mixing, resulting in unsatisfactory color blending effect.

[0004] At present, the patent "Method and equipment for rotor spun slub yarn" (patent number CN00137211.4) can achieve invariable blending ratio but the linear density changes during the rotor spinning process. The principle of the patent is that the asynchronous motor and the stepper motor drive feeding roller through the differential, screw and worm wheel. The stepper motor, under the control of the intelligent controller, performs the following operations: reducing from high speed to low speed; continuing to run for a period of time; accelerating to high speed; continuing to run for a period of time, and the rotor spins a segment of slub yarn. The patent can produce a yarn with variable densities but cannot change blending ratios of the yarn.

[0005] The production of the yarn with the linear density and blending ratio both changed, requires not only that the feeding amount of the two or more of the fed roving can be controlled separately on line, but also that the total amount of the fed roving can be controlled when the feeding amount of the roving is changed. There is no prior art that discloses the production of such yarn. The main problem of the existing rotor spinning technology which can produce the yarn having an invariable linear density and blending ratio is that it is impossible to blend two or more fibers in any proportion during the rotor spinning process.

[0006] The following patent/patent application documents relate to rotor spinning method:

[0007] D1 CN103938322 A, is to provide a rotor spun yarn blending method, using the same or different, and two or more fiber strands are fed at the same feed speed or a different location in the same straight line density carding and twisting means, by opening, carding, mixed, agglomerated with twisted, made of color segments or rotor spinning yarn segment color mixing.

[0008] D2 CN104711730 A, relates to a colorful bunchy yarn spinning method based on two-component combined type asynchronous and synchronous two-stage drafting.

[0009] D3 EP 1564318 A2, relates to the method of sliver feeding in production of fancy yarn on spindle-less rotor machines with sliver feeding by a feed roller to the stripping roller, stripping individual fibres from the sliver that are consequently used at the spinning rotor for yarn spinning plus spinning units for this method performance.

[0010] D4 EP 1352998 A2, relates to a feed roller for a spinning apparatus with a work area for providing a first textile material for a spinning element as well as an opening device for a spinning apparatus having a rotatably mounted in a housing opening roller and a feed device for feeding a sliver to the opening roller.

SUMMARY OF THE INVENTION

[0011] In order to solve the above problem, the present invention improves the structure of the conventional rotor spinning machine. A device for implementing a rotor spinning method with three-level carding and multi-component feeding, includes a spinning system and a computer control system. The spinning system comprises a feeding and carding mechanism, a collecting and twisting mechanism, and a winding mechanism. The device is characterized in that the feeding and carding mechanism comprises a three-level carding roller and a combined feeding roller with two rotation freedom degrees. The speed ratio of the two combined feeding rollers with two rotational freedom degrees that can be adjusted. The collecting and twisting mechanism include a fiber transport channel, a rotor, and a yarn guider. The winding mechanism includes a couple of guide rollers and winding mechanism. The computer control system includes a PLC programmable controller, a servo driver, and a servo motor. The combined feeding roller with two rotation freedom degrees and the three-level carding roller are driven by the servo motor. The combined feeding rollers with rotational freedom degrees comprises a shaft, a bearing, a hollow shaft, a first gear, a second gear, a washer, a first movable roller, and a second movable roller. The first and the second gears and the first and the second movable rollers rotate around the same axis. The first and the second gears respectively drive the first and the second movable rollers. The three-level carding roller comprises the first carding roller, the second carding roller, and the third roller that are arranged in parallel. The rotation speed of the three-level carding roller is progressively increased from the first level to the third level. The rotation speed of the first carding roller is 1500-3000 rpm, the rotation speed of the second carding roller is 3000-6000 rpm, and the rotation speed of the third carding roller is 6000-12000 rpm. The density of carding needles of the three-level carding roller progressively increases from the first carding roller to the third carding roller.

[0012] Another objective of the present invention is to provide a rotor spinning method using the above device. The method includes feeding, carding, collecting and twisting, guide and winding. The method is characterized in that the combined feeding roller with two rotational freedom degrees are used in the fiber feeding to feed the fiber into the carding area asynchronously, and three-level carding roller is used in the carding process.

[0013] With the combined rollers and the three-level carding roller configured in the present invention, two slivers (or two different raw material slivers, or two kinds of colored slivers, hereinafter referred to as two components) can be asynchronously fed into the rotor spinning and carding area through the combined feeding roller. After opening, carding, orienting, separating and mixing by the three-level carding roller, the two slivers are gradually combed into bundle fibers and further combed into single fibers. Under the action of centrifugal force and air flow, a continuous flow comprised by single fiber flow released and transferred from the carding roller enters into the rotor rotating at a high speed. In the rotor, the fiber flow, under the centrifugal force, is collected together into a sliver again, and then twisted by the navel, and then guided by the guide roller to form the rotor spinning yarn. In the process of spinning, the servo driving system is controlled by a computer program to feed two slivers asynchronously to the carding area by the feeding roller having two freedom degrees. By controlling the feeding amount and feeding ratio of the two feeding rollers, it is possible to dynamically configure the final yarn density of the rotor spinning and the blending ratio of the two components to produce slub yarn, segment-color yarn, segment-color slub yarn, and mélange yarn.

[0014] The speed of the first carding roller is relatively low, so that it is ensured that when the plurality of the slivers with great difference are fed, the total number of carding fibers of each sliver carded by the carding roller are within a reasonable range, thereby reducing damage to the fiber. The speed of the second carding roller is higher than that of the first carding roller. After being carded by the second carding roller, the longitudinal orientation of the fiber is optimized, horizontal transfer mixing of the fiber is further optimized. The third carding roller is a high-speed carding roller. The fiber, after being carded by the third carding roller, obtains not only a better carding and transfer, but also the transport speed is improved, thereby meeting the requirement of centrifugal force for entering the fiber transport channel. Therefore, the fiber can smoothly and orderly go into the rotor to form yarns. Through the multi-level stripping, opening, cleaning, carding, separating, and transferring, the large-scale drafting function where the slivers are combed into web, which is then combed into bundles of fibers, which are then separated as single fibers is successfully completed, which enhances the function of the carding area of the rotor spinning, providing flexibility, high efficiency, and high yield.

[0015] (2) Based on the mechanical innovation design, the present invention constructs the corresponding mathematical model of spinning and the algorithm of the program. Through the mechatronic servo control system, the random control of the linear density and blending ratio of the rotor spinning yarn are achieved. In specific embodiments, the four kinds of spinning yarns are shown as following:

① a yarn with invariable linear density and variable blending ratio, such as gradient-color or segment-color yarn with an invariable linear density segment;
② a yarn with invariable blending ratio and variable linear density, such as slub yarn, big-belly yarn, dot yarn;
③ a yarn with variable linear density and variable blending ratio, such as segment-color slub yarn, segment-color big-belly yarn, segment-color dot yarn;
④ a yarn with invariable linear density and invariable blending ratio but mixed with any proportion of blended yarn

or color-mixed yarn.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG.1 is a flowchart of the rotor spinning.
FIG.2 is a diagram of the carding and drafting process of the rotor spinning method with three-level carding roller.
FIG.3 is a diagram showing the transmission of the feeding roller, wherein 3b is the right-side view of 3a.
FIG.4 is a structural view of the combined feeding roller.
FIG.5 is a diagram of a spinning control system with two components asynchronous fed and carded.
FIG.6 is a diagram of a control model of a rotor spinning yarn system with two components asynchronous input.

1-1, 1-2, 1-3: carding roller; 1-4, 1-5: trash ejection port; 1-6: feeding roller; 1-7: sliver; 1-8: compression spring; 1-9: feeding plate; 1-10: fiber transport channel; 1-11: navel; 1-12: rotor; 1-13: degassing hole; 1-14, 1-15: guide roller, 1-16: yarn;
2-1, 2-2: feeding roller; 2-3, 2-4: sliver; 2-5: feeding plate; 2-6, 2-7, 2-8: carding roller; 2-9: fiber flow; 2-10: rotor; 2-11: yarn;
3a-1, 3a-4: rollers; 3a-2, 3a-7: gears; 3a-3, 3a-5: idler gear; 3a-6: roller shaft; 3a-8, 3a-9, 3a-10: carding roller, 3a-11: spun yarn, 3b-1: gear; 3b-2: roller; 3b-3, 3b-4: gears;
4-1: bearing; 4-2: hollow shaft; 4-3: gears; 4-5, 4-6: rollers; 4-7: gear; 4-8: shaft; two movable roller (4-5, 4-6) are driven by the gears (4-3, 4-7) respectively.

DETAILED DESCTIPTION OF THE INVENTION

[0017] Spinning process design:

Voi: linear velocity of the feeding roller 1; V_{02}: linear velocity of the feeding roller 2; V_1: the linear velocity of the carding roller 1; V_2: the linear velocity of the carding roller 2; V_3: the linear velocity of the carding roller 3; V_4: the linear speed of the rotor; V_5: the linear velocity of the guide roller.
ρ_1: linear density of sliver A (g / m)
ρ_2: linear density of sliver B (g / m)
ρ: yarn density (g / m);
ρ_{11}: linear density of the sliver A passing through the carding roller 1 (g / m)
ρ_{12}: linear density of the sliver A passing through the carding roller 2 (g / m)
ρ_{13}: linear density of the sliver A passing through the carding roller 3 (g / m)
ρ_{14}: linear density of the sliver A in the rotor (g / m)
ρ_{21}: linear density of the sliver B passing through the carding roller 1 (g / m)
ρ_{22}: linear density of the sliver B passing through the carding roller 2 (g / m)
ρ_{23}: linear density of the sliver B passing through the carding roller 3 (g / m)
ρ_{24}: linear density of the sliver B in the rotor (g / m)
E_1: draft ratio of the carding roller 1 to the feeding roller;
E_2: draft ratio of the carding roller 2 to the carding roller 1;
E_3: draft ratio of the carding roller 3 to the carding roller 2;
E_4: draft ratio of the rotor to the carding roller 3;
E_5: draft ratio of the guide roller to the rotor;
E: total draft ratio of rotor spinning, which is equal to the draft ratio of guide roller to feeding roller.

[0018] Subscripts 1, 2 represent component A, component B, respectively.

(1) Three-level roller carding process design:
As to feeding a plurality of the slivers, when the feeding speeds of feeding rollers are greatly different, the fiber holding time of each component is also greatly different. In the rotor spinning with single carding roller, due to the need of balancing the stripping /carding fibers, as well as the requirement of the fiber speed when transferring to the fiber transport channel, the rotation speed of the single carding roller is high. Therefore, when there is a significant difference in feeding amount, the number of times that a fiber of the two slivers is carded will be significantly different, and the more the fiber experiences carding, larger will be the damage to this fiber.
In order to solve the problem of the rotation speed of the carding roller against the damage to fiber and the even

mixture of fibers, the present invention adopts the form of three-level carding roller, that is, the first carding roller, the second carding roller and the third carding roller. The rotation speed of the first carding roller (ω = 1500-3000rpm) is relatively low, the needle density is relatively low, the working angle of the needle is relatively small. It is mainly configured for stripping, opening, cleaning and carding and focusing on making the total carding number of fibers of each sliver within a reasonable range, thereby reducing damage to the fiber. The speed of the second carding roller (ω = 3000-6000rpm) is mainly configured for stripping, carding and transferring fibers, wherein the needle density is larger than the needle density of the first carding roller, and the working angle of the needle is relatively larger than that of the first carding roller. After being carded by the second carding roller, the longitudinal orientation of the fiber is optimized, and horizontal transfer mixing of the fiber is further optimized. The third carding roller is a high-speed carding roller (ω =6000-12000 rpm), which is mainly configured for stripping, carding and separating, and transferring fibers, wherein the needle density is also larger than the needle density of the second carding roller, and the working angle of the needle is largest. Fibers passing through the third carding roller gets better carding and transfer. Furthermore, due to the high speed of the third carding roller, under the action of centrifugal force and air flow, a highly separated and continuous fiber flow passes through the fiber transport channel and enters orderly into the rotor to form yarns.

Through the stripping, opening, cleaning, carding, and transfer of the three-level carding roller, the large-scale drafting function, where the slivers are combed into web, which is then combed into fiber bundles which are separated into single fibers, is successful completed, which enhances the function of the carding area of the rotor spinning, meets the special requirements for the carding of multiple slivers asynchronously feeding into the rotor spun unit. The effects of flexibility, high efficiency, and high yield are realized.

(2) Draft ratio of the rotor spun yarn:

$$E_1 = \frac{(\rho_1 + \rho_2)\ V_1}{\rho_1 V_{01} + \rho_2 V_{02}} = \frac{\rho_1 + \rho_2}{\rho_{11} + \rho_{21}}$$

$$E_2 = \frac{V_2}{V_1} = \frac{\rho_{11} + \rho_{21}}{\rho_{12} + \rho_{22}}$$

$$E_3 = \frac{V_3}{V_2} = \frac{\rho_{12} + \rho_{22}}{\rho_{13} + \rho_{23}}$$

$$E = E_1 * E_2 * E_3 * E_4 * E_5 = \frac{(\rho_1 + \rho_2)\ V_5}{\rho_1 V_{01} + \rho_2 V_{02}} = \frac{\rho_1 + \rho_2}{\rho}$$

$$E_5 = \frac{V_5}{V_4} = \frac{\rho_{14} + \rho_{24}}{\rho}$$

$$E = E_1 * E_2 * E_3 * E_4 * E_5 = \frac{(\rho_1 + \rho_2)\ V_5}{\rho_1 V_{01} + \rho_2 V_{02}} = \frac{\rho_1 + \rho_2}{\rho}$$

$$E = \frac{(\rho_1 + \rho_2)\ V_5}{\rho_1 V_{01} + \rho_2 V_{02}} = \frac{\rho_1 + \rho_2}{\rho}$$

(3) Linear density of spun yarn:

$$\rho = \frac{\rho_1 V_{01} + \rho_2 V_{02}}{V_5}$$

(4) Blending ratio

The blending ratio of components A and B in the rotor spinning yarn are K_1 and K_2 respectively:

$$K_1 = \frac{\rho_1 V_{01}}{\rho_1 V_{01} + \rho_2 V_{02}}$$

$$K_2 = \frac{\rho_2 V_{02}}{\rho_1 V_{01} + \rho_2 V_{02}}$$

(4)) Dynamic linear density of rotor spun yarn

Assuming that the speed V_5 of the guide roller is invariable, the variables of feeding speed V_{01} and V_{02}, of the components A and B are as follows:

$$V_{01}' = V_{01} + \Delta V_{01}$$

$$V_{02}' = V_{02} + \Delta V_{02}$$

So that the new changed linear density of rotor spun yarn is

$$\rho' = \frac{\rho_1\ (V_{01} + \Delta V_{01}) + \rho_2\ (V_{02} + \Delta V_{02})}{V_5}$$

$$= \frac{\rho_1 V_{01} + \rho_2 V_{02}}{V_5} + \frac{\rho_1 \Delta V_{01} + \rho_2 \Delta V_{02}}{V_5}$$

$$\Delta \rho = \frac{\rho_1 \Delta V_{01} + \rho_2 \Delta V_{02}}{V_5}$$

(5)) Dynamic blending ratio of rotor spun yarn is:

Assuming that: $\rho_1 = \rho_2 = \rho_0$

$$V_{01}+V_{02} = V_0$$

[0019] Reference blending ratios are shown as below:

$$K_1 = \frac{V_{01}}{V_0}$$

$$K_2 = \frac{V_{02}}{V_0}$$

[0020] When $V_{01}+V_{02} \rightarrow V_{01}+\Delta V_{01}+V0_2+\Delta V_{02}$, the blending ratio becomes as below:

$$K_1' = \frac{V_{01}+\Delta V_{01}}{V_0+\Delta V_0}$$

$$K_2' = \frac{V_{02}+\Delta V_{02}}{V_0+\Delta V_0}$$

[0021] Assuming that

$$k_1=0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1$$

$$k_2=1, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, 0.1, 0$$

[0022] Mixed configuration is gradient to realize different color scheme.

[0023] By changing V_{01} and V_{02}, the blending ratio (color mixing ratio) of different fibers (different colors) in the yarn can be changed under the condition that V_0 is kept invariable, so that k_1 and k_2 are changed between 0 - 100%. In various color mixing modes of two primary colors, the minimum increment of the color mixing ratio is 0.1, wherein the color scheme is as follows:

Table 1 color scheme

		color A color mixing ratio k_1	color B color mixing ratio k_2	Color code
Monochromatic	Color A	1	0	1
	Color B	0	1	2

(continued)

		color A color mixing ratio k_1	color B color mixing ratio k_2	Color code
Double-color mixing	AB	0.1	0.9	3
		0.2	0.8	4
		0.3	0.7	5
		0.4	0.6	6
		0.5	0.5	7
		0.6	0.4	8
		0.7	0.3	9
		0.8	0.2	10
		0.9	0.1	11
Note: for k_1+k_2 = 100%, there can be numerous combinations.				

[0024] In the present invention, 0.1 is selected as a gradient to perform color matching. According to the above statistics, based on the two primary colors (two kinds of color sliver) by coupling drawing, color change, color matching, alternating gradient twisting mixed, 11 color schemes can eventually be formed, and 11 kinds of color distribution can be formed in the yarn to form a segment-color yarn.

[0025] (6) Random dynamic control method of spun yarn density and blending ratio Dynamic change rate of density of rotor spun yarn is shown as below:

$$\epsilon_\rho = \frac{\Delta\rho}{\rho} = \frac{\dfrac{\rho_1 \Delta V_{01} + \rho_2 \Delta V_{02}}{V_5}}{\dfrac{\rho_1 V_{01} + \rho_2 V_{02}}{V_5}}$$

$$= \frac{\rho_1 \Delta V_{01} + \rho_2 \Delta V_{02}}{\rho_1 V_{01} + \rho_2 V_{02}}$$

and

$$\rho_1 = \rho_2 = \rho_0$$

$$V_{01} + V_{02} = V_0$$

then

$$\epsilon_\rho = \frac{\Delta V_{01} + \Delta V_{02}}{V_0}$$

$$= \frac{\Delta V_0}{V_0}$$

[0026] From the absolute increment of the linear density and relative increment of the linear density, it can be found that the change of yarn linear density, which totally depends on the $V_{01}+\Delta V_{01}$, $V_{02}+\Delta V_{02}$, can have 5 different patterns. Therefore, there can be 5 kinds of yarn in different forms.

① A yarn with variable linear density, wherein one component has variable linear density and one components has invariable linear densities.

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [V_{01} + (V_{02} + \Delta V_{02})]$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [V_{02} + (V_{01} + \Delta V_{01})]$$

② A yarn with variable linear density, wherein both of two components have variable linear densities.

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})]$$

③ A yarn with variable linear density, wherein one component is continuous and one component is discontinuous.

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (0 \leq t \leq T_1)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{02} + \Delta V_{02})] \qquad (T_1 \leq t \leq T_2)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (T_2 \leq t \leq T_3)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{02} + \Delta V_{02})] \qquad (T_3 \leq t \leq T_4)$$

④ A yarn with variable linear density, wherein both of two components are discontinuous.

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (0 \leq t \leq T_1)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01})] \qquad (T_1 \le t \le T_2)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (T_2 \le t \le T_3)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{02} + \Delta V_{02})] \qquad (T_3 \le t \le T_4)$$

⑤ A yarn with variable linear density, wherein two components are continuous and have variable linear densities.

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})]$$

⑥ The method of dynamic feed speed control of spun yarn

[0027] Because

$$\Delta V_0 = \Delta V_{01} + \Delta V_{02}$$

ΔV may come from ΔV_{01}, or come from ΔV_{02}, which can be determined by the blending ratio. Then:

$$\Delta V_{01} = K'_1(V_0 + \Delta V) - V_{01}$$

$$\Delta V_{02} = K'_2(V_0 + \Delta V) - V_{02}$$

$$\frac{K_1'}{K_2'} = \frac{V_{01} + \Delta V_{01}}{V_{02} + \Delta V_{02}}.$$

Claims

1. A rotor spinning method for two-sliver asynchronous inputting and three-level carding, comprising:

1) feeding fiber (2-9) by a combined feeding roller comprising two feeding rollers (2-1, 2-2) with two rotational freedom degrees into carding area where a three-level carding roller comprising three carding rollers (2-6, 2-7, 2-8) is used for carding;
2) moving the two feeding rollers (2-1, 2-2) at linear speeds V_{01} and V_{02}, respectively; moving a rotor (2-10) at a linear speed V_4 and moving a guide roller at a linear speed V_5; setting linear densities of two slivers (2-3, 2-4) drafted by the two feeding rollers (2-1, 2-2) to be ρ_1 and ρ_2, respectively, and setting a rotor spun yarn density to be p, such that a draft ratio of a rotor spinning yarn (2-11) is as below:

$$E = \frac{(\rho_1+\rho_2)\ V_5}{\rho_1 V_{01}+\rho_2 V_{02}} = \frac{\rho_1+\rho_2}{\rho}\ (1)$$,

a linear density of the rotor spun yarn is formed,

$$\rho = \frac{\rho_1 V_{01}+\rho_2 V_{02}}{V_5}\ (2)$$

wherein speeds of the three carding rollers (2-6, 2-7, 2-8) are as follows: a speed of a first carding roller (2-6) is 1500-3000 rpm, a speed of a second carding roller (2-7) is 3000-6000 rpm, a speed of a third carding roller (2-8) is 6000-12000 rpm,

3) blending ratios of the two slivers (2-3, 2-4) in the rotor spinning yarn are K1 and K2 respectively:

$$K_1 = \frac{\rho_1 V_{01}}{\rho_1 V_{01}+\rho_2 V_{02}}\ (3)$$

$$K_2 = \frac{\rho_2 V_{02}}{\rho_1 V_{01}+\rho_2 V_{02}}\ (4)$$

4) assuming that the speed V_5 of the guide roller is invariable, the variables of feeding speeds V_{01} and V_{02} of the two feeding rollers (2-1, 2-2) of the two slivers (2-3, 2-4) are respectively as follows: $V_{01}' = V_{01} + \Delta V_{01}$, $V_{02}' = V_{02} + \Delta V_{02}$, then the dynamic linear density of the rotor spun yarn is obtained according to formula (5)

$$\Delta\rho = \frac{\rho_1 \Delta V_{01}+\rho_2 \Delta V_{02}}{V_5}\ (5)$$,

5) assuming that $\rho_1 = \rho_2 = \rho_0$, $V_{01}+V_{02} = V_0$, obtaining a reference blending ratio according to the formulas (3), (4) as $K_1 = \frac{V_{01}}{V_0}$, $K_2 = \frac{V_{02}}{V_0}$, wherein, when $V_{01}+V_{02} \rightarrow V_{01}+\Delta V_{01}+V_{02}+\Delta V_{02}$, the blending ratio becomes as below:

$$K_1' = \frac{V_{01}+\Delta V_{01}}{V_0+\Delta V_0}\ (6)$$,

$$K_2' = \frac{V_{02}+\Delta V_{02}}{V_0+\Delta V_0}\ (7)$$,

realizing dynamically adjustable spinning of different color blending ratios or color mixing ratios in the yarn with different fibers or colors by controlling of V_{01} and V_{02}.

2. The method according to claim 1, further comprising: assuming $\rho_1 = \rho_2 = \rho_0$, $V_{01} + V_{02} = V_0$, obtaining a dynamic change rate of the rotor spun yarn density according to formulas (2) and (5):

$$\epsilon_\rho = \frac{\Delta V_{01} + \Delta V_{02}}{V_0} = \frac{\Delta V_0}{V_0} \quad (8)$$

,

achieving a random dynamic regulation of the density and the blending ratio of the rotor spun yarn by controlling the speed of the two feeding rollers (2-1, 2-2).

3. The method according to claim 2, **characterized in that**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [V_{01} + (V_{02} + \Delta V_{02})]$$

,

or

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [V_{02} + (V_{01} + \Delta V_{01})]$$

,

changing speed of one of the two feeding rollers (2-1, 2-2) to achieve a yarn with variable linear density, wherein one component has variable linear density and one component has invariable linear density.

4. The method according to claim 2, **characterized in that**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})]$$

,

changing speed of two of the two feeding rollers (2-1, 2-2) to achieve a yarn with variable linear density, wherein two components have variable linear densities.

5. The method according to claim 2, **characterized in that**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (0 \le t \le T_1)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{02} + \Delta V_{02})] \qquad (T_1 \le t \le T_2)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (T_2 \le t \le T_3)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{02} + \Delta V_{02})] \qquad (T_3 \le t \le T_4)$$

wherein speed change of the two feeding rollers (2-1, 2-2) and speed change of one of the two feeding rollers (2-1, 2-2) alternate to realize a yarn with variable linear density wherein one component is continuous and one component is discontinuities, wherein t, T1, T2, T3 and T4 represent time.

6. The method according to claim 2, **characterized in that**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (0 \le t \le T_1)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01})] \qquad (T_1 \le t \le T_2)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (T_2 \le t \le T_3)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{02} + \Delta V_{02})] \qquad (T_3 \le t \le T_4)$$

wherein speed change of the two feeding rollers (2-1, 2-2) and speed change of one of the two feeding rollers (2-1, 2-2) alternate while changing speed of one of the two feeding rollers (2-1, 2-2) to realize a yarn with variable linear density wherein two components are discontinuities, wherein t, T1, T2, T3 and T4 represent time.

7. The method according to claim 2, **characterized in that**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})]$$

changing speed of the two feeding rollers (2-1, 2-2) to realize a variable linear density yarn with two continuous components with variable linear densities.

8. The method according to claim 2, **characterized in that**: in control method of dynamic feeding speed of the yarn, $\Delta_{V0} = \Delta V_{01} + \Delta V_{02}$, change of the speed is derived from ΔV_{01} or ΔV_{02} and determined by the blending ratio, and then $\Delta V_{01} = K'_1(V_0+\Delta V)-V_{01}$, $\Delta V_{02} = K'_2(V_0+\Delta V)-V_{02}$.

9. A device for realizing the method according to any one of the preceding claims, comprising a spinning system and a computer control system, wherein the spinning system comprises a feeding and carding mechanism, a collecting and twisting mechanism, and a winding mechanism, the feeding and carding mechanism comprises a combined feeding roller comprising two feeding rollers (2-1, 2-2) having two rotation freedom degrees, a three-level carding roller comprising three carding rollers (2-6, 2-7, 2-8); wherein a speed ratio of the two feeding rollers (2-1, 2-2) of the combined feeding roller with two rotational freedom degrees is adjusted, the collecting and twisting mechanism includes a fiber transport channel (1-10), a rotor (1-12), and a guide device; the winding mechanism includes a guide and winding mechanism; the computer control system includes a PLC programmable controller, a servo driver, a servo motor; wherein the combined feeding roller (2-1, 2-2) with two rotational freedom degrees and the three-level carding roller (2-6, 2-7, 2-8) are driven by the servo motor.

10. The device according to claim 9, **characterized in that** the combined feeding roller (2-1, 2-2) with two rotational freedom degrees comprises a shaft (4-8), a bearing (4-1), a hollow shaft (4-2), a first gear (4-3), a second gear (4-7), a washer, a first movable roller (4-5), a second movable roller (4-6), wherein the first gear (4-3), the second gears (4-7), the first movable roller (4-5) and the second movable roller (4-6) are rotated around the same axis, the first gear (4-3) and the second gear (4-7) drive the first movable roller (4-5) and the second movable roller (4-6), respectively.

Patentansprüche

1. Rotorspinnverfahren zur asynchronen Eingabe von zwei Bändern und zur dreistufigen Kardierung, umfassend:

1) Zuführen von Fasern (2-9) durch eine kombinierte Zuführwalze, die zwei Zuführwalzen (2-1, 2-2) mit zwei

Rotationsfreiheitsgraden in den Kardierbereich umfasst, wobei eine dreistufige Kardierwalze mit drei Kardierwalzen (2-6, 2-7, 2-8) zum Kardieren verwendet wird;

2) Bewegen der beiden Zuführwalzen (2-1, 2-2) mit den Lineargeschwindigkeiten V_{01} und V_{02}; Bewegen eines Rotors (2-10) mit einer Lineargeschwindigkeit V_4 und Bewegen einer Führungswalze mit einer Lineargeschwindigkeit V_5; Einstellen der linearen Dichten von zwei Bändern (2-3, 2-4), die von den beiden Zuführwalzen (2-1, 2-2) entworfen wurden, auf jeweils ρ1 und ρ2, und Einstellen einer Rotorspinngarndichte auf p, so dass ein Streckverhältnis eines Rotorspinngarns (2-11) wie unten beschrieben ist:

$$E = \frac{(\rho_1 + \rho_2)\, V_5}{\rho_1 V_{01} + \rho_2 V_{02}} = \frac{\rho_1 + \rho_2}{\rho} \quad (1),$$

eine lineare Dichte des Rotorspinngarns gebildet wird,

$$\rho = \frac{\rho_1 V_{01} + \rho_2 V_{02}}{V_5} \quad (2),$$

wobei die Geschwindigkeiten der drei Kardierwalzen (2-6, 2-7, 2-8) wie folgt sind: eine Geschwindigkeit einer ersten Kardierwalze (2-6) beträgt 1500-3000 rpm, eine Geschwindigkeit einer zweiten Kardierwalze (2-7) beträgt 3000-6000 rpm, eine Geschwindigkeit einer dritten Kardierwalze (2-8) beträgt 6000-12000 rpm,

3) Mischungsverhältnisse der beiden Bänder (2-3, 2-4) im Rotorspinngarn sind jeweils K1 und K2:

$$K_1 = \frac{\rho_1 V_{01}}{\rho_1 V_{01} + \rho_2 V_{02}} \quad (3)$$

$$K_2 = \frac{\rho_2 V_{02}}{\rho_1 V_{01} + \rho_2 V_{02}} \quad (4)$$

4) unter der Annahme, dass die Geschwindigkeit V_5 der Führungswalze unveränderlich ist, sind die Variablen der Vorschubgeschwindigkeiten V_{01} und V_{02} der beiden Zuführwalzen (2-1, 2-2) der beiden Bänder (2-3, 2-4) jeweils wie folgt: $V_{01}' = V_{01} + \Delta V_{01}$, $V_{02}' = V_{02} + \Delta V_{02}$, dann wird die dynamische lineare Dichte des Rotorspinngarns gemäß Formel (5) erhalten.

$$\Delta \rho = \frac{\rho_1 \Delta V_{01} + \rho_2 \Delta V_{02}}{V_5} \quad (5),$$

5) unter der Annahme, dass $\rho_1 = \rho_2 = \rho_0$, $V_{01}+V_{02} = V_0$, ein Referenzmischungsverhältnis gemäß den Formeln (3), (4), wie $K_1 = \frac{V_{01}}{V_0}$, $K_2 = \frac{V_{02}}{V_0}$, wobei, wenn $V_{01}+V_{02} \rightarrow V_{01}+\Delta V_{01}+V_{02}+\Delta V_{02}$, Mischungsverhältnis wie folgt wird:

$$K_1' = \frac{V_{01} + \Delta V_{01}}{V_0 + \Delta V_0} \quad (6)$$,

$$K_2' = \frac{V_{02} + \Delta V_{02}}{V_0 + \Delta V_0} \quad (7)$$,

Realisierung eines dynamisch einstellbaren Spinnens von verschiedenen Farbmischungsverhältnissen oder Farbmischungsverhältnissen im Garn mit unterschiedlichen Fasern oder Farben durch Steuerung von V_{01} und V_{02}.

2. Verfahren nach Anspruch 1, ferner umfassend: unter der Annahme $\rho_1 = \rho_2 = \rho_0$, $V_{01} + V_{02} = V_0$, eine dynamische Änderungsrate der Rotorspinnfadendichte gemäß den Formeln (2) und (5) erhalten wird:

$$\epsilon_\rho = \frac{\Delta V_{01} + \Delta V_{02}}{V_0} = \frac{\Delta V_0}{V_0} \quad (8)$$,

Erreichen einer zufälligen dynamischen Regelung der Dichte und des Mischungsverhältnisses des Rotorgesponnenen Garns durch Steuern der Geschwindigkeit der beiden Zuführwalzen (2-1, 2-2).

3. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [V_{01} + (V_{02} + \Delta V_{02})]$$,

oder

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [V_{02} + (V_{01} + \Delta V_{01})]$$,

changing speed of one of the two feeding rollers (2-1, 2-2) to achieve a yarn with variable linear density, wherein one component has variable linear density and one component has invariable linear density.

4. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})]$$,

Ändern der Geschwindigkeit von zwei der beiden Zuführwalzen (2-1, 2-2), um ein Garn mit variabler linearer Dichte zu erreichen, wobei zwei Komponenten variable lineare Dichte aufweisen.

5. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (0 \leq t \leq T_1)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{02} + \Delta V_{02})] \qquad (T_1 \leq t \leq T_2)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (T_2 \leq t \leq T_3)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{02} + \Delta V_{02})] \qquad (T_3 \leq t \leq T_4)$$

wobei sich die Änderung der Geschwindigkeit der beiden Zuführwalzen (2-1, 2-2) und die Änderung der Geschwindigkeit einer der beiden Zuführwalzen (2-1, 2-2) abwechseln, um ein Garn mit variabler linearer Dichte zu realisieren, wobei eine Komponente kontinuierlich ist und eine Komponente Diskontinuitäten ist, wobei t, T1, T2, T3 und T4 Zeit darstellen.

6. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (0 \leq t \leq T_1)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01})] \qquad (T_1 \leq t \leq T_2)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (T_2 \leq t \leq T_3)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{02} + \Delta V_{02})] \qquad (T_3 \leq t \leq T_4)$$

wobei die Änderung der Geschwindigkeit der beiden Zuführwalzen (2-1, 2-2) und die Änderung der Geschwindigkeit einer der beiden Zuführwalzen (2-1, 2-2) abwechseln, während die Geschwindigkeit einer der beiden Zuführwalzen (2-1, 2-2) geändert wird, um ein Garn mit variabler linearer Dichte zu realisieren, wobei zwei Komponenten Diskontinuitäten sind, wobei t, T1, T2, T3 und T4 Zeit darstellen.

7. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})]$$

Ändern der Geschwindigkeit der beiden Zuführrollen (2-1, 2-2), um ein Garn mit variabler linearer Dichte mit zwei kontinuierlichen Komponenten mit variablen linearen Dichten zu realisieren.

8. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass**: im Steuerverfahren der dynamischen Zuführgeschwindigkeit des Garns, $\Delta_{v0} = \Delta V_{01} + \Delta V_{02}$, die Änderung der Geschwindigkeit von ΔV_{01} oder ΔV_{02} abgeleitet und durch das Mischungsverhältnis bestimmt wird, und dann $\Delta V_{01} = K'_1(V_0+\Delta V)-V_{01}$, $\Delta V_{02} = K'_2(V_0+\Delta V)-V_{02}$.

9. Vorrichtung zur Realisierung des Verfahrens nach einem der vorhergehenden Ansprüche, umfassend ein Spinnsystem und ein Computersteuerungssystem, wobei das Spinnsystem einen Zuführ- und Kardiermechanismus, einen Sammel- und Twist-mechanismus und einen Wickelmechanismus umfasst, wobei der Zuführ- und Kardiermechanismus eine kombinierte Zuführwalze umfasst, die zwei Zuführwalzen (2-1, 2-2) mit zwei Rotationsfreiheitsgraden umfasst, eine dreistufige Kardierwalze, die drei Kardierwalzen (2-6, 2-7, 2-8) umfasst; wobei ein Geschwindigkeitsverhältnis der beiden Zuführwalzen (2-1, 2-2) der kombinierten Zuführwalze mit zwei Rotationsfreiheitsgraden eingestellt ist, der Sammel- und Twist-mechanismus einen Fasertransportkanal (1-10), einen Rotor (1-12) und eine Führungseinrichtung beinhaltet; der Aufwickelmechanismus einen Führungs- und Aufwickelmechanismus beinhaltet; das Computersteuerungssystem eine PLC-programmierbare Steuerung, einen Servotreiber, einen Servomotor beinhaltet; wobei die kombinierte Zuführwalze (2-1, 2-2) mit zwei Rotationsfreiheitsgraden und die dreistufige Kardierwalze (2-6, 2-7, 2-8) durch den Servomotor angetrieben werden.

10. Die Vorrichtung nach Anspruch 9, **dadurch gekennzeichnet, dass** die kombinierte Zuführwalze (2-1, 2-2) mit zwei Rotationsfreiheitsgraden eine Welle (4-8), ein Lager (4-1), eine Hohlwelle (4-2), ein erstes Zahnrad (4-3), ein zweites Zahnrad (4-7), eine Scheibe, eine erste bewegliche Rolle (4-5), eine zweite bewegliche Rolle (4-6) umfasst, wobei das erste Zahnrad (4-3), die zweiten Zahnräder (4-7), die erste bewegliche Rolle (4-5) und die zweite bewegliche Rolle (4-6) um die gleiche Achse gedreht werden, das erste Zahnrad (4-3) und das zweite Zahnrad (4-7) die erste bewegliche Rolle (4-5) bzw. die zweite bewegliche Rolle (4-6) antreiben.

Revendications

1. Procédé de filage à rotor pour l'entrée asynchrone à deux rubans et le cardage à trois niveaux, comprenant:

1) alimentation de la fibre (2-9) par deux rouleaux d'alimentation (2-1, 2-2) avec deux degrés de liberté de rotation dans la zone de cardage où un rouleau de cardage à trois niveaux comprenant trois rouleaux de cardage (2-6, 2-7, 2-8) est utilisé pour le cardage;
2) déplacement de deux rouleaux d'alimentation (2-1, 2-2) aux vitesses linéaires V_{01} et V_{02}, respectivement ; déplacement d'un rotor (2-10) à une vitesse linéaire V_4 et déplacement d'un rouleau de guidage à une vitesse linéaire V_5 ; réglage des densités linéaires de deux rubans (2-3, 2-4) aspirés par les deux rouleaux d'alimentation (2-1, 2-2) à ρ_1 et ρ_2, respectivement, et réglage de la densité d'un filé de rotor pour qu'elle soit p, de telle sorte que le rapport de tirant d'eau d'un filé de rotor (2-11) est tel qu'indiqué ci-dessous :

$$E = \frac{(\rho_1+\rho_2)\ V_5}{\rho_1 V_{01}+\rho_2 V_{02}} = \frac{\rho_1+\rho_2}{\rho} \quad (1)$$

,

une densité linéaire du filé de rotor est formée,

$$\rho = \frac{\rho_1 V_{01}+\rho_2 V_{02}}{V_5} \quad (2)$$

,

dans laquelle les vitesses de trois rouleaux de cardage (2-6, 2-7, 2-8) sont les suivantes : la vitesse d'un premier rouleau de cardage (2-6) est de 1500-3000 tr/min, une vitesse d'un deuxième rouleau de cardage (2-7) est de 3000-6000 tr/min, une vitesse d'un troisième rouleau de cardage (2-8) est de 6000-12000 tr/min,
3) les rapports de mélange de deux rubans (2-3, 2-4) dans le fil de filage de rotor sont K1 et K2 respectivement :

$$K_1 = \frac{\rho_1 V_{01}}{\rho_1 V_{01} + \rho_2 V_{02}} \quad (3)$$

$$K_2 = \frac{\rho_2 V_{02}}{\rho_1 V_{01} + \rho_2 V_{02}} \quad (4)$$

4) en supposant que la vitesse V_5 du galet de guidage est invariable, les variables des vitesses d'alimentation V_{01} et V_{02}, de deux rouleaux d'alimentation (2-1, 2-2) de deux rubans (2-3, 2-4) sont respectivement comme suit: $V_{01}' = V_{01} + \Delta V_{01}$, $V_{02}' = V_{02} + \Delta V_{02}$, puis la densité linéaire dynamique du filé de rotor est obtenue selon la formule (5)

$$\Delta \rho = \frac{\rho_1 \Delta V_{01} + \rho_2 \Delta V_{02}}{V_5} \quad (5)$$

,

5) en supposant que $\rho_1 = \rho_2 = \rho_0$, $V_{01}+V_{02} = V_0$, obtention d'un rapport de mélange de référence selon les formules (3), (4) comme suit

$$K_1 = \frac{V_{01}}{V_0}, \quad K_2 = \frac{V_{02}}{V_0},$$

dans laquelle, lorsque $V_{01}+V_{02} \rightarrow V_{01}+\Delta V_{01}+V_{02}+\Delta V_{02}$, le rapport de mélange devient comme ci-dessous :

$$K_1' = \frac{V_{01} + \Delta V_{01}}{V_0 + \Delta V_0} \quad (6)$$

,

$$K_2' = \frac{V_{02} + \Delta V_{02}}{V_0 + \Delta V_0} \quad (7)$$

,

réalisation du filage dynamiquement ajustable de différents rapports de mélange de couleurs ou de mélanges de couleurs dans le fil avec différentes fibres ou couleurs par contrôle de V_{01} et V_{02}.

2. Procédé selon la revendication 1, en outre comprenant: en supposant que $\rho_1 = \rho_2 = \rho_0$, $V_{01} + V_{02} = V_0$, obtention d'un taux de variation dynamique de la densité du filé de rotor selon les formules (2) et (5) :

$$\varepsilon_\rho = \frac{\Delta V_{01} + \Delta V_{02}}{V_0} = \frac{\Delta V_0}{V_0} \quad (8)$$

,

obtention d'une régulation dynamique aléatoire de la densité et du rapport de mélange du filé de rotor en contrôlant la vitesse de deux rouleaux d'alimentation (2-1, 2-2).

3. Procédé selon la revendication 2, **caractérisé en ce que**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [V_{01} + (V_{02} + \Delta V_{02})]$$,

ou

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [V_{02} + (V_{01} + \Delta V_{01})]$$,

changement de vitesse de l'un de deux rouleaux d'alimentation (2-1, 2-2) pour obtenir un fil à densité linéaire variable, dans laquelle un composant a une densité linéaire variable et un composant a une densité linéaire invariable.

4. Procédé selon la revendication 2, **caractérisé en ce que**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})]$$,

changement de vitesse de deux de deux rouleaux d'alimentation (2-1, 2-2) pour obtenir un fil à densité linéaire variable, dans laquelle deux composants ont des densités linéaires variables.

5. Procédé selon la revendication 2, **caractérisé en ce que**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (0 \le t \le T_1)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{02} + \Delta V_{02})] \qquad (T_1 \le t \le T_2)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (T_2 \le t \le T_3)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{02} + \Delta V_{02})] \qquad (T_3 \le t \le T_4)$$

dans lequel le changement de vitesse de deux rouleaux d'alimentation (2-1, 2-2) et le changement de vitesse de l'un de deux rouleaux d'alimentation (2-1, 2-2) alternent pour réaliser un fil à densité linéaire variable dans lequel un composant est continu et un composant est discontinu, dans lequel t, T1, T2, T3 et T4 représentent le temps.

6. Procédé selon la revendication 2, **caractérisé en ce que**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (0 \le t \le T_1)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01})] \qquad (T_1 \le t \le T_2)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})] \qquad (T_2 \le t \le T_3)$$

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{02} + \Delta V_{02})] \qquad (T_3 \le t \le T_4)$$

dans lequel le changement de vitesse de deux rouleaux d'alimentation (2-1, 2-2) et le changement de vitesse de l'un de deux rouleaux d'alimentation (2-1, 2-2) alternent en changeant la vitesse de l'un de deux rouleaux d'alimentation (2-1, 2-2) pour réaliser un fil à densité linéaire variable dans lequel deux composants sont des discontinuités, dans lequel t, T1, T2, T3 et T4 représentent le temps.

7. Procédé selon la revendication 2, **caractérisé en ce que**:

$$\rho' = \rho + \Delta\rho = \frac{\rho}{V_0} * [(V_{01} + \Delta V_{01}) + (V_{02} + \Delta V_{02})]$$

changement de vitesse de deux rouleaux d'alimentation (2-1, 2-2) pour réaliser un fil à densité linéaire variable avec deux composants continus à densité linéaire variable.

8. Procédé selon la revendication 2, **caractérisé en ce que**: dans la méthode de contrôle de la vitesse d'alimentation dynamique du fil, $\Delta_{V0} = \Delta V_{01} + \Delta V_{02}$, le changement de vitesse est dérivé de ΔV_{01} ou ΔV_{02} et déterminé par le rapport de mélange, et puis $\Delta V_{01} = K'_1(V_0+\Delta V)-V_{01}$, $\Delta V_{02} = K'_2(V_0+\Delta V)-V_{02}$.

9. Dispositif pour réaliser le procédé selon l'une quelconque des revendications précédentes, comprenant un système de filage et un système de contrôle par ordinateur, dans lequel le système de filage comprend un mécanisme d'alimentation et de cardage, un mécanisme de collecte et de torsion, et un mécanisme d'enroulement, le mécanisme d'alimentation et de cardage comprend un rouleau d'alimentation combiné comprenant deux rouleaux d'alimentation (2-1, 2-2) ayant deux degrés de liberté de rotation, un rouleau de cardage à trois niveaux comprenant trois rouleaux de cardage (2-6, 2-7, 2-8) ; dans laquelle un rapport de vitesse de deux rouleaux d'alimentation combinés (2-1, 2-2) des les rouleaux d'alimentation combinés avec deux degrés de liberté de rotation est ajusté, le mécanisme de collecte et de torsion comprend un canal (1-10) de transport de fibres, un rotor (1-12) et un dispositif de guidage ; le mécanisme de remontage comprend un mécanisme de guidage et de remontage ; le système de commande par ordinateur comprend un automate programmable PLC, un servomoteur, un servomoteur ; dans laquelle le rouleau d'alimentation combiné (2-1, 2-2) avec deux degrés de liberté de rotation et le rouleau de cardage à trois niveaux (2-6, 2-7, 2-8) sont entraînés par le servomoteur.

10. Dispositif selon la revendication 9, **caractérisé en ce que**: le rouleau d'alimentation combiné (2-1, 2-2) avec deux degrés de liberté de rotation comprennent un arbre (4-8), un palier (4-1), un arbre creux (4-2), un premier engrenage (4-3), un deuxième engrenage (4-7), une rondelle, un premier rouleau mobile (4-5), un deuxième rouleau mobile (4-6) dans lequel le premier engrenage (4-3), le deuxième engrenage (4-7), le premier rouleau mobile (4-5) et le deuxième rouleau mobile (4-6) tournent autour du même axe, le premier engrenage (4-3) et le deuxième engrenage (4-7) entraînent le premier rouleau mobile (4-5) et le deuxième rouleau mobile (4-6), respectivement.

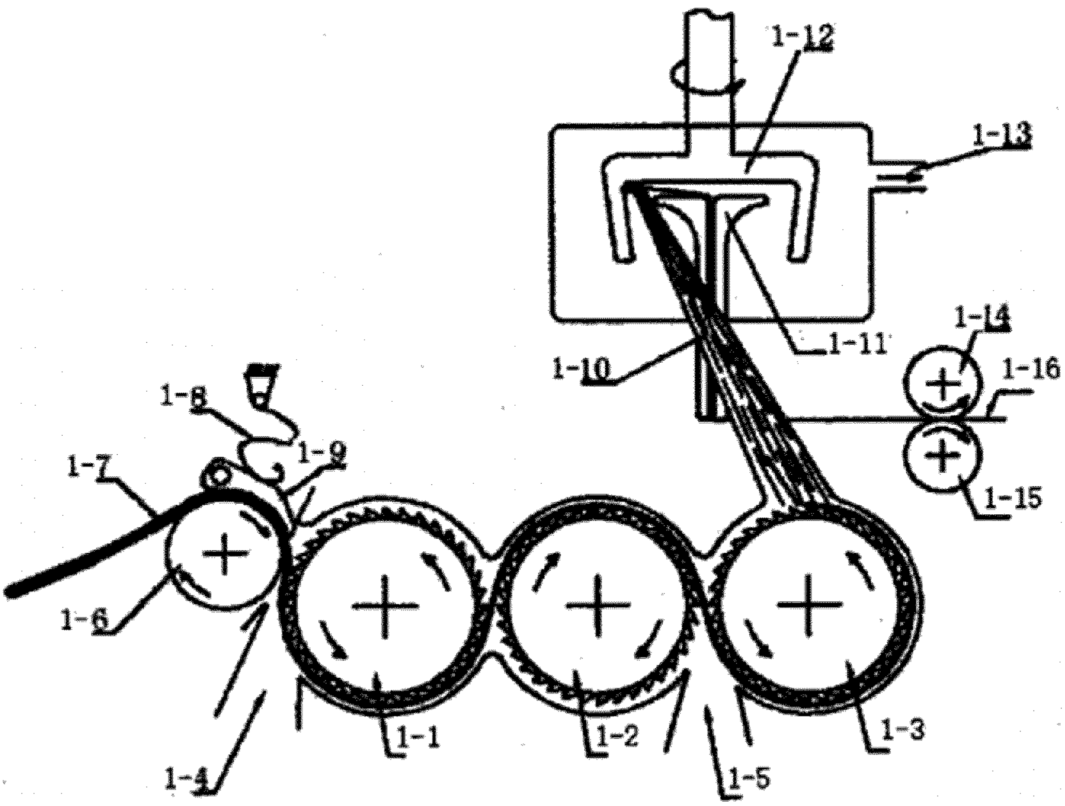


FIG. 1

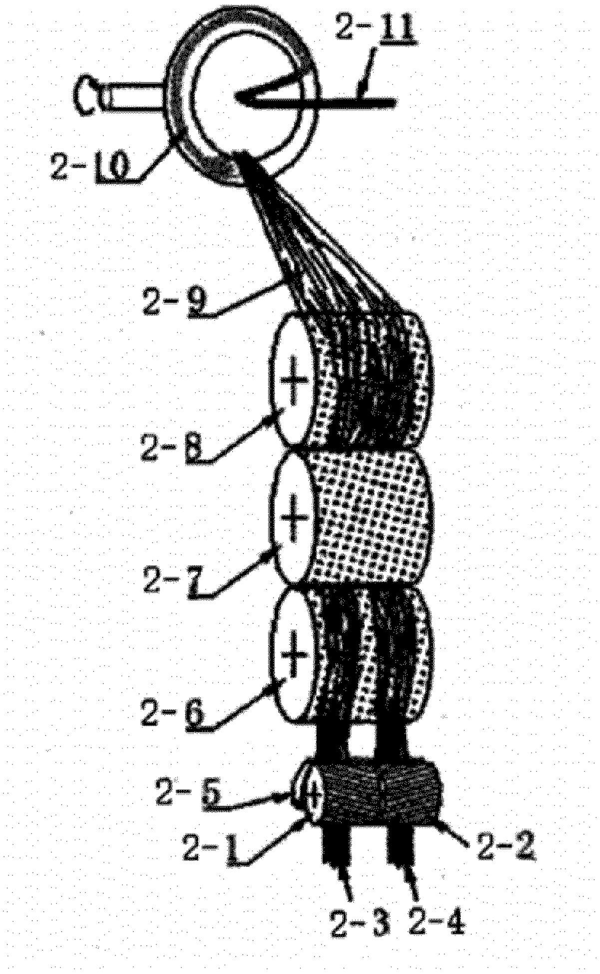
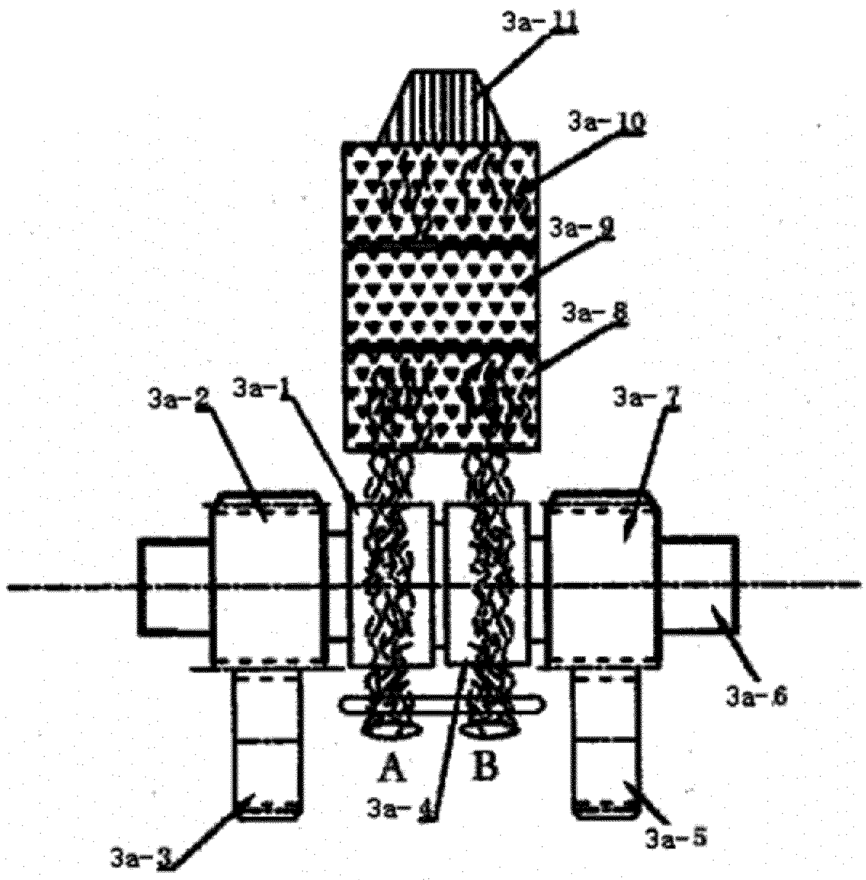
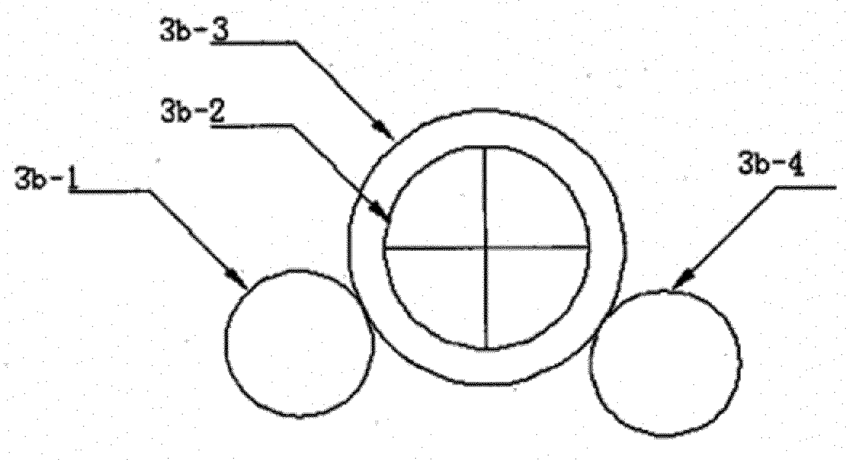


FIG. 2



3a



3b

FIG. 3

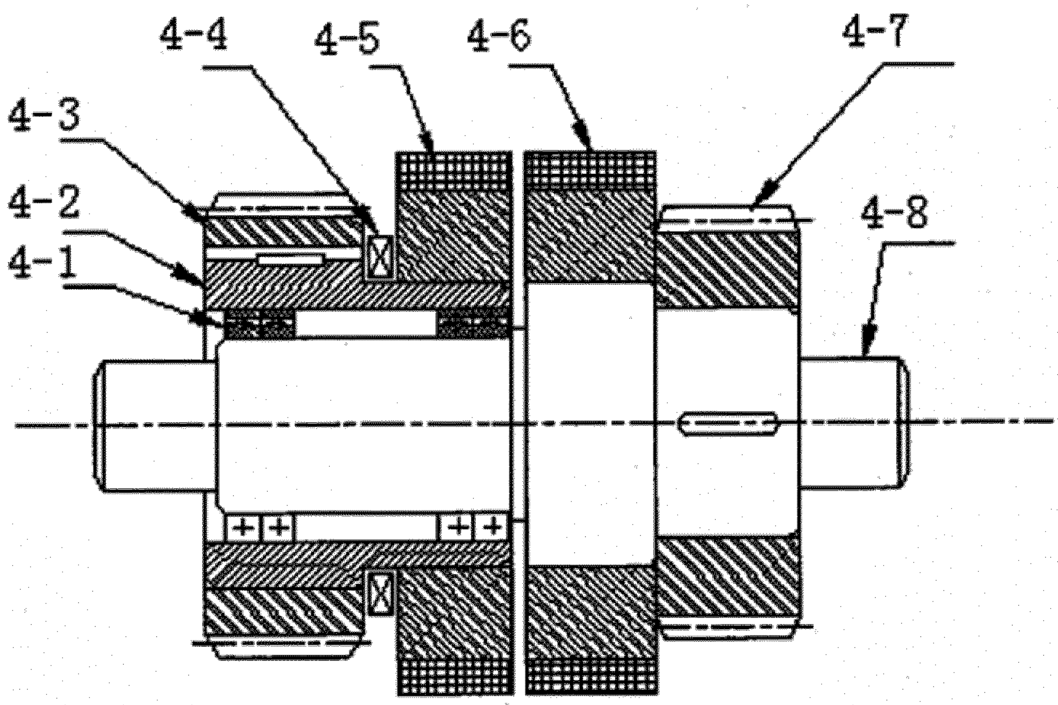


FIG. 4

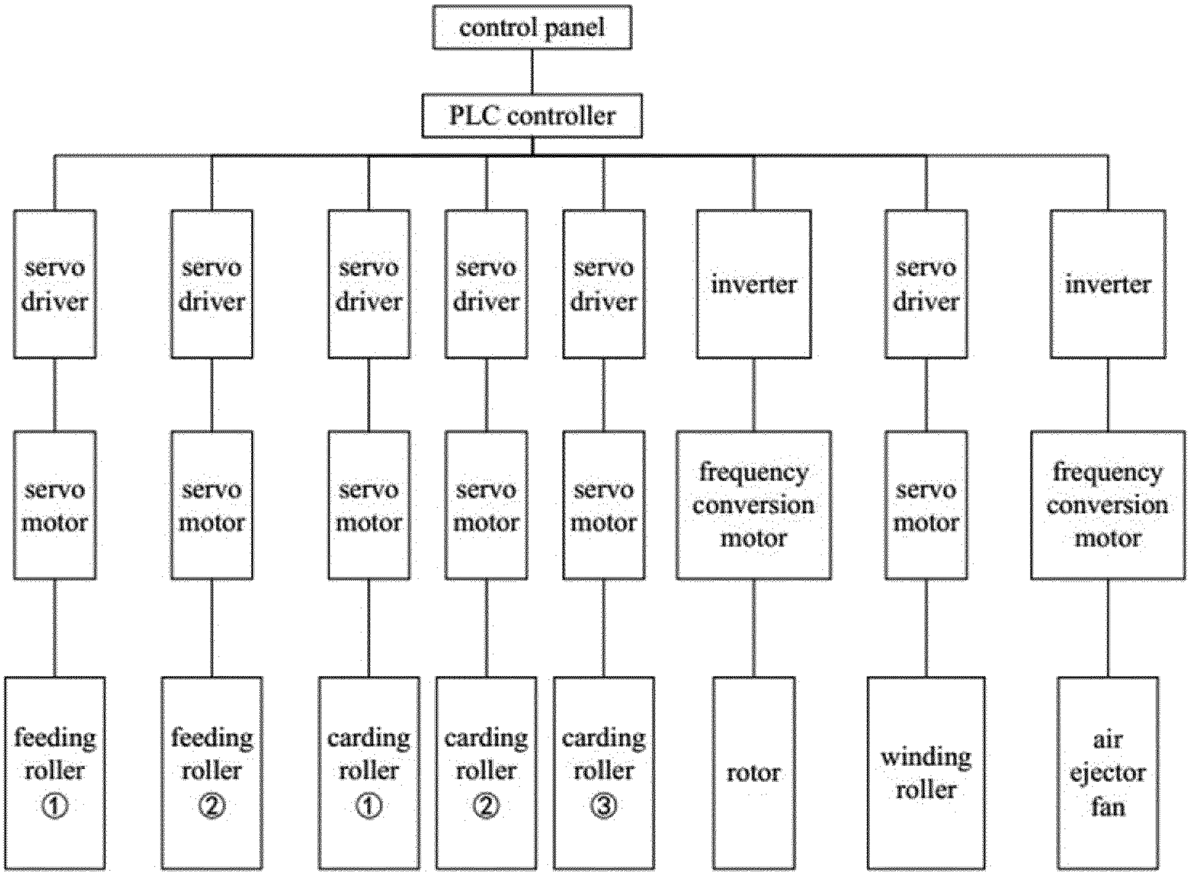

control panel
PLC controller
servo driver
servo driver
servo driver
servo driver
servo driver
inverter
servo driver
inverter
servo motor
servo motor
servo motor
servo motor
servo motor
frequency conversion motor
servo motor
frequency conversion motor
feeding roller ①
feeding roller ②
carding roller ①
carding roller ②
carding roller ③
rotor
winding roller
air ejector fan

FIG. 5

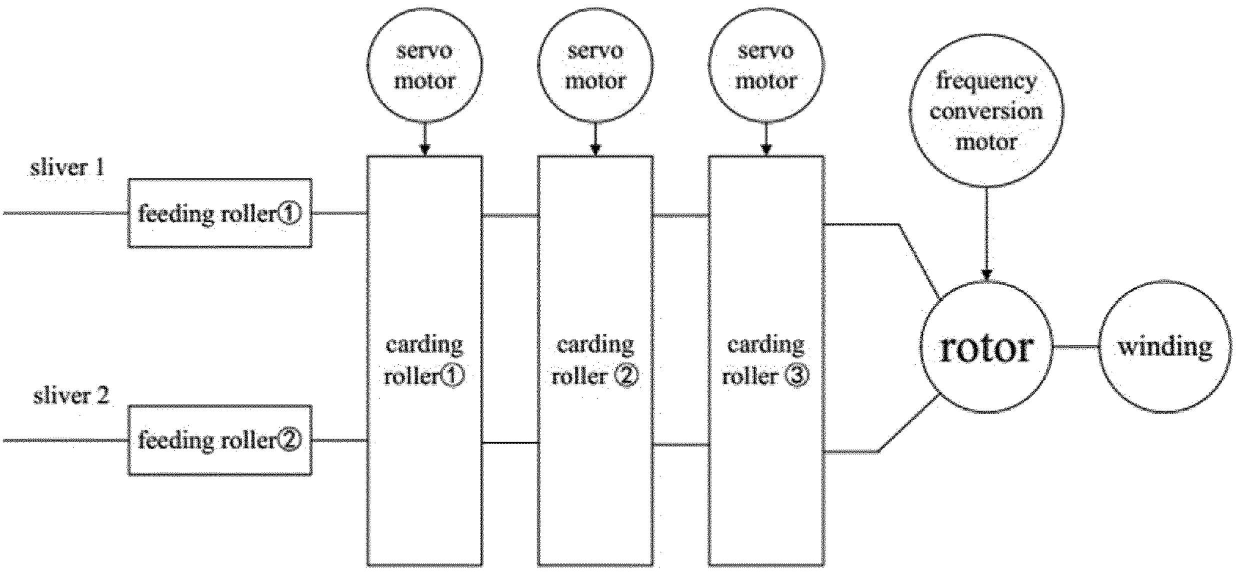

servo motor
servo motor
servo motor
frequency conversion motor
sliver 1
feeding roller①
sliver 2
feeding roller②
carding roller①
carding roller ②
carding roller ③
rotor
winding

FIG. 6

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- CN 201410190891 **[0003]**
- CN 201420229715 X **[0003]**
- CN 00137211 **[0004]**
- CN 103938322 A **[0007]**
- CN 104711730 A **[0008]**
- EP 1564318 A2 **[0009]**
- EP 1352998 A2 **[0010]**