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(54) DEVICE AND METHOD FOR REALIZING BLENDING AND COLOR MIXING BASED ON TRIPLE-ROVING COUPLING DRAFTING AND TWISTING SYSTEM, AND COLORFUL YARN PREPARED VIA METHOD

(57) A device and method for realizing blending and color mixing based on a triple-roving coupling drafting and twisting system, the device comprising a drafting and twisting system consisting of a set of rear rollers and a set of front rollers; the set of rear rollers comprises a combination rear leather roller (4) and a combination rear roller (5); the set of front rollers comprises a front leather roller (6) and a front roller (7); and the set of rear rollers is a combination rear roller having three degrees of rotational freedom and formed by sequentially positioning three sections of rings (8, 9, 10) with the same outer diameter on the same spindle. Each part of a drafting mechanism having three degrees of freedom is independently controlled for on-demand configuration of the blending ratio of the roving of different components or different colors and the configuration of the distributed length of the roving on yarns.

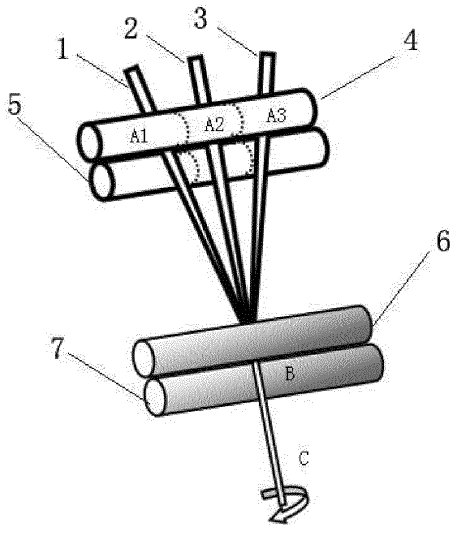

Fig. 1

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Description

Field of the Invention

[0001] The present invention relates to a method and device for realizing yarn blending and color mixing based on a triple-roving coupling drafting and twisting system, and a colorful yarn prepared via the method.

Background of the Invention

[0002] Ring spinning is one of the most often used and most universal spinning methods on the market at present. In the prior art, the ring spinning of a composite yarn is usually realized by arranging different yarns among front, middle and rear rollers in a drafting and twisting step; for example, in a preposed left-and-right shifting overfeeding composite spinning device and process having the publication number CN102787411A, a front roller rotates to enable a bridging roller, a speed adjusting roller and an overfeeding roller to frictionally drive an outer-axis long tow, or a yarn is overfed to the front portions of the front rollers and converged and twisted with an output short fiber silver to form a dual-component overfed composite yarn. In CN102704124A, a three-axis composite spinning method and an application thereof are disclosed. Synchronous three-axis feeding into a front roller is realized through a buncher; after coming out of the jaw of the front roller, two bundles of filaments are wrapped around a short fiber silver in a twisting triangle zone to form a dual-filament sleek composite yarn that are substantially non-self-twisted and short fiber silver wrapping. In CN101899734A, disclosed is a dual-structure device and method to process polyester-viscose blended yarns, wherein a plurality of yarn channels are arranged for front and middle rollers and a V-shaped collector is arranged for a rear roller to realize yarn blending; and the technique may solve the problem of uncontrollable fiber mixing in the prior art. Blending by using the ring spinning method often has defects in functionalities due to uneven mixing or an improper mixing ratio of silvers of different types.

[0003] Whereas, in the existing segmental colorful yarn production technique, a frequently utilized dyeing method has such defects as it has only one color distribution cycle mode and has limited variability of overlaid patterns on fabrics; and as for the segmental colorful yarn formed by using a colored fiber spinning method, generally, the distribution of fibers of only two colors can be regulated and controlled, and thick and thin knots may be formed on the yarn. In short, the previous colored spun yarn technique and segmental colorful yarn technique have the defects that the colors on yarns and their distribution cannot be adjusted at will and multi-color changes of a yarn cannot be realized. If three (or more than three) different colors are formed segmentally on continuous yarns, the yarns can be collectively known as multiple-color segmental colorful yarns or colorful yarns. In the prior art, such multiple-color segmental colorful yarns (colorful yarns) cannot be obtained yet through direct spinning by using existing colored rovings.

Summary of the Invention

[0004] To solve problems existing in the prior art, the primary purpose of the present invention is to provide a device for realizing yarn blending and color mixing based on a triple-roving coupling drafting and twisting system; three pure-spun roving silvers of different raw materials, such as a cotton roving silver, a polyester roving silver, a viscose roving silver and the like, are drafted and twisted together through a drafting and twisting system of a ring spinning fine yarn machine, such that three types of fibers can be blended into a yarn in a specified arbitrary ratio, and therefore, the preparation of the blended yarn of three short fiber raw materials combined in an arbitrary ratio through a short process of a ring spinning one-step method can be realized; and roving silvers of three colors, such as rovings of three primary colors red, green and blue, are drafted and twisted together through the drafting and twisting system of the ring spinning fine yarn machine, such that fibers of three colors can be blended into a yarn in a specified arbitrary ratio; meanwhile, according to the principle of matching of the three primary colors, color matching spinning of arbitrary colors may be realized. The principle is similar to the principle of a color printer. The secondary purpose of the present invention is to provide a processing method for realizing yarn blending and color mixing based on a triple-roving coupling drafting and twisting system.

[0005] To achieve the above goals, the present invention provides a device for realizing yarn blending and color mixing based on a triple-roving coupling drafting and twisting system, including a drafting and twisting system consisting of a set of rear rollers and a set of front rollers, wherein the set of rear rollers includes a combined rear leather roller and a combined rear roller; the set of front rollers includes a front leather roller and a front roller; the combined rear roller consists of rings having three degrees of rotational freedom; and the rings having three degrees of rotational freedom include a first ring, a second ring and a third ring, the three of which rotate independently of each other. Further more, the first ring, the second ring and the third ring are driven by three different servomotors respectively.

[0006] Further more, the first ring, the second ring and the third ring sleeve the same spindle in sequence, and any one ring is fixedly connected with the same spindle, while the other two rings are connected with the same spindle in a

relatively rotational manner respectively.

[0007] Further more, the first ring, the second ring and the third ring have the same outer diameter.

[0008] Further more, the first ring, the second ring and the third ring are mounted on three different spindles respectively, and the three different spindles are mounted in the same axis.

[0009] Further more, any two adjacent rings of the first ring, the second ring and the third ring are mounted on the same spindle, while the other one ring is mounted on the other different spindle, and the two spindles are mounted in the same axis; one of the two adjacent rings is fixedly connected with the spindle thereof, while the other one is connected with the spindle thereof in a relatively rotational manner.

[0010] Further more, the combined rear leather roller consists of a first leather roller, a second leather roller and a third leather roller corresponding to the first ring, the second ring and the third ring one to one respectively; the first leather roller, the second leather roller and the third leather roller rotate independently of one another.

[0011] Further more, surface linear speeds of the first ring, the second ring and the third ring or speeds of three rovings fed into a drafting zone are controlled by a control-drive system; the control-drive system includes three drivers, and the three drivers control rotating speeds of the first ring, the second ring and the third ring respectively, and keep constant sum of weights of three rovings input by the rear roller per unit time.

[0012] Additionally, the method for realizing yarn blending and color mixing based on a triple-roving coupling drafting and twisting system by using the device for realizing yarn blending and color mixing based on the triple-roving coupling drafting and twisting system is as follows:

1) the rear roller of the triple-roving coupling drafting system consists of the spindle and three sections of rings nested on the spindle which rotate independently of one aother;
2) three rovings are independently drafted by using the three sections of rings rotating independently of each other respectively;
3) the three sections of rings rotating independently of each other are controlled by three different drivers respectively; and
4) the surface linear speeds of the three sections of rings rotating independently of each other or the speeds of three rovings fed into the drafting zone are enabled to satisfy the following formula through program control:

$$V_{h1} \times \rho_1 + V_{h2} \times \rho_2 + V_{h3} \times \rho_3 = \text{Constant}$$

or

$$\frac{\rho_1}{E_1} + \frac{\rho_2}{E_2} + \frac{\rho_3}{E_3} = \text{Constant}.$$

[0013] It is assumed that V_q is the linear speed of the front roller, V_{hi} is the linear speed (m/s) of the i^{th} rear roller ring (i=1, 2, 3), $E_i=V_q/V_{hi}$ is a draft ratio of the front roller relative to the i^{th} rear roller ring (i=1, 2, 3), ρ_i is a linear density (g/m) of a roving before the i^{th} (i=1, 2, 3) silver is drafted, ρ_i' is a linear density (g/m) of a silver after the i^{th} (i=1, 2, 3) roving is drafted, and p' is a total linear density (g/m) of the silver after three rovings are drafted, combined and twisted.

[0014] After three rovings are fed into a combination drafting zone having three degrees of freedom, if any draft ratio of the three rovings is changed, it is possible that the linear density of a yarn obtained through drafting, combining and twisting is also varied. To keep the linear density thereof unchanged, under the circumstance of a constant linear speed of the front roller, the constant linear density of the finally obtained yarn can be ensured if constant sum of the weights of the three rovings input by the rear roller per unit time can be ensured.

$$\text{I.e.,}\quad V_{h1} \times \rho_1 + V_{h2} \times \rho_2 + V_{h3} \times \rho_3 = \text{Constant} \qquad (1)$$

Or

$$\frac{\rho_1}{E_1} + \frac{\rho_2}{E_2} + \frac{\rho_3}{E_3} = \text{Constant} \qquad (2)$$

[0015] The above formulas indicate that, for the triple-roving feeding drafting and twisting device having three degrees of freedom, although the draft ratio of the three rovings is changed or the speed of the rear roller is changed, the linear density of the yarn formed after drafting and twisting can be kept constant if it can be guaranteed that the surface linear speeds of the three rings of the rear roller or the draft ratios thereof relative to the front roller satisfy the constraint of the formula (1) or (2); such a drafting way where the surface linear speeds or the draft ratios of the three rings of the rear roller are able to satisfy the above condition is known to us as multi-component coupling drafting or multi-component drafting coupling for yarn forming by keeping the equivalent linear density.

[0016] If the linear densities of the three fed roving silvers are all equal, namely$\rho_1=\rho_2=\rho_3$, then the above formulas can be simplified as follows:

$$\rho_1 \times (V_{h1} + V_{h2} + V_{h3}) = \text{Constant} \tag{3}$$

Or

$$\rho_1 \times \left(\frac{1}{E_1} + \frac{1}{E_2} + \frac{1}{E_3}\right) = \text{Constant} \tag{4}$$

[0017] The formulas (3) and (4) explain that, in order to keep the yarn forming linear density of the triple-roving feeding combination drafting and twisting device unchanged, it is necessary to keep the sum of the surface linear speeds of the three rings of the rear roller or the sum of the draft ratios of the three rovings constant; such triple-component drafting satisfying the above conditions is known to us as speed-coupled coupling drafting or drafting coupling, it can also be called draft ratio-coupled coupling drafting or drafting coupling.

[0018] A method for regulating and controlling a yarn forming blending ratio or a color mixing ratio of a triple-roving feeding combination drafting and twisting system having three degrees of freedom

[0019] A calculation formula of the yarn forming blending ratio or the color mixing ratio of the triple-roving feeding combination drafting and twisting system with three degrees of freedom is as follows:

$$K_1 = \frac{\rho_1'}{\rho_1'+\rho_2'+\rho_3'} = \frac{\rho_1/E_1}{\rho_1/E_1+\rho_2/E_2+\rho_3/E_3} = \frac{V_{h1}\times\rho_1}{V_{h1}\times\rho_1+V_{h2}\times\rho_2+V_{h3}\times\rho_3} \tag{5}$$

$$K_2 = \frac{\rho_2'}{\rho_1'+\rho_2'+\rho_3'} = \frac{\rho_2/E_2}{\rho_1/E_1+\rho_2/E_2+\rho_3/E_3} = \frac{V_{h2}\times\rho_{21}}{V_{h1}\times\rho_1+V_{h2}\times\rho_2+V_{h3}\times\rho_3} \tag{6}$$

$$K_3 = \frac{\rho_3'}{\rho_1'+\rho_2'+\rho_3'} = \frac{\rho_3/E_3}{\rho_1/E_1+\rho_2/E_2+\rho_3/E_3} = \frac{V_{h3}\times\rho_3}{V_{h1}\times\rho_1+V_{h2}\times\rho_2+V_{h3}\times\rho_3} \tag{7}$$

wherein K_1, K_2 and K_3 represent the yarn blending ratios or the color mixing ratios of various components of roving 1, roving 2, roving 3 and the like respectively.

[0020] To simplify the formulas, assuming $\rho_1=\rho_2=\rho_3$, $(V_{h1} + V_{h2} + V_{h3})= V$, the yarn blending ratios or the color mixing ratios of various components of roving 1, roving 2, roving 3 and the like represented by the formulas (5), (6) and (7) can be simplified as follows:

$$K_1 = \frac{V_{h1}}{V_{h1}+V_{h2}+V_{h3}} = \frac{V_{h1}}{V} \tag{8}$$

$$K_2 = \frac{V_{h2}}{V_{h1} + V_{h2} + V_{h3}} = \frac{V_{h2}}{V} \quad (9)$$

$$K_3 = \frac{V_{h3}}{V_{h1} + V_{h2} + V_{h3}} = \frac{V_{h3}}{V} \quad (10)$$

[0021] Then, formulas (3), (8), (9) and (10) indicate that, if the values of V_{h1}, V_{h2} and V_{h3} are changed independently to enable V_{h1}, V_{h2} and V_{h3} to vary within a range of 0-V respectively, and simultaneously (V_{h1}+V_{h2}+V_{h3})=V is kept as a constant value, K_1, K_2 and K_3 also may vary within a range of 0-100% individually; hence, the blending ratio of three different fibers, which form a yarn and have an unchanged total linear density after three components are stranded and twisted, or the color mixing ratio of three fibers of different colors can be changed by arbitrarily changing feeding quantities of three rovings; i.e., the blending ratio or the color mixing ratio can be changed arbitrarily.

[0022] Further more, the three rovings are three-primary color rovings.

[0023] Further more, the three primary colors are red, green and blue.

I. Alternating color changing of the three-primary color rovings:

[0024] Color mixing of the three-primary color (or three-color) rovings can be realized by three modes, namely single color mode, two-color mixing mode and three-color mixing mode. The single-color mode is: color A, color B or color C; the two-color mixing mode is color A-B mixing, color B-C mixing or color A-C mixing; and the three-color mixing mode is color A-B-C mixing. Hence, 7 color mixing modes can be realized through the alternating color changing of the three-primary color rovings.

II. Gradient color matching of the three-primary color rovings:

[0025] According to the color mixing ratios of the three-primary color rovings K_1+K_2+K_3=100%, theoretically, there can be countless combinations of K_1, K_2 and K_3. Due to limited resolution of naked eyes, the color mixing ratios need to be discretized for the sake of use. In the present invention patent, a progressive increase of 10% is selected as a gradient for color mixing and matching, and then the following color mixing and matching solutions can be formed:

Table 1 Color Matching Solutions

		Color A mixing ratio K1	Color B mixing ratio K2	Color C mixing ratio K3	Color Number
Single color	Color A	1	0	0	1
	Color B	0	0	1	2
	Color C	0	1	0	3

(continued)

		Color A mixing ratio K1	Color B mixing ratio K2	Color C mixing ratio K3	Color Number
Two-color mixing	AB	0.1	0.9	0	4
		0.2	0.8	0	5
		0.3	0.7	0	6
		0.4	0.6	0	7
		0.5	0.5	0	8
		0.6	0.4	0	9
		0.7	0.3	0	10
		0.8	0.2	0	11
		0.9	0.1	0	12
	BC	0	0.9	0.1	13
		0	0.8	0.2	14
		0	0.7	0.3	15
		0	0.6	0.4	16
		0	0.5	0.5	17
		0	0.4	0.6	18
		0	0.3	0.7	19
		0	0.2	0.8	20
		0	0.1	0.9	21
	AC	0.9	0	0.1	22
		0.8	0	0.2	23
		0.7	0	0.3	24
		0.6	0	0.4	25
		0.5	0	0.5	26
		0.4	0	0.6	27
		0.3	0	0.7	28
		0.2	0	0.8	29
		0.1	0	0.9	30

(continued)

		Color A mixing ratio K1	Color B mixing ratio K2	Color C mixing ratio K3	Color Number
Three-color mixing	ABC	0.1	0.1	0.8	31
		0.1	0.2	0.7	32
		0.1	0.3	0.6	33
		0.1	0.4	0.5	34
		0.1	0.5	0.4	35
		0.1	0.6	0.3	36
		0.1	0.7	0.2	37
		0.1	0.8	0.1	38
		0.2	0.1	0.7	39
		0.2	0.2	0.6	40
		0.2	0.3	0.5	41
		0.2	0.4	0.4	42
		0.2	0.5	0.3	43
		0.2	0.6	0.2	44
		0.2	0.7	0.1	45
		0.3	0.1	0.6	46
		0.3	0.2	0.5	47
		0.3	0.3	0.4	48
		0.3	0.4	0.3	49
		0.3	0.5	0.2	50
		0.3	0.6	0.1	51
		0.4	0.1	0.5	52
		0.4	0.2	0.4	53
		0.4	0.3	0.3	54
		0.4	0.4	0.2	55
		0.4	0.5	0.1	56
		0.5	0.1	0.4	57
		0.5	0.2	0.3	58
		0.5	0.3	0.2	59
		0.5	0.4	0.1	60
		0.6	0.1	0.3	61
		0.6	0.2	0.2	62
		0.6	0.3	0.1	63
		0.7	0.1	0.2	64
		0.7	0.2	0.1	65
		0.8	0.1	0.1	66

III. Twisting and mixing of the three-primary color rovings

[0026] After being drafted, three three-primary color silvers are converged at the jaw of the front roller and enter a twisting zone where the silvers are twisted by a ring twisting device and an auxiliary twisting device to finally form a three-primary color mixed yarn. In this case, a drawing and pulling effect of the front roller on the three three-primary color silvers and the inside-outside movement of fibers in the silvers due to twisting lead to an effective color mixing effect of the colored fibers.

[0027] The segmental colorful yarn obtained via the above method is formed by mixing three colored rovings that are dragged by three relatively independently rotating rear roller rings respectively; the sum of the linear speeds of the three relatively independently rotating rear roller rings is constant.

[0028] By means of coupling drafting, alternating color changing, gradient color matching and mixing twisting of three (three primary colors red, yellow and green or three colors A, B and C) rovings, the mixing ratio of three colored fibers A, B and C in the yarn can be controlled, i.e., the mixing ratio of the three colored fibers and the lengths thereof distributed on the yarn can be configured according to the pattern design requirements of the yarn. Meanwhile, with feasible solutions provided by the present invention patent, maximum 66 color mixing combinations can be realized on the yarn by means of gradient configurations of the mixing ratios of the three colored fibers A,B and C; as the mixing ratios of the three colored fibers vary, random distribution of different colors (66 colors at most) is realized on the yarn in the length direction, and therefore, a color-mixed multi-color segmental colorful yarn that cannot be obtained by using a traditional spinning technique is formed. Such a technique is a major breakthrough of the colored spun yarn technique and segmental colorful yarn technique.

[0029] A segmental colorful yarn prepared via the method for realizing yarn blending and color mixing based on the triple-roving coupling drafting and twisting system.

[0030] The ring spinning technique in the prior art does not realize individual control of a single yarn. In the present invention, three sections of rings are arranged on one spindle and controlled by three servomotors respectively, and therefore, individual control of each single yarn is realized; furthermore, the mixing ratios of various components in the blended yarns can be accurately controlled, and then the blended yarns of three short fiber raw materials combined in arbitrary ratios may be prepared through a short process of the ring spinning one-step method. In addition, to spin the segmental colorful yarn, yarns of different colors can be added to each independently controlled part according to requirements and blended into the yarn according to a specified arbitrary ratio; furthermore, based on the principle of matching of the three primary colors, arbitrary color matching spinning can be realized. On-demand configurations of a plurality of roving mixing ratios and color mixing ratios are realized through independent control of three degrees of freedom in the present invention, and therefore, the width of products is increased, and the method is simple and practical.

Brief Description of the Drawings

[0031]

Fig. 1 is a schematic diagram of a combination drafting and twisting device having three degrees of freedom of the present invention;
Fig. 2 is a structural diagram of a rear combined roller and a rear combined leather roller of the present invention;
Fig. 3 is a schematic diagram of the transmission of a set of rear combined rollers of the present invention;
Figs. 4, 5 and 6 are product samples of the three-primary color digital spinning of the present invention;
Fig. 7 is a diagram of a ring spinning control-drive system of triple-roving coupling drafting;
Fig. 8 is a diagram of a ring spinning control-drive system of triple-roving coupling drafting in embodiment 2;
Fig. 9 is a structural schematic diagram of a coupling drafting and twisting device having three degrees of freedom in embodiment 3.

[0032] In the figures, 1, roving 1; 2, roving 2; 3, roving 3; 4, combined rear leather roller; 5, combined rear roller; 6, front leather roller; 7, front roller; 8, first ring; 9, second ring; 10, third ring; 11 and 15, toothed belt; 12, first leather roller; 13, second leather roller; 14, third leather roller.

Detailed description of the Embodiments

[0033] To provide more obvious and easy understanding of the present invention, detailed descriptions are made below with reference to preferred embodiments in combination with accompanying drawings.

Embodiment 1

[0034] As shown in Figs. 1-3, a device for realizing yarn blending and color mixing based on a triple-roving coupling drafting and twisting system includes a drafting and twisting system consisting of a set of rear rollers and a set of front rollers, wherein the set of rear rollers includes a combined rear leather roller 4 and a combined rear roller 5; the set of front rollers includes a front leather roller 6 and a front roller 7; the combined rear roller 5 consists of rings having three degrees of rotational freedom; and the rings having three degrees of rotational freedom include a first ring 8, a second ring 9 and a third ring 10, the three of which rotate independently of each other.

[0035] The first ring 8, the second ring 9 and the third ring 10 are driven by three different servomotors respectively. The first ring 8, the second ring 9 and the third ring 10 sleeve the same spindle in sequence, and the second ring 9 thereamong is fixedly connected with the spindle through a pin, a key or interference fit; and the other two rings are connected with the spindle in a relatively rotational manner respectively. The first ring, the second ring and the third ring have the same outer diameter.

[0036] Additionally, the first ring or the third ring may also be fixedly connected with the spindle, while the other two rings are rotatably connected with the spindle. Additionally, the first ring, the second ring and the third ring further may be mounted on three different spindles respectively, and the three different spindles are mounted in the same axis; or any two adjacent rings of the first ring, the second ring and the third ring are mounted on the same spindle, while the other one ring is mounted on the other different spindle, and the two spindles are mounted in the same axis.

[0037] Corresponding to the combined rear roller 5, the combined rear leather roller 4 consists of a first leather roller 12, a second leather roller 13 and a third leather roller 14 corresponding to the first ring, the second ring and the third ring one on one respectively; the first leather roller 12, the second leather roller 13 and the third leather roller 14 rotate independently of one another.

[0038] As the three rings on the combined roller have three independent running speeds, the drafting mechanism has three degrees of freedom and triple-roving feeding combination drafting of three degrees of freedom can be realized. That is to say, in a drafting zone, the device is capable of drafting three fed roving silvers at different draft ratios between position Ai (i=1, 2, 3) where the three rovings pass through in the set of rear rollers and position B where a blended yarn passes through in the set of front rollers respectively, and the three silvers after being drafted are converged in a point B and then twisted in a point C of the twisting device to form a yarn.

[0039] Rovings 1, 2 and 3 of three different types pass through the gaps A1, A2 and A3 between the combined leather roller 4 and the combined rear roller 5, and then are converged in a gap B between the front leather roller 6 and the front roller 7 and pass through the set of front rollers to be subsequently twisted in position C of a twister (not shown).

[0040] As shown in Fig. 7, surface linear speeds of the first ring, the second ring and the third ring or speeds of three rovings fed into the drafting zone are controlled by a control-drive system; the control-drive system includes drivers 3-5 controlled by a frequency transducer, and the three drivers control rotating speeds of the first ring, the second ring and the third ring respectively, and keep constant sum of weights of three rovings input by the rear roller per unit time.

[0041] The method for realizing yarn blending and color mixing based on a triple-roving coupling drafting and twisting system by using the above device for realizing yarn blending and color mixing based on the triple-roving coupling drafting and twisting system is as follows:

1) the rear roller of the triple-roving coupling drafting system consists of the spindle and three sections of rings nested on the spindle which rotate independently of one aother;
2) three rovings are independently drafted by using the three sections of rings rotating independently of each other respectively;
3) the three sections of rings rotating independently of each other are controlled by the frequency transducer through three different drivers respectively; and
4) the surface linear speeds of the three sections of rings rotating independently of each other or the speeds of three rovings fed into the drafting zone are enabled to satisfy the preceding formula (1) or (2) through program control.

Embodiment 2

[0042] Embodiment 2 is substantially the same as embodiment 1 in structure, and differs from embodiment 1 in that:

As shown in Fig. 8, to more accurately control the various front and rear rollers and various rings, this embodiment employs a programmable controller to control the rotating speed of the spindle orderly through the frequency transducer, a main motor and mechanical transmission in such forms as a chain, a toothed belt, a triangular belt or the like; the programmable controller controls the first ring of the rear roller orderly through a driver 3, an auxiliary motor 3 and the mechanical transmission in such forms as the chain, the toothed belt, the triangular belt or the like, controls the second ring of the rear roller orderly through a driver 4, an auxiliary motor 4 and the mechanical transmission

in such forms as the chain, the toothed belt, the triangular belt or the like, and controls the third ring of the rear roller orderly through a driver 5, an auxiliary motor 5 and the mechanical transmission in such forms as the chain, the toothed belt, the triangular belt or the like respectively. In addition, the programmable controller controls the front and middle rollers and a ring bar through drivers, auxiliary motors and the mechanical transmission respectively. By means of program control on the rotating speed of each ring of the rear roller, it is accurately realized that the surface linear speeds of three sections of rings rotating independently of each other or the speeds of three rovings fed into the drafting zone satisfy the preceding formula (1) or (2); moreover, on the premise of satisfying the formula (1) or (2), the rotating speeds of the first, second and third rings are regulated to realize on-demand adjustment of ratios of rovings of different types and different colors.

[0043] Additionally, the present invention may also realize independent control on the rotating speeds of the three rings by using other devices, such as a single chip computer, a computer and the like, in such drive and transmission forms as the servomotors and the like, and realize that the rotating speeds thereof satisfy the needs of the formulas (1) and (2).

Embodiment 3

[0044] As shown in Fig. 9, illustrated is a three-primary color coupling drafting and twisting device of the present invention, which consists of a drafting system and a twisting system. The drafting system consists of a rear combined roller 100, a middle roller 200 and a front roller 300; a flare opening 500 is formed between the front roller and the middle roller.

[0045] As shown in Fig. 2, the rear combined roller 100 includes three sections of a first ring 8, a second ring 9 and a third ring 10 having the same outer diameter, and a first leather roller 12, a second leather roller 13 and a third leather roller 14 corresponding to the first ring 8, the second ring 9 and the third ring 10 one to one. The first ring 8, the second ring 9 and the third ring 10 sleeve the same spindle in sequence, and are driven by three different servomotors respectively. The second ring 9 thereamong is fixedly connected with the spindle through a pin, a key or interference fit; and the other two rings are connected with the spindle in a relatively rotatable manner respectively.

[0046] Two servomotors drive the first ring 8 and the third ring 10 to rotate through a first toothed belt 15 and a third toothed belt 11 respectively; the second ring 9 then rotates synchronously along with the spindle and is controlled by aother servomotor.

[0047] As the three rings on the combined rear roller have three independent running speeds, the drafting mechanism has three degrees of freedom and is capable of realizing coupling drafting of three degrees of freedom to the fed red colored roving A, yellow colored roving B and blue colored roving C. That is to say, in the drafting zone, holding points of the red colored roving A, the yellow colored roving B and the blue colored roving C with the front leather roller and the front roller are Pa, Pb and Pc respectively, and the holding points of them with the middle leather roller and the middle roller are Qa, Qb and Qc respectively; three silvers are converged at the front leather roller and the front roller with a holding point R; the device is capable of drafting the fed red colored roving A, yellow colored roving B and blue colored roving C and the silvers at different draft ratios respectively, and the three drafted silvers are converged in the point R and then twisted and mixed to form a colorful yarn.

[0048] As shown in Fig. 7, surface linear speeds of the first ring, the second ring and the third ring or speeds of three rovings fed into the drafting zone are controlled by a control-drive system; the control-drive system includes drivers 3-5 controlled by a frequency transducer, and the three drivers control rotating speeds of the first ring, the second ring and the third ring respectively, and keep constant sum of weights of three colored rovings input by the rear roller per unit time.

[0049] Color mixing modes of the three primary colors (or three colors A, B and C)

1. Three modes of mixing of the three primary colors

[0050] There can be three modes for realizing color changes of yarns by means of mixing of the three primary colors (or three colors), namely single color, two-color mixing and three-color mixing. The single-color mode is: color A, color B or color C; the two-color mixing mode is color A-B mixing, color B-C mixing or color A-C mixing; and the three-color mixing mode is color A-B-C mixing.

2. Gradient configuration of color mixing ratios and solutions for realizing different color matching

[0051] In various color mixing modes of the three primary colors, the following mixed colors can be formed through color matching with a progressive increase of 10% of the color mixing ratios as the minimum increment:

Table 1 Color Matching Solutions

		Color A mixing ratio K1	Color B mixing ratio K2	Color C mixing ratio K3	Color Number
Single color	Color A	1	0	0	1
	Color B	0	0	1	2
	Color C	0	1	0	3
Two-color mixing	AB	0.1	0.9	0	4
		0.2	0.8	0	5
		0.3	0.7	0	6
		0.4	0.6	0	7
		0.5	0.5	0	8
		0.6	0.4	0	9
		0.7	0.3	0	10
		0.8	0.2	0	11
		0.9	0.1	0	12
	BC	0	0.9	0.1	13
		0	0.8	0.2	14
		0	0.7	0.3	15
		0	0.6	0.4	16
		0	0.5	0.5	17
		0	0.4	0.6	18
		0	0.3	0.7	19
		0	0.2	0.8	20
		0	0.1	0.9	21
	AC	0.9	0	0.1	22
		0.8	0	0.2	23
		0.7	0	0.3	24
		0.6	0	0.4	25
		0.5	0	0.5	26
		0.4	0	0.6	27
		0.3	0	0.7	28
		0.2	0	0.8	29
		0.1	0	0.9	30

(continued)

		Color A mixing ratio K1	Color B mixing ratio K2	Color C mixing ratio K3	Color Number
Three-color mixing	ABC	0.1	0.1	0.8	31
		0.1	0.2	0.7	32
		0.1	0.3	0.6	33
		0.1	0.4	0.5	34
		0.1	0.5	0.4	35
		0.1	0.6	0.3	36
		0.1	0.7	0.2	37
		0.1	0.8	0.1	38
		0.2	0.1	0.7	39
		0.2	0.2	0.6	40
		0.2	0.3	0.5	41
		0.2	0.4	0.4	42
		0.2	0.5	0.3	43
		0.2	0.6	0.2	44
		0.2	0.7	0.1	45
		0.3	0.1	0.6	46
		0.3	0.2	0.5	47
		0.3	0.3	0.4	48
		0.3	0.4	0.3	49
		0.3	0.5	0.2	50
		0.3	0.6	0.1	51
		0.4	0.1	0.5	52
		0.4	0.2	0.4	53
		0.4	0.3	0.3	54
		0.4	0.4	0.2	55
		0.4	0.5	0.1	56
		0.5	0.1	0.4	57
		0.5	0.2	0.3	58
		0.5	0.3	0.2	59
		0.5	0.4	0.1	60
		0.6	0.1	0.3	61
		0.6	0.2	0.2	62
		0.6	0.3	0.1	63
		0.7	0.1	0.2	64
		0.7	0.2	0.1	65
		0.8	0.1	0.1	66

[0052] Notes: on the basis of K1+K2+K3=100%, there can be countless combinations. The present invention patent

selects 0.1 as a gradient for gradient color mixing and matching; according to above statistics, 66 matched colors can be finally formed by means of coupling drafting, alternating color changing, gradient color matching and twisting mixing of the three-primary color rovings (three-color rovings), i.e., a segmental colorful yarn having the distribution of 66 colors can be formed; more importantly, on the same segmental colorful yarn, color matching can be changed continuously according to requirements. When fabricating cloth with patterns, color changes for forming the patterns on different yarns may be extracted through computerized typesetting and set in advance, and then the set patterns are naturally formed by different segmental colorful yarns after weaving.

[0053] A coloration effect of fibers of the three primary colors evenly mixed in a certain ratio belongs to spatial color mixing in physical color mixing.

[0054] The embodiments are merely used for illustrating the present invention rather than limiting the scope of the present invention. Additionally, it should be appreciated that those skilled in the art, after reading and understanding the contents of the present invention, may make various alterations or modifications to the present invention, and these equivalent forms also fall into the scope defined by the appended claims of the present invention.

Claims

1. A device for realizing yarn blending and color mixing based on a triple-roving coupling drafting and twisting system, is characteristic in that the device comprises a drafting and twisting system consisting of a set of rear rollers and a set of front rollers, wherein the set of rear rollers comprising a combined rear leather roller and a combined rear roller; the set of front rollers comprising a front leather roller and a front roller; the combined rear roller consisting of rings having three degrees of rotational freedom; and the rings having three degrees of rotational freedom comprising a first ring, a second ring and a third ring, the three of which rotating independently of one another.

2. The device for realizing yarn blending and color mixing based on the triple-roving coupling drafting and twisting system of claim 1, wherein the first ring, the second ring and the third ring are driven by three different servomotors respectively.

3. The device for realizing yarn blending and color mixing based on the triple-roving coupling drafting and twisting system of claim 2, wherein the first ring, the second ring and the third ring sleeve the same spindle in sequence, and any one ring is fixedly connected with the same spindle, while the other two rings are connected with the same spindle in a relatively rotational manner respectively.

4. The device for realizing yarn blending and color mixing based on the triple-roving coupling drafting and twisting system of claim 2, wherein the first ring, the second ring and the third ring have the same outer diameter.

5. The device for realizing yarn blending and color mixing based on the triple-roving coupling drafting and twisting system of claim 2, wherein the first ring, the second ring and the third ring are mounted on three different spindles respectively, and the three different spindles are mounted on the same axis.

6. The device for realizing blending and color mixing based on the triple-roving coupling drafting and twisting system of claim 2, wherein any two adjacent rings of the first ring, the second ring and the third ring are mounted on the same spindle, while the other one ring is mounted on aother different spindle, and the two spindles are mounted on the same axis; one of the two adjacent rings is fixedly connected with the spindle thereof, while the other one is connected with the spindle thereof in a relatively rotational manner.

7. The device for realizing yarn blending and color mixing based on the triple-roving coupling drafting and twisting system of claim 1, wherein the combined rear leather roller consists of a first leather roller, a second leather roller and a third leather roller corresponding to the first ring, the second ring and the third ring one on one respectively; the first leather roller, the second leather roller and the third leather roller rotate independently of one aother.

8. The device for realizing yarn blending and color mixing based on the triple-roving coupling drafting and twisting system of claim 1, wherein surface linear speeds of the first ring, the second ring and the third ring or the speeds of the three rovings fed into the drafting zone are controlled by a control-drive system; which comprises three drivers, and the three drivers control rotating speeds of the first ring, the second ring and the third ring respectively, and keep constant sum of weights of three rovings input by the rear roller per unit time.

9. A method for realizing yarn blending and color mixing by using the device for realizing blending and color mixing

based on the triple-roving coupling drafting and twisting system of claim 1, is characteristic in that it comprise:

1) the rear roller of the triple-roving coupling drafting system consists of the spindle and three sections of rings nested on the spindle which rotate independently of one aother;
2) three rovings are independently drafted by using the three sections of rings rotating independently of one aother respectively;
3) the three sections of rings rotating independently of one aother are controlled by three different drivers respectively; and
4) the surface linear speeds of the three sections of rings rotating independently of one aother or the speeds of three rovings fed into the drafting zone are enabled to satisfy the following formula through program control:

$$V_{h1} \times \rho_1 + V_{h2} \times \rho_2 + V_{h3} \times \rho_3 = \text{Constant}$$

or

$$\frac{\rho_1}{E_1} + \frac{\rho_2}{E_2} + \frac{\rho_3}{E_3} = \text{Constant};$$

wherein, V_q represents the linear speed of the front roller;
V_{hi} represents the linear speed of the i^{th} rear roller ring, wherein i=1, 2, 3;
$E_i=V_q/V_{hi}$ represents a draft ratio of the front roller relative to the i^{th} rear roller ring, wherein i=1, 2, 3; and
ρ_i represents the linear density of the colored roving before the i^{th} silver is drafted, wherein i=1, 2, 3.

10. The method of claim 9, wherein a blending ratio or a color mixing ratio K_i of the triple-rovings fed into the drafting and twisting device satisfies the following formula:

$$K_1 = \frac{\rho_1'}{\rho_1'+\rho_2'+\rho_3'} = \frac{\rho_1/E_1}{\rho_1/E_1+\rho_2/E_2+\rho_3/E_3} = \frac{V_{h1} \times \rho_1}{V_{h1} \times \rho_1 + V_{h2} \times \rho_2 + V_{h3} \times \rho_3}$$

$$K_2 = \frac{\rho_2'}{\rho_1'+\rho_2'+\rho_3'} = \frac{\rho_2/E_2}{\rho_1/E_1+\rho_2/E_2+\rho_3/E_3} = \frac{V_{h2} \times \rho_{21}}{V_{h1} \times \rho_1 + V_{h2} \times \rho_2 + V_{h3} \times \rho_3}$$

$$K_3 = \frac{\rho_3'}{\rho_1'+\rho_2'+\rho_3'} = \frac{\rho_3/E_3}{\rho_1/E_1+\rho_2/E_2+\rho_3/E_3} = \frac{V_{h3} \times \rho_3}{V_{h1} \times \rho_1 + V_{h2} \times \rho_2 + V_{h3} \times \rho_3},$$

wherein ρ_i' represents the linear density of the silver after the i^{th} colored roving is drafted, and p' represents a total linear density of a silver after three colored rovings are drafted, combined and twisted, and i=1, 2, 3;
and $(V_{h1}+V_{h2}+V_{h3})=V$ is a constant value; To have a unchanged total linear density after three components are stranded and twisted, by arbitrarily changing feeding quantities of three rovings; whereas the blending ratio of three different fibers which form the yarn or the color mixing ratio of three different colored fibers can be changed arbitrarily.

11. The method of claim 10, wherein the three roving silvers have the same linear density, i.e., $\rho_i=\rho_2=\rho_3$; the sum of the surface linear speeds of the three rings of the rear roller is a constant, or the sum of the drafting ratios of the three rovings is a constant.

12. The method of claim 10, wherein the three rovings are three-primary color rovings.

13. The method of claim 12, wherein the three primary colors are red, green and blue.

14. A segmental colorful yarn prepared via the method of claim 12.

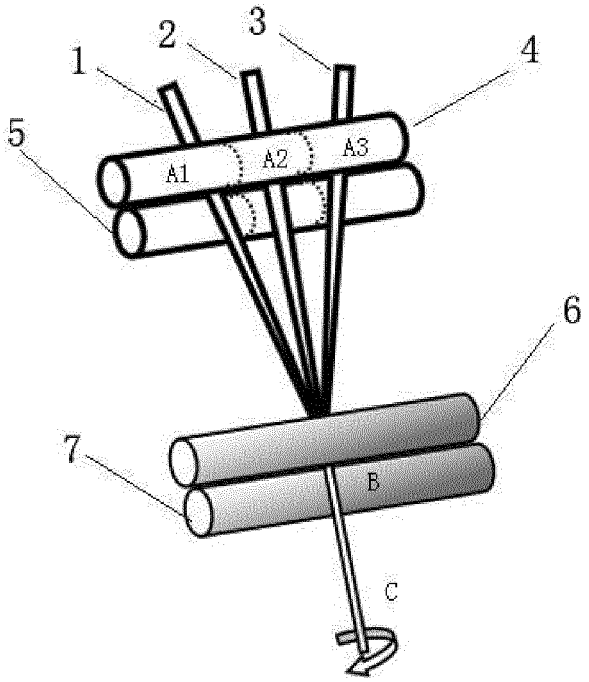

Fig. 1

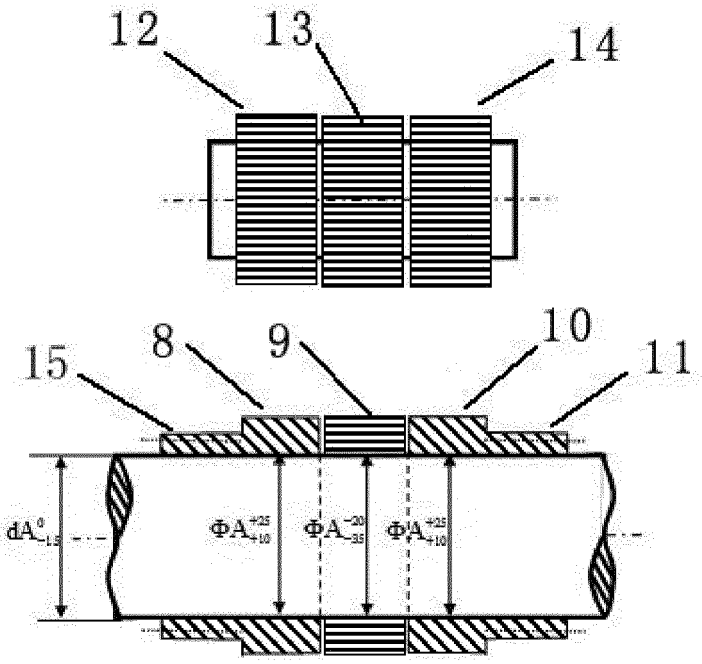

Fig. 2

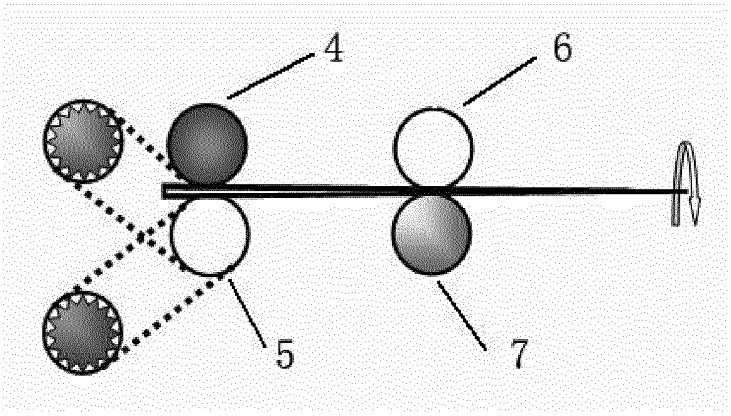

Fig. 3

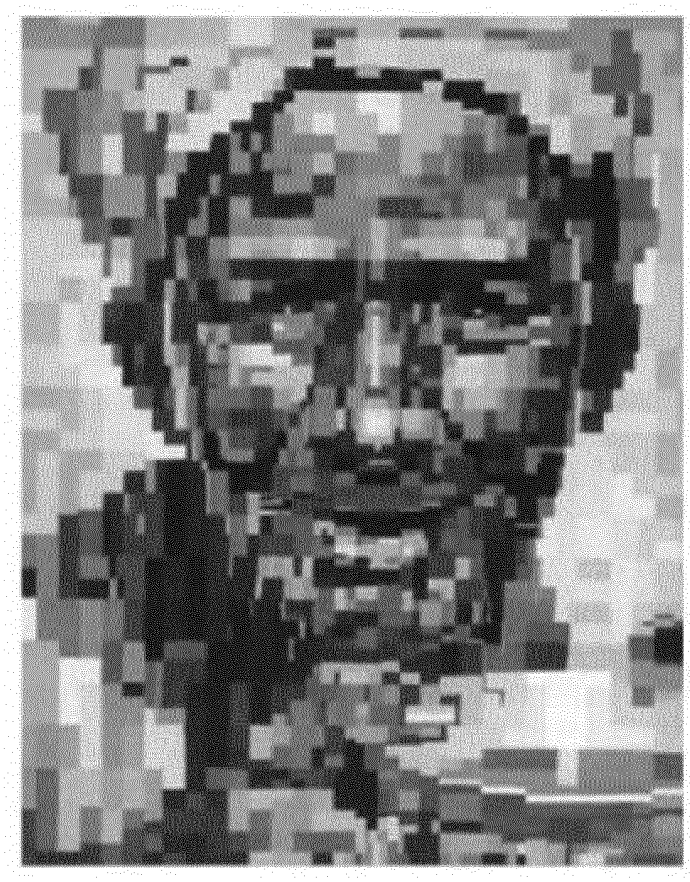

Fig. 4

Fig. 5

Fig. 6

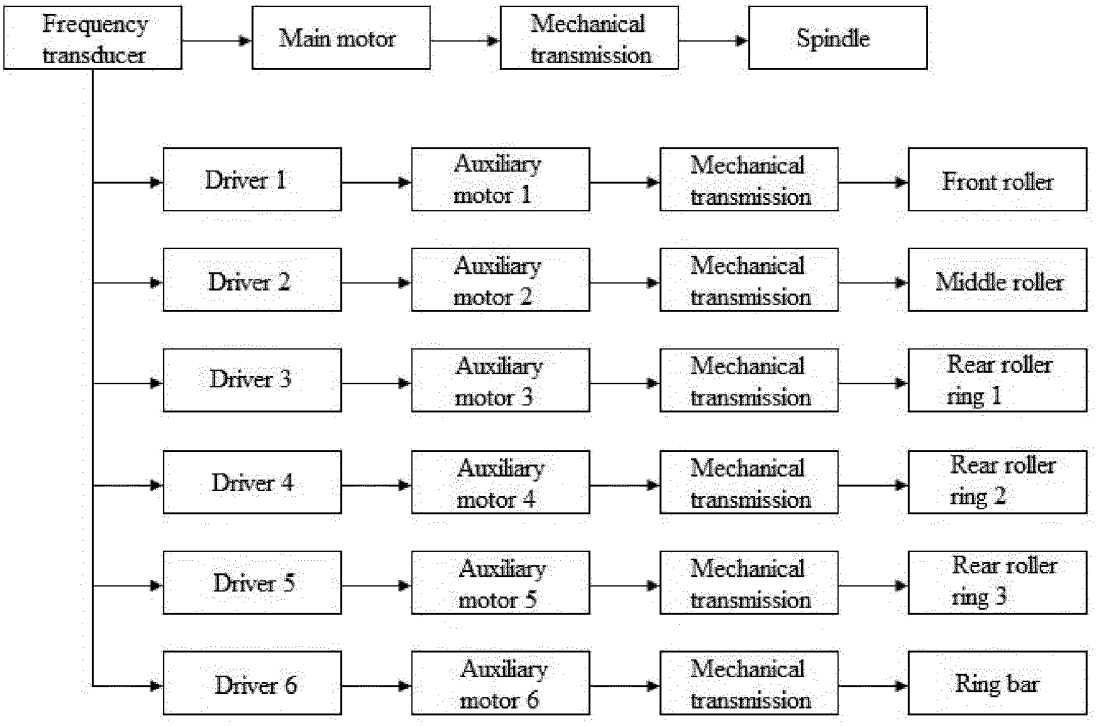
Frequency transducer
Main motor
Mechanical transmission
Spindle
Driver 1
Auxiliary motor 1
Mechanical transmission
Front roller
Driver 2
Auxiliary motor 2
Mechanical transmission
Middle roller
Driver 3
Auxiliary motor 3
Mechanical transmission
Rear roller ring 1
Driver 4
Auxiliary motor 4
Mechanical transmission
Rear roller ring 2
Driver 5
Auxiliary motor 5
Mechanical transmission
Rear roller ring 3
Driver 6
Auxiliary motor 6
Mechanical transmission
Ring bar

Fig. 7

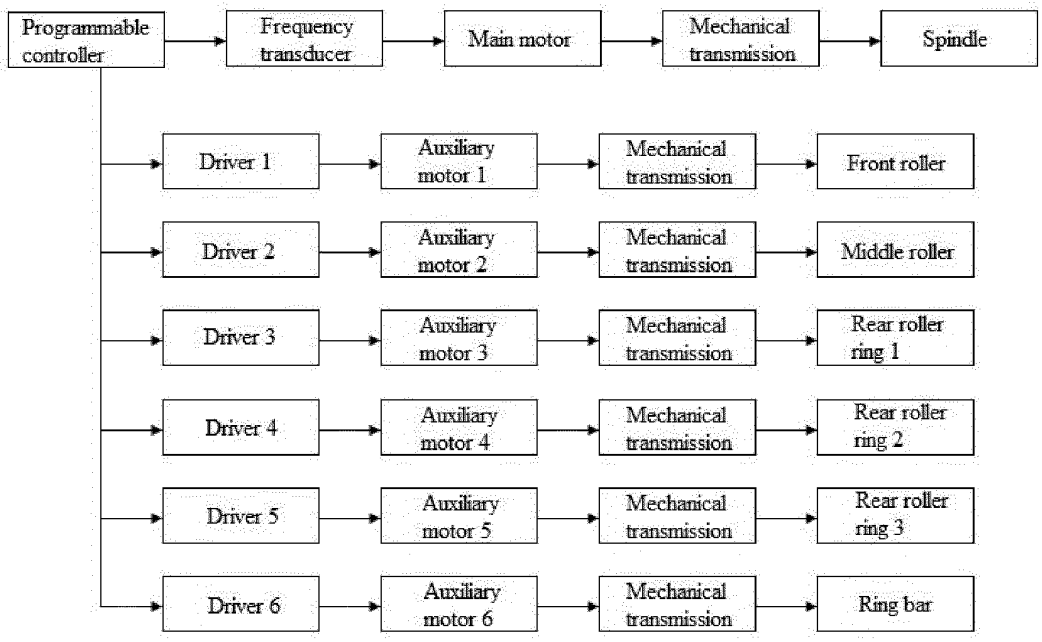
Programmable controller
Frequency transducer
Main motor
Mechanical transmission
Spindle
Driver 1
Auxiliary motor 1
Mechanical transmission
Front roller
Driver 2
Auxiliary motor 2
Mechanical transmission
Middle roller
Driver 3
Auxiliary motor 3
Mechanical transmission
Rear roller ring 1
Driver 4
Auxiliary motor 4
Mechanical transmission
Rear roller ring 2
Driver 5
Auxiliary motor 5
Mechanical transmission
Rear roller ring 3
Driver 6
Auxiliary motor 6
Mechanical transmission
Ring bar

Fig. 8

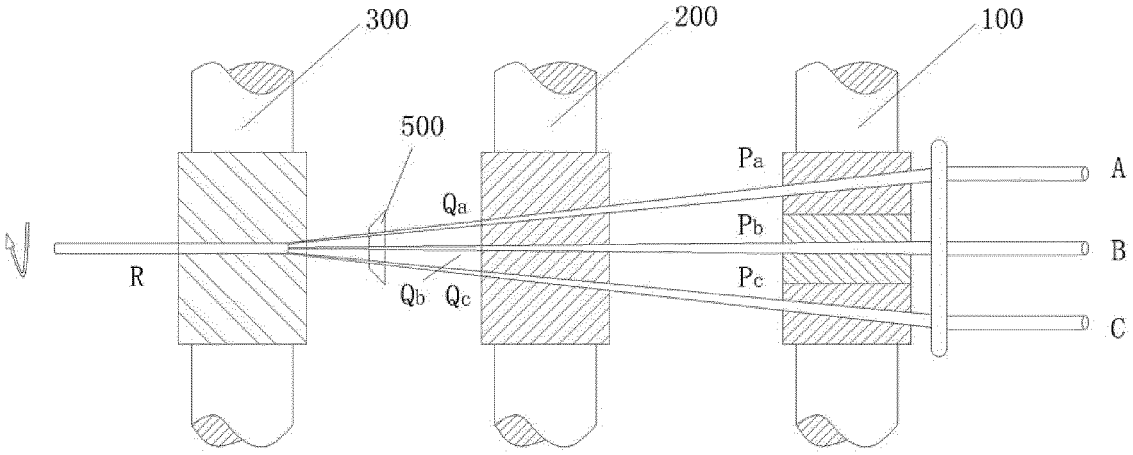

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/000746

A. CLASSIFICATION OF SUBJECT MATTER

D01H 5/32 (2006.01) i; D02G 3/22 (2006.01) n
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: D01H 5; D02G 3

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CPRSABS; SIPOABS, CNTXT, VEN: mix+, blend+, colo?r+, linear density, section, segment+, equal+, constant, conservation, roller

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 103556320A (UNIV JIAXING) 5 February 2014 (05.02.2014) the whole document	1-13
E	CN 203846172 U (UNIV JIAXING) 24 September 2014 (24.09.2014) claims1-8	1-7
A	CN 102733031 A (CHEN, Weixiong) 17 October 2012 (17.10.2012) see the description, paragraphs [0024]-[0034] and figures 1, 2 and 5	1-13
A	JP 02293426 A (TEIJIN LTD) 4 December 1990(04.12.1990) the whole document	1-13
A	CN 102560759 A (CHEN, Weixiong) 11 July 2012 (11.07.2012) the whole document	1-13
A	CN 102704124 A (UNIV DONGHUA) 3 October 2012(03.10.2012) the whole document	1-13
A	CN 102493030 A (UNIV JIANGNAN) 13 June 2012 (13.06.2012) the whole document	1-13

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

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"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 October 2014	24 October 2014
Name and mailing address of the ISA State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	Authorized officer WANG, Han Telephone No. (86-10) 62085483

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/000746

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 102677247 A (RUGAO CITY DINGYAN TEXTILE CO LTD) 19 September 2012(19.09.2012) the whole document	1-13
A	KR 101297057 B1 (SONG YU CHEL) 14 August 2013(14.08.2013) the whole document	1-13

Form PCT/ISA /210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/000746

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 103556320 A	5 February 2014	CN 203846172 U	24 September 2014
CN 203846172 U	24 September 2014	CN 103556320 A	5 February 2014
CN 102733031 A	17 October 2012	CN 202755128 U	27 February 2013
JP 02293426 A	4 December 1990	JP H02293426 A	4 December 1990
CN 102560759 A	11 July 2012	CN 102733015 A	17 October 2012
		CN 202626391 U	26 December 2012
		CN 102733015 B	4 June 2014
CN 102704124 A	3 October 2012	None	
CN 102493030 A	13 June 2012	None	
CN 102677247 A	19 September 2012	None	
KR 101297057 B1	14 August 2013	None	

Form PCT/ISA /210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 102787411 A **[0002]**
- CN 102704124 A **[0002]**
- CN 101899734 A **[0002]**