United States Patent [19]

Yazawa et al.

[11] **3,713,190**

[45] **Jan. 30, 1973**

[54] **METHOD FOR DEVELOPING AND CONVERGING A BAND OF FIBERS OR THREADS**

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[22] Filed: **June 19, 1970**

[21] Appl. No.: **47,775**

[30] **Foreign Application Priority Data**

July 3, 1969 Japan 44/52635

[52] **U.S. Cl.** ....**19/65 T,** 26/58, 26/64

[51] **Int. Cl.** **D01d 11/02**

[58] **Field of Search**..........19/65 T, 66 T, 150; 26/64, 26/58; 28/76, 55

[56] **References Cited**

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Primary Examiner—Dorsey Newton
Attorney—James E. Armstrong and Ronald S. Cornell

[57] **ABSTRACT**

The present invention provides a method and apparatus for uniformly spreading and converging, that is, altering the width of a band of fibers or threads arranged in parallel, while the band travels in a lengthwise direction, into a predetermined width and thickness with the least amount of uneveness. The fibers are spread and converged by placing the band of fibers on a rotating conveyor in which the forward path of travel widens and the return path narrows. The resulting fibers are well adapted for subsequent textile processing.

4 Claims, 15 Drawing Figures

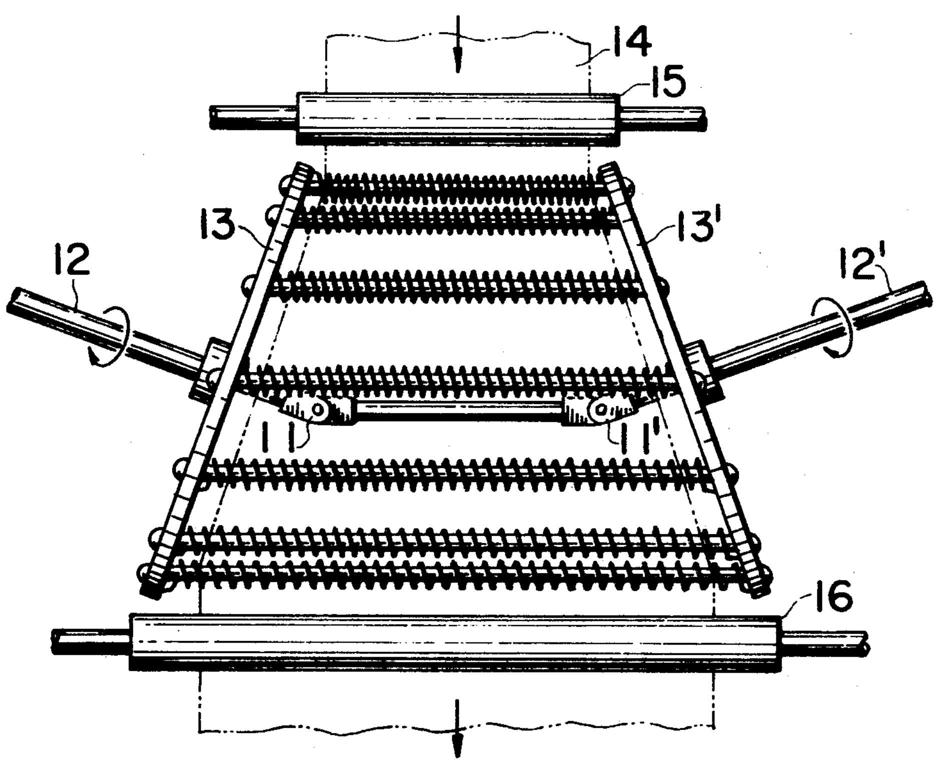


FIG. 1a

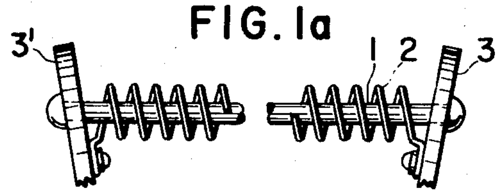


FIG. 1b

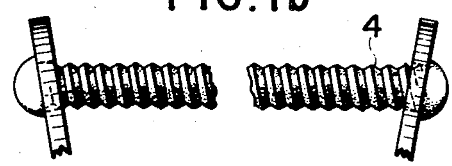


FIG. 1c

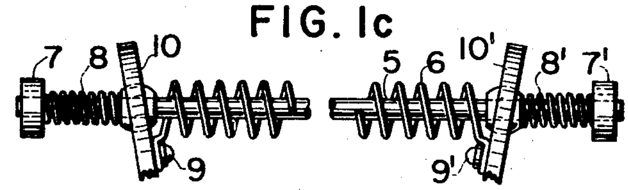


FIG. 2

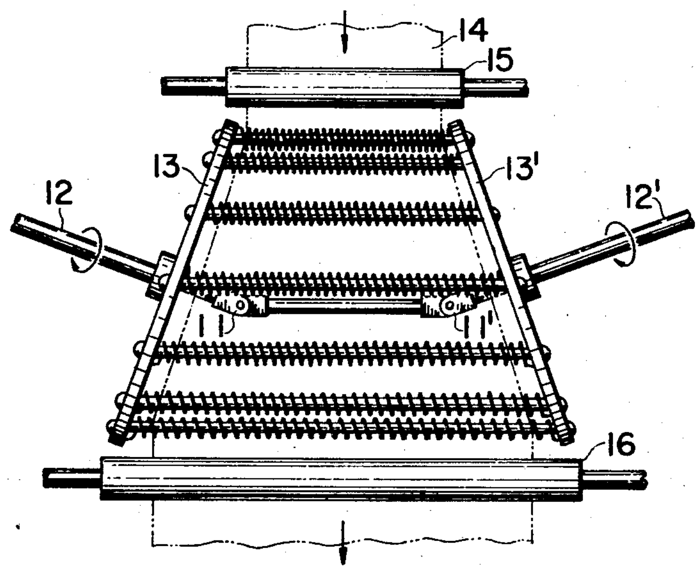
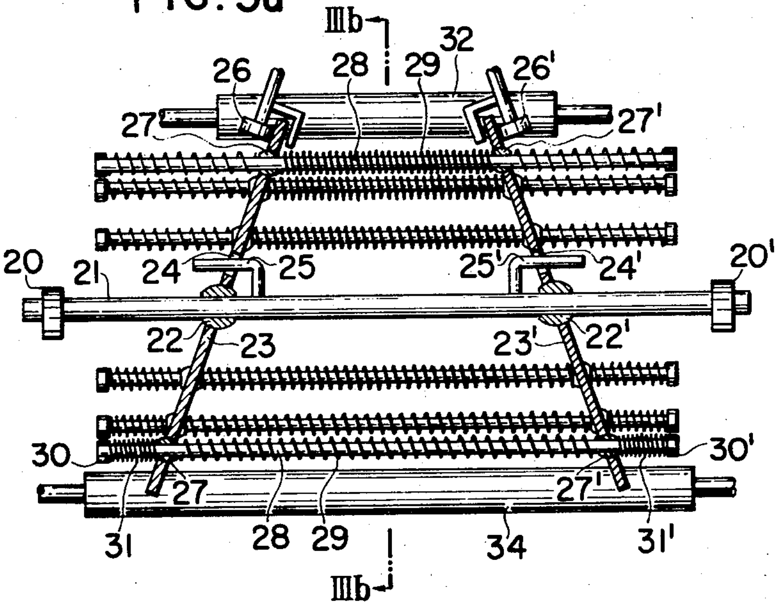


FIG. 3a


IIIb
32
26
28
29
26'
27
27'
20
21
24
25
25'
24'
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22
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22'
30
30'
27
27'
31
28
29
34
31'
IIIb

FIG. 3b

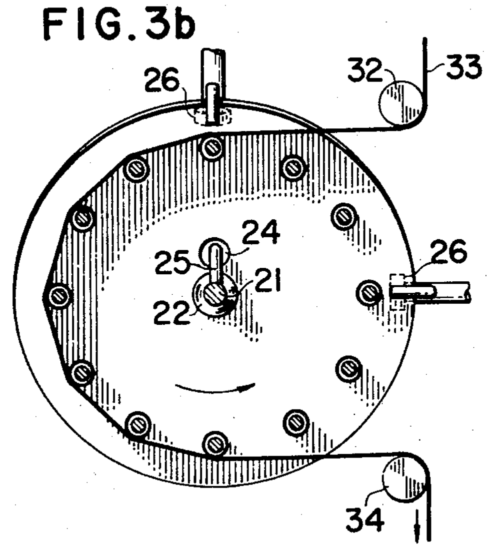

26
32
33
24
25
26
21
22
34

FIG. 4a

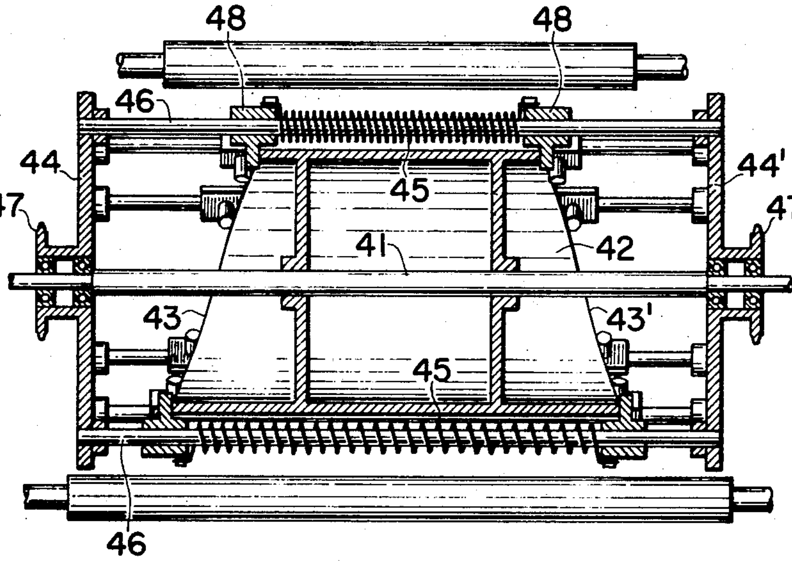


FIG. 4b

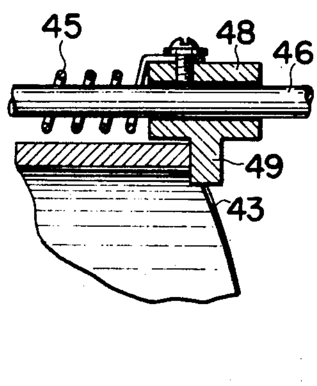


FIG. 4c

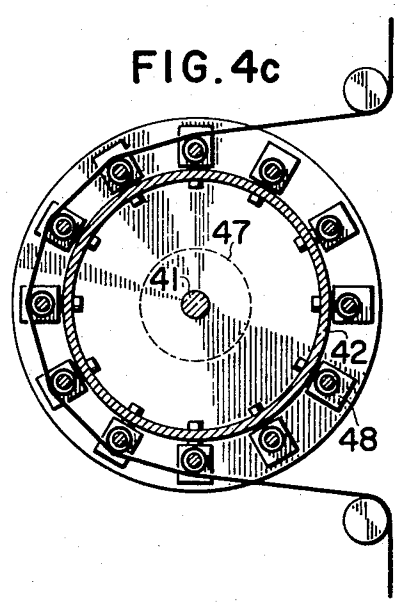


FIG. 5a

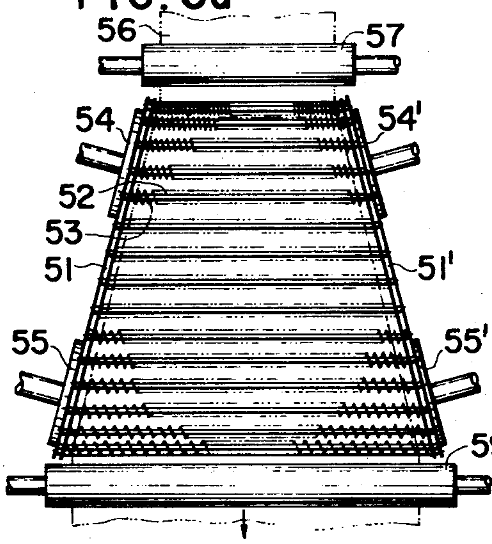


FIG. 5b

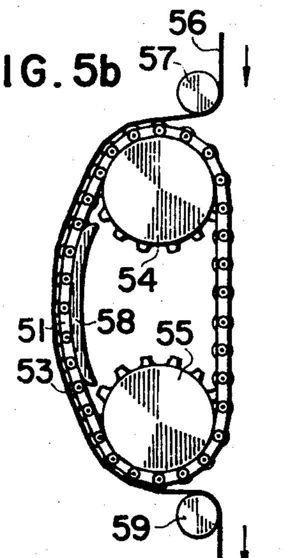


FIG. 6a

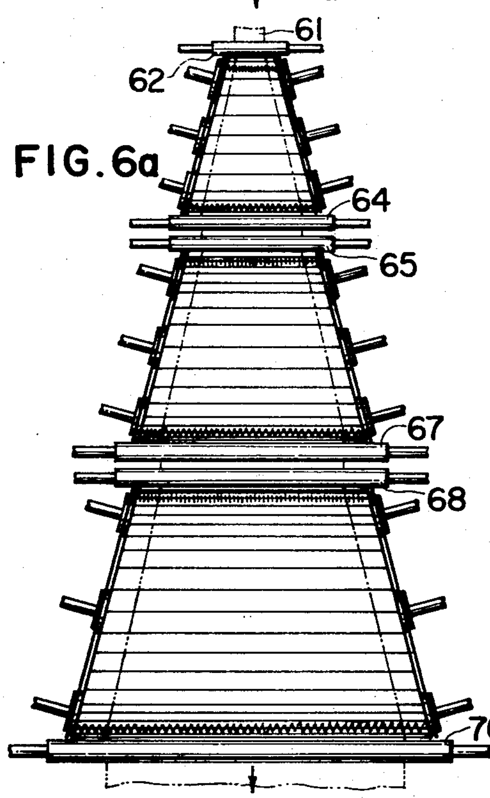


FIG. 6b

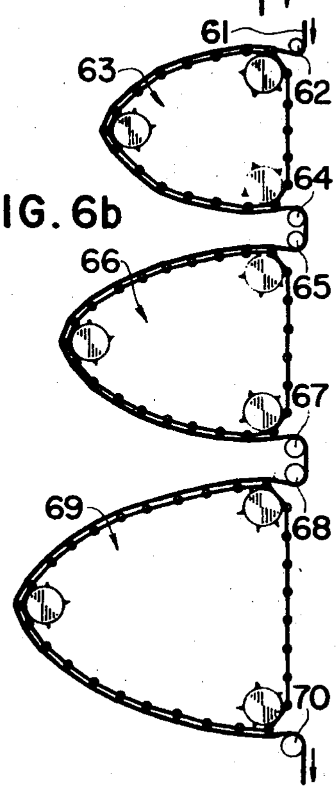
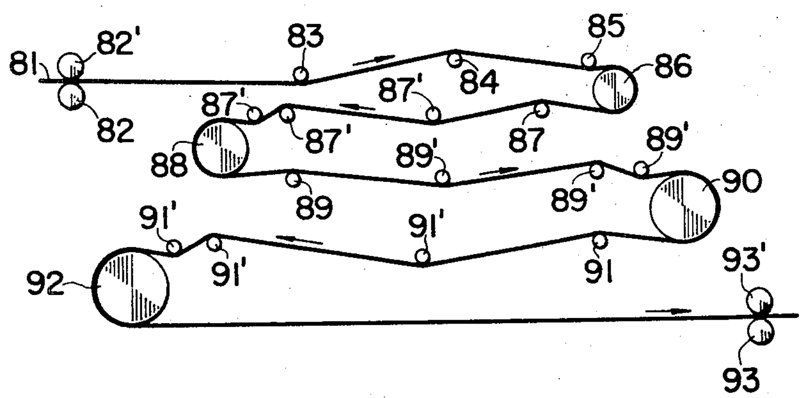


FIG. 7a


81
82'
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87'
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91'
91'
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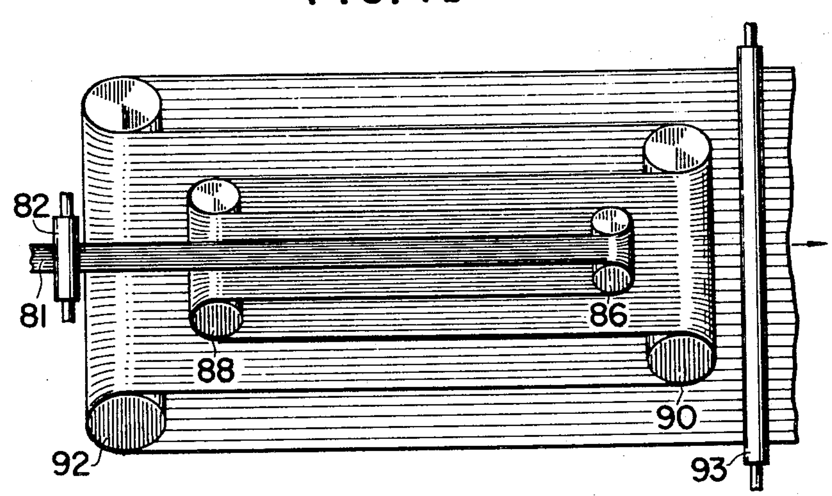
92
93'
93

FIG. 7b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METHOD FOR DEVELOPING AND CONVERGING A BAND OF FIBERS OR THREADS

BACKGROUND OF THE INVENTION

Up to this time most filament tows of artificial fibers have been crimped in a narrow width by the stuffer box method for the purpose of intertwining the individual fibers or filaments to prevent disorder of the tow, and also to crimp the fibers. When cutting such a tow into staples for making slivers of spinning material by the tow spinning method (using a machine such as, for example, a Turbo Stapler or Pacific Converter), it is necessary to spread the two into a uniform thickness suitable for each machine. A conventional method for spreading a tow to a suitable width is to use a great number of straight or curved bars in combination. However, it is difficult to spread a tow uniformly to a definite width and thickness. Accordingly, it is difficult to heat each fiber uniformly between the hot plates of a Turbo Stapler. This is generally believed to be the cause of difficulty of obtaining a silver having a good staple diagram.

Also, for a split fiber web (made from a wide monoaxially stretched film) consisting of a continuous network of short fibers, it is important to maintain a constant spreading ratio based on the original width in industrial production such as mentioned hereinunder. This is not necessary in the case of developing the web wound after bundling it together, but also in the case of spreading a web having a width approximating the stretched film just before splitting into a width several times as wide as the original one, and fixing the web thus spread with an adhesive binder to make a non-woven fabric, having fibers arranged lengthwise of small g/m^2 value. Further, in order to make a non-woven fabric, having fibers arranged in lengthwise and crosswise directions, of a low g/m^2 value, it is necessary first to make such fabrics as above-mentioned, to pile them crosswise each other and to heat-bind the piled ones. In most cases, a non-woven fabric of low g/m^2, therefore having a low price per square meter, is required for laminating with film or paper for the purpose of reinforcement.

Another situation in which uniform spreading and converging is required is described in my copending application Ser. No. 811,650 filed Mar. 28, 1969. A filament tow spread to a thickness, for example, of 20,000 d/cm, or a band of many threads once having been partially warped and wound on a beam, unwound and collected to a proper thickness is padded with bleaching or dyeing solution, and is converged uniformly into a narrower band. The fiber band is introduced into a high temperature and pressurized chamber of saturated steam above 100° C. through a pressure-sealing narrow pipe. Processing is finished continuously within one minute, and the tow is drawn out through a pressure-sealing narrow pipe into the open air. The narrow band, without disordering both edges, is spread into a uniform thickness. Further, the tow undergoes rinsing, oiling, drying, converging, traverse winding or stuffing crimping, etc. It is always necessary to spread or converge the band of fibers to a uniform thickness in case of processing the fiber band continuously at a high temperature and pressure, and then post-treating it in the air.

Up to the present, a great number of straight or curved bars have been used in combination for spreading and converging, viz., altering the width of such fiber band, but because of much difficulty in spreading and converging it to a uniform thickness, the results have been unsatisfactory.

SUMMARY

A band of fibers is placed on a track of a rotary conveyor in which the forward path of travel widens and the return path narrows. The rotating conveyor consists of an endlessly circulating group of a great number of coil springs arranged in parallel, each coil spring having a shaft passing through its center. The coil springs are made to expand or contract in a direction perpendicular to the band as the conveyer rotates, the band being placed so that the coils of the springs can come in contact with the fiber band in waves, or so that some of the coils can wedge into the band. When spreading the band, the band is placed to travel on a narrower part of the forward path of the rotating conveyor, and after the band is spread to a predetermined width by the expansion of the coil springs in a perpendicular direction as the converyer rotates, the band is removed therefrom. When converging the band, the band is placed on a wider part of the return path of the conveyor, and after the band is converged to a predetermined width by the contraction of the coil springs in a perpendicular direction, the band is removed from the conveyor. If necessary, two or more of such conveyors are successively driven in series, and while the band passes on a bar or a roller having a small radius of curvature disposed before and after each of the conveyors, the direction of travel of the fiber band is changed.

DETAILED DESCRIPTION

This invention provides a method and apparatus for spreading and converging, viz., altering the width of a band of fibers or threads uniformly in a definite ratio keeping it in good order. The moving band is placed on the track of a rotary conveyor in which the forward path of travel spreads and the return path narrows in width. The conveyor comprises an endlessly circulating group of a many coil springs arranged in parallel with one another, each having a shaft passing through the coil spring. The coil springs are made to expand or contract perpendicularly to the band, the band being placed so that a group of coils of the coil spring can come in contact with the fiber band in waves, or so that some of the coils can wedge in the band. When spreading the band, the band is placed on the forward path of travel of the conveyor and is spread by the expansion of the coil springs in a direction perpendicular to that of travel as the conveyer rotates. When the band is placed on the return path of the conveyor, the band is converged by the contraction of the coil springs in a perpendicular direction.

If necessary, the fiber band can be passed through two or more of such conveyors successively driven in series. If the spreading or converging ratio of each individual conveyors is less than 200 percent, any desired spreading or converging ratio can be obtained. If the direction of travel of the band is changed by passing it over a guide bar or roller having a small radius of curvature before or after each conveyor, unevenness in the thickness will be reduced because the thicker layer of fibers or threads is spread over onto the thinner part. If the band is placed on or taken off conveyors in series repeatedly and its width spread or converged, if necessary the direction of travel is changed repeatedly by passing it over guide bars or rollers having a small radius of curvature, a predetermined spread or converged width is easily obtained, and moreover, in a case where two or more conveyors are spaced far apart, it is possible to eliminate the disorder of the fibers resulting from the processing or winding of the fibers or threads with traversing, and to spread or converge them while maintaining their parallel relationship. These are the advantages obtained using this invention.

With respect to a split fiber web made from a monoaxially stretched film, having a width nearly as wide as the film just before splitting, if one web or several webs of split fibers in parallel are each spread 2 to 2.5 times in one step, a thin layer on the order of 5 to 10 g/m^2 can be readily obtained. However, if the webs of such fiber are once bundled and wound, they should be warped with a certain space between each web, and should be passed on a conveyor of a spreading ratio of 1.5 to 2.0 times repeatedly to obtain a predetermined width.

In general, polyester and acrylic fiber filament tows on the market are those of about 300,000 to 600,000 deniers, and they are sold as crimped tows with crimps provided by the stuffer box method, being stuffed generally at a ratio of 100,000 d/25 mm width. In order to use these tows in making slivers at the first stage of tow spinning, it is necessary to spread them into a width of 50 to 100 mm per 100,000 deniers. In this case it is necessary to pass them through the apparatus of this invention at a spreading ratio of 1.5 to 2 in series at least twice. At this time, if guide bars having a small radius of curvature are disposed before or after each spreading conveyor in order to make the tow travel a zigzag course, unevenness in thickness of the tow is additionally improved, while the spreading width of the tow is determined by the conveyors. This is because, when fibers change direction of travel on a curved surface under a tension, the tension of the thicker part of the fibers on the exterior surface of the band becomes greater than that of the thinner part of the fibers or that of those in contact with the curved surface in proportion to the difference in thickness between the thicker and thinner parts, viz. difference in travelling radii of curvature between the two, accordingly, the thicker part spreads out and the entire band tends to become uniform in thickness.

Another method of spreading in a uniform thickness is to converge the band in a subsequent conveyor, which band has been spread in the preceding conveyor. Thus, by repetition of spreading and converging, spreading in a uniform thickness of fibers within a predetermined range of width is attainable, because the degree of uniformity will increase with each successive spreading and converging, and by this repetition, even if the filament tow contains some amount of disordered fibers, that is, fibers that cross obliquely, the parallel relationship will be restored when the spreading ratio of the conveyors in each step is kept as low as about 1.5 and each conveyor is spaced at a long distance from a preceding conveyor. This is because the fibers, originally being parallel at the time of the tow production, even if subsequently made to cross obliquely with one another in the course of preceding processing, must have their parallel relationship restored, owing to the fact that fibers do not have enough length to cross each other, and accordingly they travel straight.

BRIEF DESCRIPTION OF THE DRAWINGS

Each of FIGS. **1***a*, **1***b*, and **1***c* shows a single coil spring surrounding a shaft, the spring being used for spreading and converging a band of fibers or threads.

FIGS. **2**, **3***a*, **3***b*, **4***a*, **4***b*, **4***c*, **5***a* and **5***b* show example of various kinds of rotating conveyors used in this invention.

FIGS. **6***a*, **6***b*, **7***a* and **7***b* show schematically the method of spreading or converging using multi-staged conveyors.

DETAILED DESCRIPTION OF THE DRAWINGS

FIGS. **1***a*, **1***b* and **1***c* show several kinds of coil springs and the manner of their arrangement. Each coil spring surrounds a central shaft. A large group of coil springs is arranged in parallel to provide a rotating conveyor which circulates endlessly, and in the forward path of travel of the conveyor, the coil spring widens and in return path it narrows. FIG. **1** *a* shows both ends of shaft **1** fixed with spherical joints to the peripheries of the wall of two discs **3** and **3'** (right and left) which rotate while inclining to each other. Both ends of coil spring **2** are also fixed to the discs. Shaft **1** is conveniently a rubber tube which is capable of expansion and contraction or alternatively one half of the shaft is a sheath tube and the other half is a bar which is movable within the tube, making the length of the shaft adjustable. FIG. **1** *b* shows a special case in which a male-screw-like rubber bar **4** that can expand and contract serves both as a shaft and a coil spring, united in one body. In FIG. **1** *c* shows another possible alternative. Shaft **5**, a rigid bar, passes through two discs **10**, **10'** (left and right) which rotate while inclining to each other. Coil springs **8**, **8'**, to prevent one end of the shaft from coming off far aside, are fitted between the discs and collars **7**, **7'**, which are at the end of the shaft. Both ends of coil spring **6** of the conveyor, on which a fiber band is to be placed, are fixed to the discs with bolts **9**, **9'**. When the discs rotate while inclining to each other, coil spring **6** expands or contracts, sliding on the shaft **5**.

The purpose of this apparatus in which a shaft passes through a coil spring is to make the spring expand or contract in a direction substantially perpendicular to the direction of travel of the band, preventing the coil spring from being bent too much by tension, if any, from the band of fibers or threads while expanding or contracting.

Moreover, in the absence of a shaft, fibers or threads may slip down between the coils obliquely or pass under and wrap around the adjacent coils, when the band changes its direction on the surface of the conveyor, especially when the travelling speed of the band differs from that of the conveyor surface.

With a shaft, the fibers or threads that slip down deeply between the coils are suspended by the shaft, so that there will be no fear of wrapping around adjacent coils. Of course, it is necessary to arrange the coil springs so that there will be a certain space between each coil even at the maximum contraction, thus preventing fibers or threads from being caught between the coils.

FIG. 2 shows a conveyor in which a great number of coil springs, each having a rubber shaft as shown in FIG. 1 *a* are arranged in parallel along the peripheries of two inclined discs **13, 13'** each of which are fixed respectively to axes **12, 12'**, jointed and rotated at the same speed by means of universal joints **11, 11'**. Fiber band **14** is placed on the narrower part of the conveyor through guide rollers **15**, and after being spread to a predetermined width while the conveyer rotates together with the band, the band is removed from the conveyor by guide roller **16**.

A conveyor comprising rubber shafts is well suited for spreading to a predetermined width a thin fiber band, i.e., a web having short fiber network such as a split fiber web from a wide monoaxially stretched film, provided that too much tension is not to be applied to the band.

When a split fiber web, which immediately after splitting is bundled into a narrow web without spreading, is wound while traversing on a beam for winding as much as 100 kg of web, for example, considerable tension is observed. In such a case, if the web is uniformly converged in a lateral direction to a narrower width by using a conveyor having rigid shafts as shown in FIGS. *3a, 3b, 4a, 4b, 4c, 5a* and *5b*, and is wound while traversing, it is easy to obtain uniform spreading in a lateral direction upon unwinding.

FIGS. *3a* and *3b* show another type of conveyor; FIG. *3a* being an elevated view, and FIG. *3b*, the section at III*b*—III*b* of FIG. *3a*. Two discs **23, 23'** are supported at spherical bearings **22, 22'** on a rotary straight shaft **21** supported at both ends by bearings **20, 20'**. When shaft **21** is rotated, the discs **23, 23'** are guided by guide grooves **26, 26'** disposed at at least two places in each of the peripheral tracks, and are rotated with spherical bearings **22, 22'** as the center by arms **25, 25'**, fixed to shaft **21** and extended so as to pass through apertures **24, 24'** bored through the discs, inclining to each other with shaft **21** as the center. A number of spherical bearings **27, 27'** facing each other are arranged with equal spacing at the peripheries of the two discs. Solid shafts **28** of the coil springs pass through spherical bearings **27, 27'**. Both ends of coil springs **29** are attached to the wall of the discs. Shaft **28** passes through spherical bearings **27, 27'** and the shaft is freely movable to right and left. Therefore, in order to leave parts of the same length at both ends on the outside of both the discs, additional coil springs **31, 31'** of a certain length should be fitted between the discs and collars **30, 30'** fitted at both ends of the shaft. Thus the extending parts become almost equal in length, with a better appearance and less danger. Band **33** of fibers or threads is placed on a narrower part of the conveyor after passing guide roller **32**, and while travelling a half round in an elliptical track, the band comes in contact with the coil springs in waves while some parts of the coils wedging into the band. The coil springs are stretched laterally according to the rotation of the discs, the space between the discs being increased as they rotate in a forward direction. The band is mechanically spread out without slipping laterally on the coil springs which expand as the discs rotate while inclining to each other. After being spread, the band leaves the conveyor and passes guide roller **34** to be transferred to a subsequent processing. If the band is to be subsequently converged, it is mounted at the wider part of the conveyor and after it has travelled a half round, it is removed.

Each of FIGS. *4a, 4b* and *4c* shows another type of conveyor structure suitable for the practice of this invention. FIG. *4a* is a sectional portion of an elevated view. FIG. *4b* is an enlarged view of a section in which an extending portion of the attachment that fixes each end of the coil spring is guided by a cam track during movement. FIG. *4c* is a sectional view of FIG. *4a*. In FIG. *4a*, both ends of drum **42**, having a circular section associated with fixed shaft **41**, form two cam tracks **43, 43'**. A squirrel cage shaped roller consisting of two side discs **44, 44'** joined with a number of shafts **46** of coil springs **45** at equal intervals at their peripheries is driven by sprocket wheel **47, 47'** around fixed shaft **41** concentrically with the drum. As shown enlarged in FIG. *4b*, extending portion **49** (of attachment **48** for the coil spring which slides on the shaft) is guided along the cam track **43**, and with the rotation of the roller, the coil spring, guided by the cam track, expands and contracts on the shaft. In this case the conveyor takes a circular track in section.

FIGS. *5a* and *b* show the structure of another form of rotating conveyor. This conveyor consists of two chains (left and right) **51, 51'** in association with the ends of shaft **52** of coil spring **53**, the chains being capable of rotation, spreading out in width in the forward path of travel and narrowing in the return path, and the shafts joining the chains laterally. The shaft may be a rubber tube which is capable of expansion and contraction, or it may consist of a sheath tube and an axle. The axle, which comprises left half of the shaft, is able to slip in and out from the sheath tube comprising the right half. Thus the total length of the shaft can be extended and contracted. Coil springs **53** are fitted outside the shafts, and both ends of the shafts together with the both end of the springs are fixed to the chains. The chains are driven by sprocket wheels **54, 54'** and **55, 55'**. Band **56** passes over guide bar **57**, and is placed to travel on a narrower part of the conveyor, and as it passes over curved guide plate **58**, the band is spread out to a predetermined width in the forward path of travel. After this, the band passes over guide roller **59** and is removed for subsequent processing.

The apparatus shown in FIG. *6a* and *b* is a modified type of that of FIGS. *5a* and *5b*. The chains pass on triangular tracks having a slight outward curvature. The band is spread on the tracks of each of two sides of the triangles. FIG. *6a* is the elevated view and FIG. *6b* is a sectional view of the elevation. Band **61** passes over guide bar **62**, and the first spreading is done on first conveyor **63**. After passing over guide bars **64, 65**, the band is led onto the second conveyor **66** to undergo a second spreading, and finally, after passing over guide bars **67, 68** a third spreading is done on the third conveyor **69** to a predetermined width. After this, the band passes over guide roller **70** and moves on for subsequent processing. For convergence the direction of travel of the band is reversed.

FIGS. 7a and 7b show an arrangement of multi-staged conveyors arranged in series, each conveyor being spaced apart; this arrangement advantageous for correcting obliqueness and disorder of fibers or threads while the band is travelling on the conveyors. FIG. 7a is the elevated view, and FIG. 7b, the plan. The feeding speed of the band **81** is controlled by pinch rollers **82**, **82'**. The band passes over guide rollers **83**, **84** and **85**, and undergoes a first spreading on the first rotary conveyor **86**, which is similar to the conveyors shown in FIG. 2, FIGS. 3a 3b or FIGS. 4a 4b or 4c The band then takes a zigzag course on slightly curved guide bars **87**, **87'**, the purpose of which is to prevent the band from narrowing. The band then undergoes a second spreading on the second rotary conveyor **88** which is spaced apart from conveyor **86**. Again after taking a zigzag course on guide bars **89**, **89'**, the band undergoes a third spreading on the third conveyor **90** spaced apart from conveyor **88**. Further, after travelling a zigzag course on guide bars **91**, **91'** the band undergoes a fourth spreading on the fourth conveyor **92** spaced apart from conveyor **90**. The band is spread to a predetermined width during the entire operation, during which time unevenness in width is reduced on the guide bars and the parallel relationship of fibers is restored. The band is then passed on for subsequent processing, after passing between pinch rollers **93**, **93'**.

The foregoing description explains the spreading of the band. For convergence, the conveyors are used in the opposite direction of travel. The band is placed on the wider parts of the conveyors and is taken off at the narrower parts.

Our invention is further illustrated by the following examples:

EXAMPLE 1

High density polyethylene was extruded through an annular die into the air, was blown and subsequently air-cooled into a film at a speed of 15 m/min to make a tubular film of 0.06 mm in thickness and 900 mm in folded width. The resulting film was passed between a group of pinch rollers, and while it travelled vertically downward, it passed around the circumference of a ring guide of 570 mm in outside diameter to restore the tubular form. While hot water at 95° C. was jetted toward the inner surface of the tubular film at a level 70 cm below the position of the ring guide, the film was stretched five times in a lengthwise direction by a group of drawing rollers positioned vertically downward which were operated at a peripheral speed of 75 m/min. The film was then cut lengthwise with a knife held at the center of one side of the folded film. A ring guide and a hot water supply tube were inserted and held behind the cut part. The film was taken up by the rollers positioned downward to obtain a primary stretched film having a folded width of 400 mm. Both half widths of the cut film were then opened right and left along the center cut line to provide a film 800 mm in width. Then after passing over a guide roller, the film was introduced into a hot air chamber at 110° C., and was passed over a number of rough-surfaced rollers, 300 mm in diameter, disposed in the chamber, and steam-heated internally at 115° C. The surface speed of the rollers, including the pinch rollers in the air at the outlet side, was 150 m/min. The primary stretched film was dried, and then subjected to secondary stretching in this hot chamber to obtain a film about 563 mm in width where it was stretched to ten times its original length. The film was then run and slide-rubbed under tension over a splitter 65 mm in diameter having a rough surface like a file, and rotating at a surface speed of 350 m/min, the angle between the inlet and outlet side of the stretched film being 80° C. A split fiber web of network structure was obtained. While it was successively passed on internally steam-heated drums at 124° C., it underwent relax-heat-treatment allowing a 20 percent contraction in the longitudinal direction. A split fiber web of high dimensional stability having a width of about 650 mm was obtained.

A number of coil springs, 6 mm in inner diameter, (consisting of spiral coils 0.5 mm thick and rubber tubes 3 mm in diameter passing through the coil springs) were arranged laterally in parallel on a conveyor of a diameter of 50 cm, in which the forward path of travel spreads and the return path narrows in width as shown in FIG. 2.

The above-mentioned split fiber web of high dimensional stability was placed to travel on the conveyor so that the coils of the coil springs could wedge into the meshes of the web at an early stage of the forward path of travel of the conveyor, and so that the coil springs could expand to twice their original length at the end of the forward path of travel. The web was spread to a width of 1,300 mm of uniform fiber density. After this, it was removed from the conveyor by a turn roller, and was immediately passed between sizing pinch rollers. For sizing a 30 percent solids content copolymer emulsion of 40 percent vinyl acetate and 60 percent ethylene was deposited on the fibers to the extent of a 15 percent solids content, based on the weight of the fiber. While the sized fiber was passed successively on stream drums coated with a fluorine containing resin, it was dried and a non-woven fabric of lengthwise arranged split fiber webs, 1,250 mm in width with a split fiber content of 10 g/m^2 and an adhesive binder content of 1.5 g/m^2 was obtained. Two sheets of this non-woven fabrics of lengthwise arranged split fiber webs are piled crosswise to each other and heat-bound to provide a non-woven fabric having a weight of 23 g/m^2. This non-woven fabric was further laminated with film or paper and heat-bound for reinforcement. A strong and tenacious packaging material for heavy duty was obtained.

In the foregoing example the continuous processing of one wide sheet of split fibers, including spreading in a certain ratio, binder addition and fixing, and winding was described. However, in the case of winding wide web after splitting, if the web is converged uniformly into a narrow width with a conveyor as shown in FIGS. **2**, **3a**, **3b** or **4a 4b** or **4c** and wound with traversing, later unwinding and uniform spreading can be achieved.

EXAMPLE 2

In the case of a polyethylene web of narrow width of about 10 to 20 cm, unlike that of previous example, the web is bundled during winding. In the process of unwinding, each web is introduced into a flat wind channel, spreading in width in the forward path of travel and jetted with pressurized air, and is fed tangentially to a rotating roller. The jetted air is allowed to escape in a tangential direction to the roller surface, and the web only is taken up along the roller. After each web is first spread in a certain ratio approximating that of the original stretched film, sheets of the webs are arranged in parallel so that the adjacent selvages of spread webs may overlap slightly. If necessary, the overlapped parts are bound with a hot-melt type adhesive. The bound web is further spread to a width of a predetermined ratio using an apparatus of the type shown in FIGS. 2, 3*a*, 3*b* or 4*a*, 4*b* or 4*c*, anyone of which works well and the spread width is fixed with an adhesive binder. A non-woven fabric for reinforcement of paper and film was obtained. Although its fiber density at the selvages of each original web is somewhat higher than that of the other part, it is well suited for practical use.

In the foregoing examples polyethylene was used as the fiber forming material. However, the method of this invention is effectively used to split fiber webs made of films of other fiber-forming polymers such as polypropylene, and to those webs made using any other splitting methods.

EXAMPLE 3

A 500,000 d commercially available acrylic fiber tow, crimped by the stuffer box method, was drawn out from the container with pinch rollers. During this operation it travelled a zigzag course on several guide bars. Thus the crimps were somewhat stretched and the tow was delivered from the pinch rollers in a width of 150 mm. The tow was spread to 300 mm in width, using a conveyor of the type shown in FIGS. 4*a*, 4*b* and 4*c*. The thickness of the coil spring wire was 1 mm; the inner diameter of the coil, 12 mm; the diameter of the metallic shaft, 10 mm; the diameter of the conveyor, 500 mm; and the spreading ratio, two times. After this, while the tow was passed for a distance three meters through a steam chamber at 95° C. at atmospheric pressure, the tow was stretched lengthwise as much as 13 percent to stretch out the crimps, and was subsequently taken up by pinch rollers. The tow was then sent to be padded with a cationic dye solution until it absorbed 40 percent by weight of solution, based on the weight of the fibers. The padded tow was then passed on the converging side of two sets of the conveyor as shown in FIGS. 4*a*, 4*b* and 4*c*, and it was uniformly converged to about one fourth width of the spread band, that is, to 75 mm in width. It was further bundled to pass through a narrow pressure sealing pipe having an elliptical cross section of variable area, and was introduced into a saturated steam heating chamber at 134° C. It was passed through the chamber in one minute without coming into contact with condensed water. It was then again drawn out through a pressure sealing narrow pipe into the air with pinch rollers. The tow 50 mm in width was widened to 100 mm in width by passing it over guide bars. It was then passed in series twice on additional two coil spring conveyors, each having a spreading ratio of twice and of the same type as that of the former conveyor to spread it four times its original width. During this spreading, the tow was passed on guide bars having a zigzag course to be spread to a tow of 450 mm in width in a uniform thickness. It was then passed through multi-staged rinsing baths, and was squeezed and oiled. It was sent to steam drum driers in a spread state, 500 mm in width and of a uniform thickness. After being passed successively over the driers and dried, it was pre-heated by passing it through a stream chamber at 95° C. at atmospheric pressure and was then converged to a width of 120 mm, by passing it over two converging sides of the above-mentioned conveyor. After passing over zigzag bars, it was subjected to stuffer box crimping. A dyed crimped tow was obtained.

Tow spread or converged with the coil spring conveyors of this invention are characterized by good parallel relationship of the fibers because of spreading or converging to a uniform width and a uniform thickness. This is a considerable improvement over the results obtained when tows are spread or converged with a conventional combination of curved or straight bars, particularly when the tows are to be processed further for two spinning.

EXAMPLE 4

In a partial warping of 1,000 ends of polyester filament yarns (each yarn: 75 d), polyvinyl alcohol was sized so that the yarns could take up 5 percent by weight (based on the weight of the fibers) of it. The yarns were wound on a beam with 200 yarns in one group. At the beginning and the last ends of the wound yarns, sized threads were fastened obliquely across the yarns in order to fix the arrangement of the yarns. Also, fine talc powder was dusted to keep the yarns separate from each other. Before introducing the wound yarns into a stuffer box crimper having rollers 20 mm in width in the rewinding operation, the yarns were converged uniformly in multiple steps to a width of 20 mm with apparatuses as shown in FIGS. 4*a*, 4*b* and 4*c*. The crimped yarns in a tow form coming from the crimper (after crimping the length was reduced apparently half of that of the original one) was wrapped one and a half times around it with a running cloth under tension. Then it was heat-treated for 30 seconds in a saturated steam chamber at 160° C. to set the crimps, and was drawn out in the air. The crimped yarns was removed from the cloth, and was divided into five groups, each consisting of 200 yarns, which were wound on spools, respectively. The 200 yarns were spread in multiple steps to a width of 300 mm with an apparatus similar to that shown in FIGS. 4*a*, 4*b* and 4*c*. The yarns, spread in a parallel relationship, were separated and were sent to a twister having 200 spindles. Each yarn was given a twist of 200 T/m, and wound. No difficulty in separating yarns was observed, because of talc powder dusted on the surface of the yarns and the parallel relationship of the yarns. The crimps fixed with high temperature saturated steam, even if straightened in weaving, recovered the crimps fixed at the time of crimp setting, when heated with water or steam at 85° to 100° C. in tension-free state. Thus, the method of this example provides an efficient processing method for preparing textured yarns collectively from a bundle of filament yarns. The method described is of greater productivity than the conventional false twist method, in which twist setting is done separately on each spindle. This results from the spreading and converging according to the method of this invention.

What is claimed is:

1. Apparatus for altering the width and thickness of a band of filaments uniformly into a predetermined width comprising a plurality of elongated, axially extensible,

substantially cylindrical support elements for said band of filaments, each of said support elements including a core portion and a helical portion formed of adjacent turns disposed around said core portion; means for mounting said support elements in spaced relationship parallel to each other; means for directing a band of filaments into contact with said support elements whereby the individual filaments comprising said band fall between the adjacent turns of the helical portion of said support elements; driving means for moving said support elements in a direction perpendicular to their axes; and means for altering the axial length of said support elements while they are so moved whereby the distance between the adjacent turns of said helical portion is simultaneously altered thereby uniformly changing the width and thickness of said band of filaments, wherein said means for mounting the support elements, said driving means for moving the support elements, and said means for altering the axial length of the support elements all cooperate to periodically return the support elements to their points of origin at their original axial length, and wherein said elongated support element comprises a rubber tube which is capable of expansion and contraction and a coil spring surrounding said core member.

2. Apparatus for altering the the width and thickness of a band of filaments uniformly into a predetermined width comprising a plurality of elongated, axially extensible, substantially cylindrical support elements for said band of filaments, each of said support elements including a core portion and a helical portion formed of adjacent turns disposed around said core portion; means for mounting said support elements in spaced relationship parallel to each other; means for directing a band of filaments into contact with said support elements whereby the individual filaments comprising said band fall between the adjacent turns of the helical portion of said support elements; driving means for moving said support elements in a direction perpendicular to their axes; and means for altering the axial length of said support elements while they are so moved whereby the distance between the adjacent turns of said helical portion is simultaneously altered thereby uniformly changing the width and thickness of said band of filaments, wherein said means for mounting the support elements, said driving means for moving the support elements, and said means for altering the axial length of the support elements all cooperate to periodically return the support elements to their points of origin at their original axial length, and wherein said elongated support element is a solid bar slideably seated in said means for mounting said support elements and a coil spring surrounds said core member.

3. Apparatus for altering the width and thickness of a band of filaments uniformly into a predetermined width comprising a plurality of elongated, axially extensible, substantially cylindrical support elements for said band of filaments, each of said support elements including a core portion and a helical portion formed of adjacent turns disposed around said core portion; means for mounting said support elements in spaced relationship parallel to each other; means for directing a band of filaments into contact with said support elements whereby the individual filaments comprising said band fall between the adjacent turns of the helical portion of said support elements; driving means for moving said support elements in a direction perpendicular to their axes; and means for altering the axial length of said support elements while they are so moved whereby the distance between the adjacent turns of said helical portion is simultaneously altered thereby uniformly changing the width and thickness of said band of filaments; wherein said means for mounting the support elements, said driving means for moving the support elements, and said means for altering the axial length of the support elements all cooperate to periodically return the support elements to their points of origin at their original axial length, and wherein said mounting means comprises a plurality of spaced discs mounted for rotation around a central point by said driving means, said support elements being mounted on said discs outwardly of said central point, said discs being adjustably disposed other than in planes which are parallel to each other, and further including means for maintaining the relative positions of said discs despite rotation thereof.

4. Apparatus for altering the width and thickness of a band of filaments uniformly into a predetermined width comprising a plurality of elongated, axially extensible, substantially cylindrical support elements for said band of filaments, each of said support elements including a core portion and a helical portion formed of adjacent turns disposed around said core portion; means for mounting said support elements in spaced relationship parallel to each other; means for directing a band of filaments into contact with said support elements whereby the individual filaments comprising said band fall between the adjacent turns of the helical portion of said support elements; driving means for moving said support elements in a direction perpendicular to their axes; and means for altering the axial length of said support elements while they are so moved whereby the distance between the adjacent turns of said helical portion is simultaneously altered thereby uniformly changing the width and thickness of said band of filaments; wherein said means for mounting the support elements, said driving means for moving the support elements, and said means for altering the axial length of the support elements all cooperate to periodically return the support elements to their points of origin at their original axial length, and wherein said means for mounting said support elements is a cage-shaped roller comprised of two discs spaced apart and in parallel planes, and the respective ends of said core portion are joined with said discs, and wherein a central fixed shaft extends between said parallel discs and around said shaft is located a drum the ends of which form cam tracks which are non-parallel, and wherein said means for altering the axial length of said support elements is in contact with and guided by said cam tracks and moves thereon as the discs rotate.

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