United States Patent [19]

Izawa et al.

[11] **3,763,520**

[45] **Oct. 9, 1973**

[54] **METHODS AND APPARATUS FOR TRANSFERRING TOWS**

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[21] Appl. No.: **177,887**

[52] **U.S. Cl.** ..... **19/65 T,** 28/1.6

[51] **Int. Cl.** **B65h 5/12,** D01d 11/04

[58] **Field of Search** ..... 28/1.6, 1 CF; 19/65 T, 66 T

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Primary Examiner—Louis K. Rimrodt

Attorney—Sherman and Shalloway

[57] **ABSTRACT**

The present invention relates to methods and apparatus for displacing the travelling path of tows in substantially parallel form in a process for advancing and transferring tows. Tow feed roller means and take-up roller means therefor are disposed in parallel and a plurality of guide cylinders are arranged therebetween, at least two of the guide cylinders being disposed in nonparallel relation with both the feed and take-up rollers such that distortions are not caused in the plane of the tows going around the rollers. The lengths of the tows travelling between the feed and take-up roller means are thus made substantially equal at any portion across the tows thereby preventing uneven tow tension in the advancing tows.

11 Claims, 14 Drawing Figures

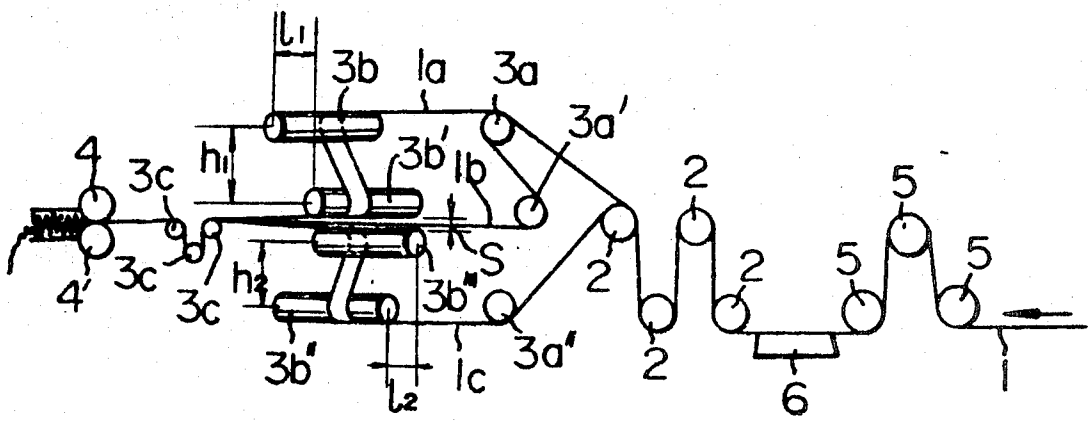


Fig. 1

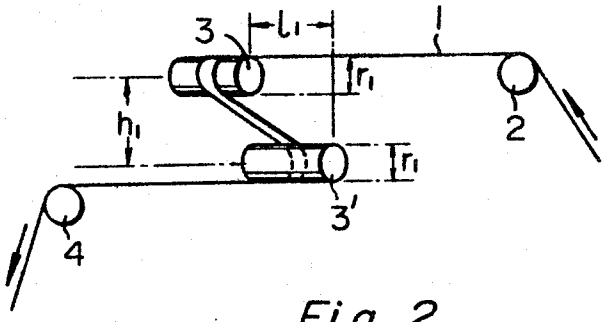


Fig. 2

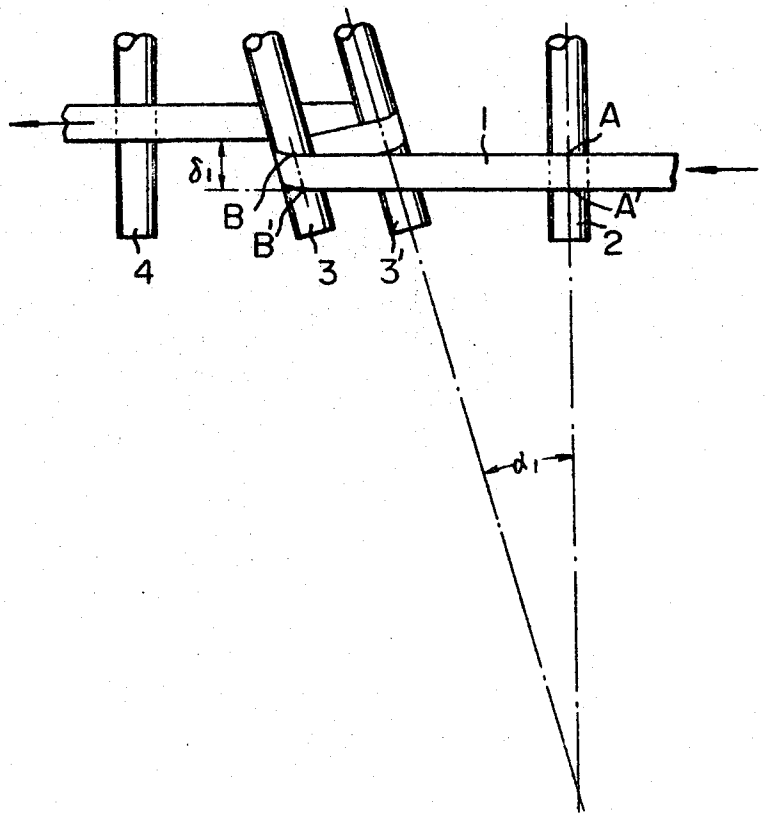


Fig. 3

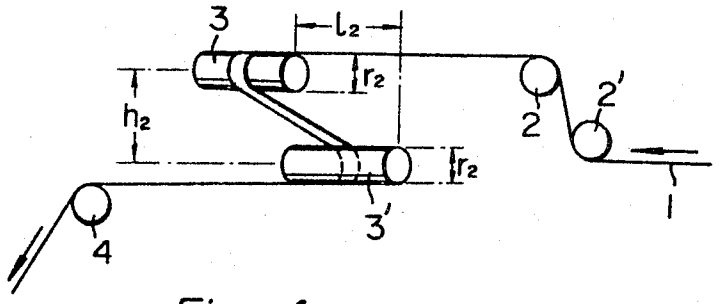


Fig. 4

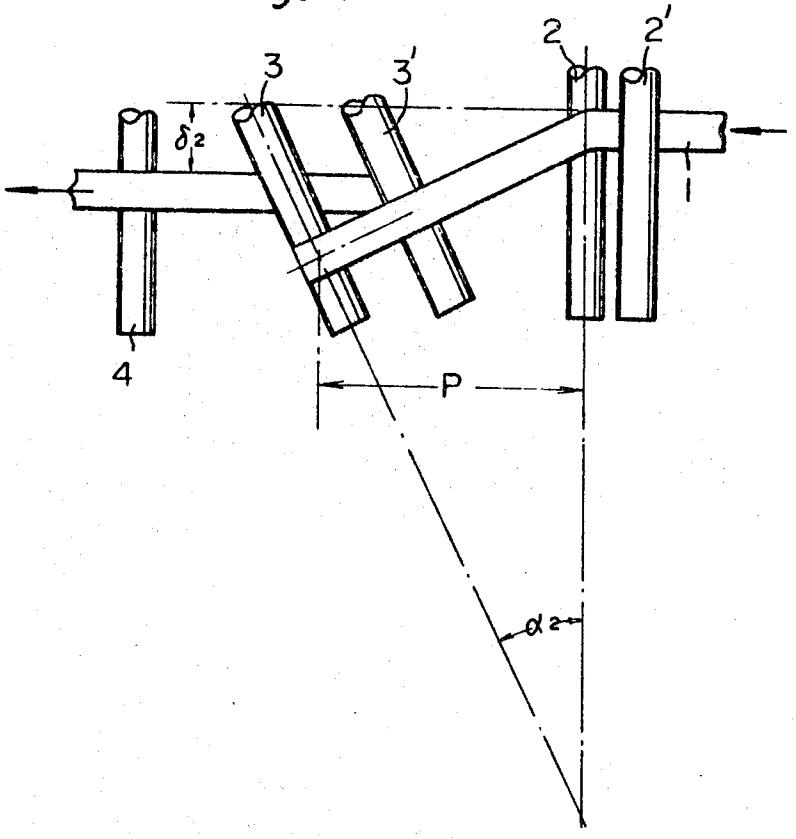


Fig. 5

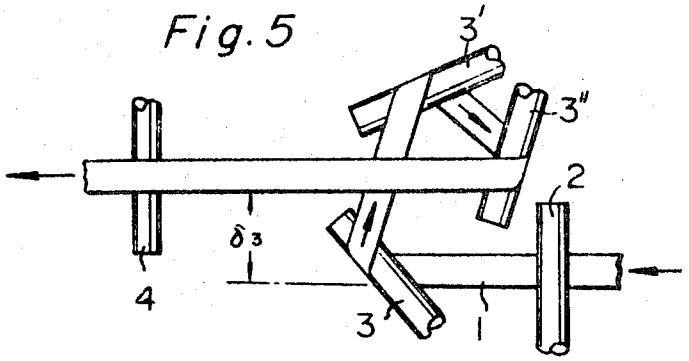


Fig. 6

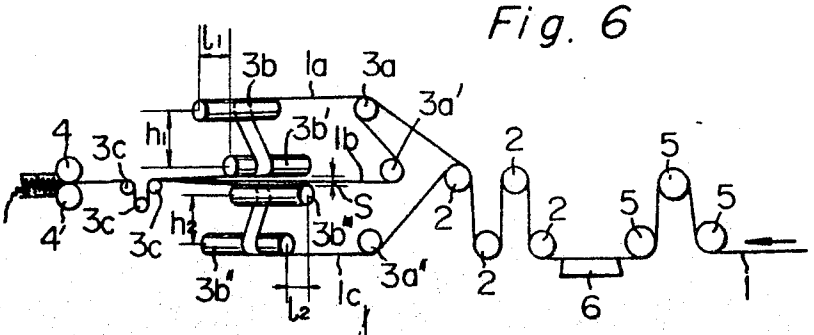


Fig. 7

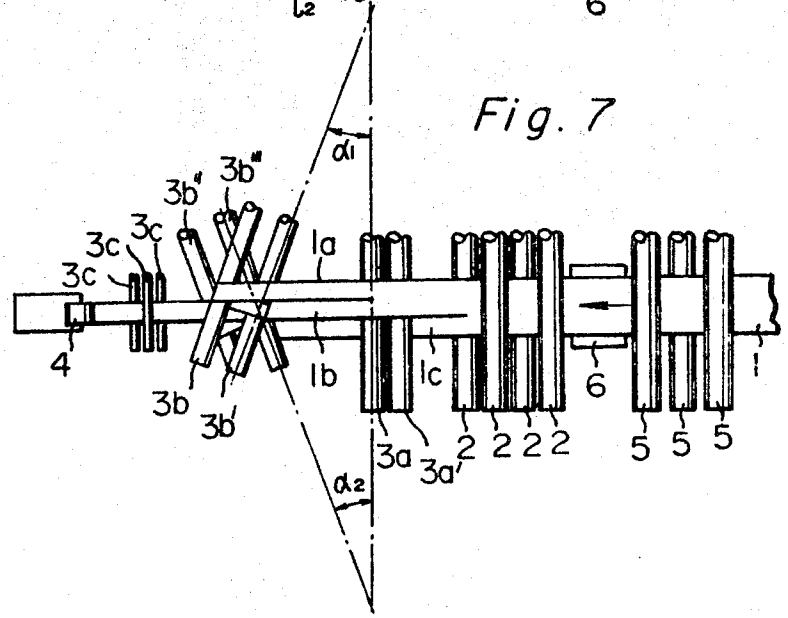


Fig. 8

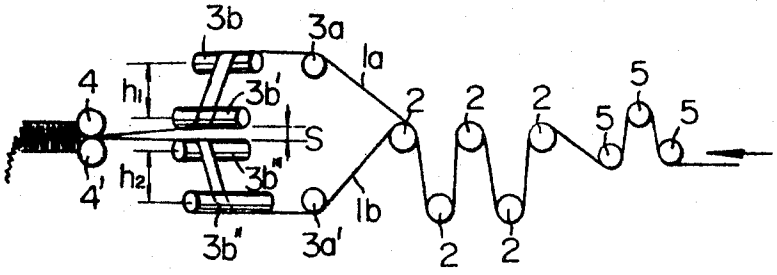

3b
3a
1a
4
h1
3b'
S
h2
3b''
4'
1b
3b''
3a'
2
2
2
5
5
5
2
2

Fig. 9

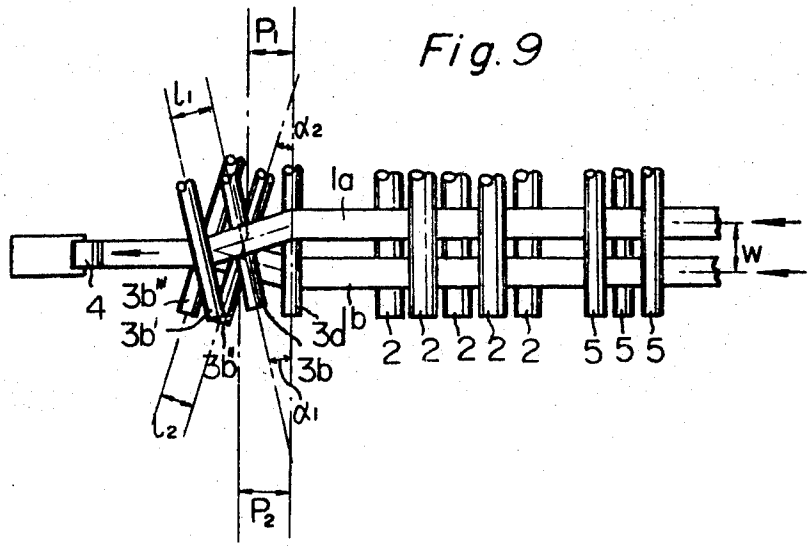

P1
l1
α2
1a
W
4
3b''
3b'
3d
1b
3b''
3b
α1
l2
P2
2 2 2 2 2
5 5 5

Fig. 10

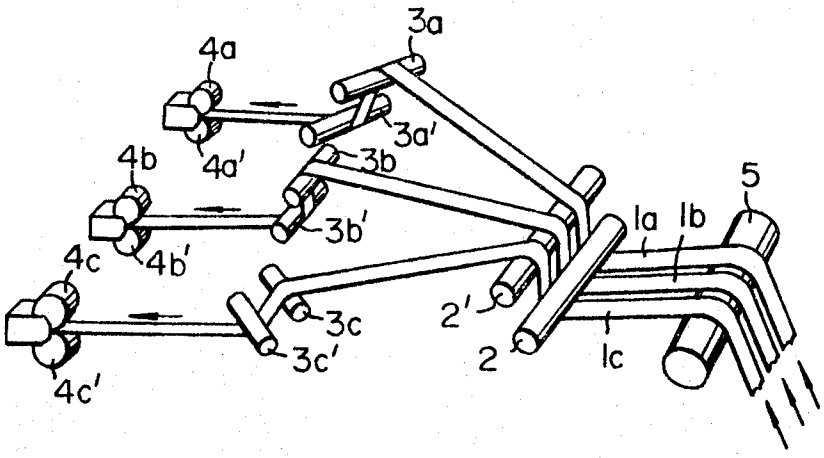

3a
4a
3a'
4a'
3b
4b
5
3b'
1a
1b
4b'
4c
3c
2'
3c'
2
1c
4c'

Fig. 11

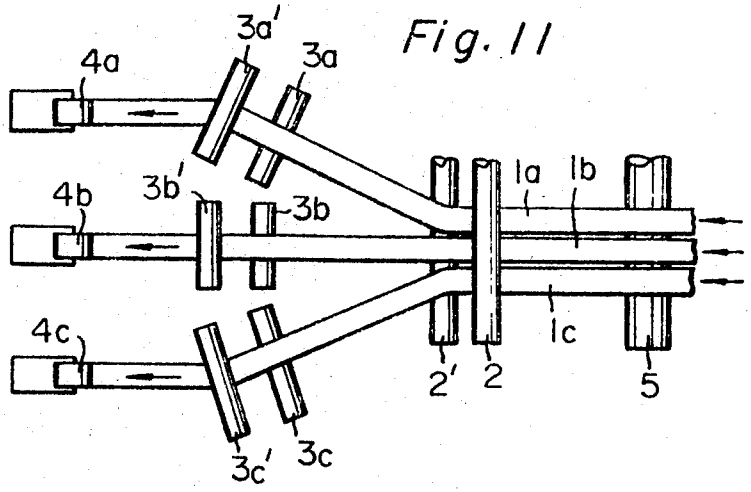

3a'
4a
3a
1a
1b
3b'
4b
3b
4c
1c
2'
2
5
3c'
3c

Fig. 12

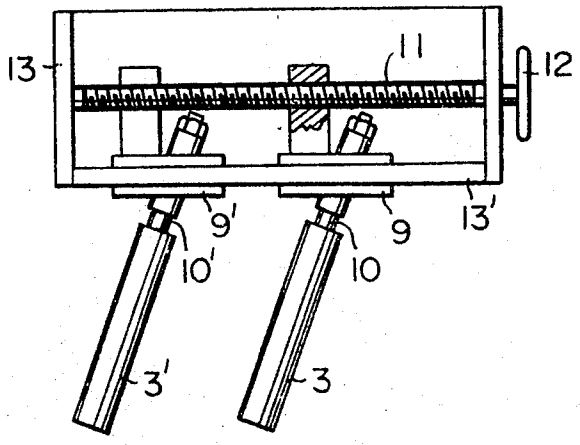


Fig. 13

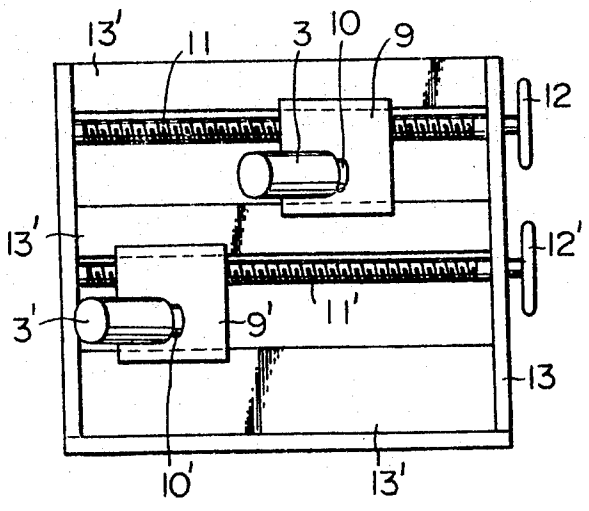
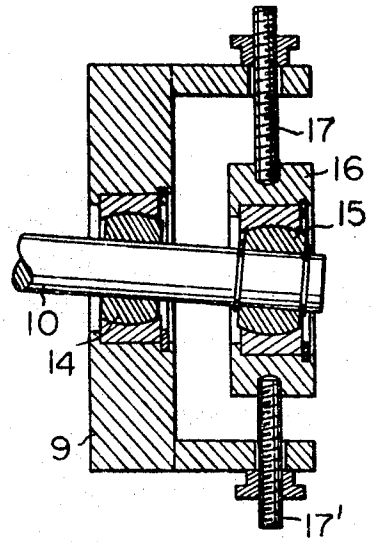


Fig. 14



METHODS AND APPARATUS FOR TRANSFERRING TOWS

The present invention relates to methods and apparatus for transferring tows, particularly, without causing uneven tow tension across the tows by displacing the path of travel of the tows in substantially parallel form.

In general, in a process for treating tows, a tow obtained in the preceding process is in some cases transferred from a feed roller means to a take-up roller means by displacing its path of travel in substantially parallel.

For instance, usually in the manufacture of synthetic staple fibers, an undrawn synthetic tow having a denier of 500,000 to 6,000,000 is drawn to 2 to 6 times the original length between feed roller means and draw roller means; it is then fed to a crimping machine having a pair of nip rollers substantially parallel with the draw roller means to impart zigzag crimp to the tow, heat set the crimped tow and cut with a cutter into staple fibers.

Generally the width of a tow in the drawing process is several times as broad as that of the nip rollers of a crimping machine, and it is impossible to feed the broad tow to the nip rollers without further processing.

For this reason, the tow is divided into a plurality of subtows overlapping each other to make one thick tow having the same width as that of the nip rollers for feeding to a crimping machine, or the tow is divided into a plurality of subtows fed into a plurality of crimping machines, respectively.

In the latter case, the take-up roller means is frequently arranged in substantially parallel relation with feed roller means. In the former case, that is, in dividing a tow into several subtows and overlapping each other, it is essential to cause the center line of each divided subtow to agree with the receiving direction of the take-up roller means and reach the take-up roller means. If without further processing the divided subtows are sent to the take-up roller means, most of divided subtows will reach the take-up roller means without any agreement of the center line of each subtow with the receiving direction of the take-up roller means. For the subtows that will reach the take-up roller means without agreement of their center lines with the receiving direction of the take-up roller means, the tow paths should be displaced in parallel form and agreed with the receiving direction of the take-up roller means to permit the subtows to stack each other.

In the latter case, that is, in supplying divided subtows into a plurality of crimping machines, respectively, the center line of one of the divided subtows agrees with the receiving direction of the take-up roller means, but the center lines of the other divided subtows will disagree with the receiving directions of take-up roller means. Therefore they should be adjusted such that they agree with the directions.

It is well known in the art, e.g., British Pat. No. 962,516 that in methods of transferring tows from feed rollers in the preceding process to take-up rollers in the subsequent process substantially parallel with the feed rollers in the preceding process while displacing the path of travel of the tows in substantially parallel form, guide cylinders are disposed between the feed rollers in the preceding process and the take-up rollers in the subsequent process so that they are inclined to a plane passing through the feed and take-up rollers to permit

each tow which is to be transferred to be urged against each guide cylinder one time and to thereby displace the path of each tow leaving the preceding process in parallel form and transfer the tows from the preceding process to the subsequent process.

However when the distance between the feed rollers in the preceding process and the take-up rollers in the subsequent process is small, distortions occur in the planes of the tows between the last roller of the feed rollers and the inclined guide cylinder and in the planes of the tows between the guide cylinder and the first roller of the take-up rollers, and the lengths of travel of tows between the feed and take-up rollers differ at each portion across the tows. Thus uneven tension in the width direction of the tows is caused and as a result, the stable operation in the subsequent process, for instance, a crimping process, is damaged. Hence when this method is used the distance from the last roller of the feed rollers in the preceding process to the first roller of the take-up rollers of the subsequent process should be lengthened in order that such distortions of tow planes may be reduced and differences in the lengths of travel within the tows may be lessened. Since, for instance, 5 to 10 meter distance is required, there is a drawback that the equipment needs a great space.

As described above, conventional methods have disadvantages that uneven tow tension in the width-wise direction occurs or a great space is needed for the device.

As described above, uneven tow tension in the widthwise direction is caused by distortions generated in the plane of the travelling tows and differences in the lengths of travel of the tows between the last feed roller and the first take-up roller occurring at each portion in the widthwise direction of the tows.

In other words, if distortions of planes of the travelling tows are prevented and the lengths of travel of tows are so arranged as not to be different at any portion in the widthwise direction of the tows, uneven tension in the widthwise direction of the tows will not occur.

With this point in mind, the present invention has eliminated such drawbacks of conventional methods.

The object of the present invention is to provide methods of and apparatus for transferring tows from the last roller of a drawing machine to a pair of nip rollers of a stuffer crimper substantially parallel with the last roller of the drawing machine without causing uneven tow tension in the widthwise direction and in a considerably short-distant path by displacing the tows in parallel form.

Other objects and advantages of the invention will be obvious and apparent hereinafter.

According to the present invention, in displacing the tow paths in parallel form between feed and take-up roller means substantially parallel with each other in their axes in a process for transferring tows, a plurality of guide cylinders are disposed between the feed and take-up rollers and by means of the relative positions of the guide cylinders, the lengths of travel of tows between both the rollers are caused not to vary at any portion across the tows and occurrence of distortions of travelling tows is prevented. Thus the tow path can be displaced in parallel form without any widthwise uneven tension of tows.

Transferring tows from the feed roller means to the take-up roller means by displacing the tow path in par-

allel form means to transfer the tows from the feed roller means to the take-up roller means such that when the travelling paths of the tows just before they have left the feed roller means and the travelling paths of the tows just before they have reached the take-up roller means are projected in a plane formed by the axes of the feed and take-up rollers from the direction perpendicular to the plane, the projected travelling paths are parallel with each other.

The present invention will be described below with reference to the accompanying drawings.

FIGS. 1 and 2 show cases where the guide cylinders in the present invention are held in the stationary state and FIG. 1 is a side view and FIG. 2 is a plan view.

FIGS. 3 and 4 show cases where the guide cylinders are held in the rotatable state and FIG. 3 is a side view and FIG. 4 is a plan view.

FIG. 5 is a plan view modifying FIG. 2.

FIGS. 6 and 8 are side views showing applications of the present invention.

FIG. 7 is a plan view of FIG. 6.

FIG. 9 is a plan view of FIG. 8.

FIG. 10 is a perspective view of another application of the present invention.

FIG. 11 is a plan view of FIG. 10.

FIG. 12 is a plan view showing the arrangement of guide cylinders of the present invention.

FIG. 13 is a side view of FIG. 12.

FIG. 14 is a detailed view of a device for holding the guide cylinder of the present invention.

One embodiment of the present invention will be described below.

In FIGS. 1 and 2, a feed roller 2 and a take-up roller 4 are arranged such that their axes are substantially parallel. Two guide cylinders 3, 3' are held in the stationary state between said rollers and the axes of the guide cylinders 3, 3' are disposed in nonparallel relation with the axes of the feed roller 2 and the take-up roller 4. A tow 1 reaches the take-up roller 4 from the feed roller 2 via the guide cylinders 3, 3'. In FIG. 2, the path of the tow 1 between the feed roller 2 and the guide cylinder 3 is parallel with that between the guide cylinder 3' and the take-up roller 4, and the paths are displaced for a distance δ_1. The displacement occurs between the guide cylinders 3 and 3'.

First with such a tow advancing state in mind, in order that the distortions of plane of the advancing tow may be avoided, it is essential that the guide cylinders are arranged such that a tow departure line and a tow arrival line on the roller and guide cylinder adjacent and facing each other along the tow path or on the guide cylinders (guides) facing and adjacent each other along the tow travelling path are coplanar. For instance, in the case of the feed roller 2 and the guide cylinder 3 considered guides adjacent and facing each other along the tow path, the feed roller 2 and the guide cylinder 3 are arranged such that the tow departure line A-A' and the tow arrival line B-B' are coplanar.

For such an arrangement, it is sufficient that when the diameters of the feed roller 2 and the guide cylinder 3 are the same, both are arranged so that their axes are coplanar, but when their diameters are different, the positions of both guides may be appropriately rearranged according to difference in the diameters.

This is also the case with the subsequent tow paths, that is, between the guide cylinders 3 and 3' or between the guide cylinder 3' and the take-up roller 4. It is easily possible to prevent the distortions of tow plane.

Second the directions of the guide cylinders 3, 3' become a primary problem. For instance when the axes of the feed roller and the guide cylinder are parallel, there will be no change in tow path. However if the axes of the feed roller and the guide cylinder are rendered unparallel and intersect to make an angle α_1, the displacement of a tow becomes possible as shown in FIGS. 1 and 2. This is one embodiment in which the axes of the guide cylinders are parallel to each other but another embodiment in which they are unparallel to each other is shown in FIG. 5.

In one embodiment of the present invention, the axes of the guide cylinders 3 and 3' are positioned in one and the same plane and parallel, as shown in FIG. 2. The arrangement can very easily be determined experimentally and is rotional. The tow supported with the guide cylinders 3, 3' with the axes kept parallel, which is sectioned by the tow departure line and the tow arrival line, forms a parallelogram. The guide cylinders 3, 3' are each inclined to the axes of the rollers 2, 4 at the same angles, respectively. Under these circumstances, the travelling tow is bent but not twisted nor distorted, and the lengths of travel of the tow are the same in the width direction. Hence the tow is transferred from the feed roller 2 to the take-up roller 4 while being displaced in the parallel form without any trouble.

In summary the present invention relates to methods and apparatus for transferring tows whereby between feed roller means and take-up roller means arranged such that the axes of both the roller means are parallel, a plurality of guide cylinders are disposed in the stationary state and the axes of the guide cylinders are parallel, but unparallel with the axes of the feed and take-up roller means; a tow departure line and a tow arrival line on a roller and a guide cylinder adjacent and facing each other along the tow paths or on the guide cylinders adjacent and facing each other along the tow paths are coplanar.

In this case, a distance of displacement of the tow δ_1 is governed by an angle α_1 made by the feed roller 2 and the guide cylinder 3 as well as the distance between the guide cylinders 3, 3'.

However in FIGS. 1 and 2, the guide cylinders are disposed in the stationary state, but it has been found that when they are rotatably disposed, an entirely different state occurs. In FIGS. 3 and 4, they are freely or positively rotatable, but the arrangement of the feed roller 2, 2' and the take-up roller 4 and the relative positioning of the guide cylinders 3, 3' are much the same as in FIGS. 1 and 2. Most preferably, the guide cylinders are freely rotatable. For instance, as shown in FIG. 3, when the tow 1 is pulled with the take-up roller 4, etc., the guide cylinders 3, 3' are caused to rotate in the direction of travel of the tow to insure an operation free from slippage of the tow on the surfaces of the guide cylinders and prevent the damage of the tow.

As described above, when the guide cylinders 3, 3' are made freely rotatable by the tow, it is a particularly conspicuous phenomenon that the engagement relationship of the tow with the guide cylinders is naturally adjusted and the direction of entry of the tow makes a right angle with the axis of the guide cylinder. In FIG. 4, the tow path is displaced in parallel form for a distance δ_2 but the state of advance of a tow is found considerably different from those in FIGS. 1 and 2. That is,

as shown in FIG. 4, the tow 1 changes its direction of travel gradually on the feed roller 2 and enters the guide cylinder 3 and then the guide cylinder 3', perpendicularly to them. The tow enters the take-up roller 4 at a right angle by changing its direction of of travel gradually on the guide cylinder. In this case, the lengths of travel of a tow between the feed and take-up rollers are substantially the same at any portion across the tow.

In one embodiment as shown in FIGS. 1 to 4, it is noted that it is the angles of a plurality of guide cylinders and the distance between the guide cylinders that control the distance of displacement of a tow in parallel form. If such controlling elements are adopted, a desired purpose can be attained, despite a short distance between the feed and take-up rollers.

For instance, in FIGS. 1 and 2, as the angle α_1 becomes large, the distance of the displacement of the tow δ_1 becomes large. If the distance l_1 between the guide cylinders 3 and 3' is made greater, the distance of the displacement of the tow δ_1 becomes large. A combination between a change of angles and that of distances is also possible.

In any embodiment in FIGS. 2 to 4, a desired distance of the displacement of the tow is obtainable by appropriately arranging the above-described angle and distance. Hence there is no need to lengthen the distance between the feed roller 2 and the take-up roller 4 as has been the case with conventional methods. The guide cylinders 3, 3' may or may not be rotatable (rotatable or stationary). Generally speaking, it is more advantageous to use rotatable guide cylinders because of less wear and abrasion of the guide cylinders and less damage of a tow. When unrotatable guide cylinders are used, it is desirable to render their surface matte finished to reduce susceptibility to damage of a tow.

In embodiments in FIGS. 1 to 4, the tow 1 is displaced in parallel form with the two guide cylinders 3, 3' arranged in parallel, but it is possible to displace the tow in parallel form with three unparallel guide cylinders.

Another embodiment of the present invention with the use of three unrotatable guide cylinders is shown in FIG. 5.

In FIG. 5, between the feed roller 2 in the preceding process and the take-up roller 4 in the subsequent process are arranged three unparallel unrotatable guide cylinders 3, 3', 3'' so that they are unparallel to the feed roller 2 in the preceeding process and the tow departure line and the tow arrival line are coplanar on the roller and guide cylinder adjacent and facing each other along the path of travel of a tow or on the two guide cylinders adjacent and facing each other. The tow 1 is urged against each guide cylinder one time and transferred so that the path of travel of the tow 1 is displaced from the feed roller 2 to the take-up roller 4 in the subsequent process substantially in parallel form without occurrence of lateral uneven tow tension. The distance of the displacement of the tow in this case is shown in δ_3.

Generally the higher the number of guide cylinders disposed between the feed roller means in the preceding process and the take-up roller means in the subsequent process, the more complicated become the operations between the two processes. Thus it is desirable to arrange guide cylinders in the least possible number and to use the minimum two guide cylinders unparallel to the feed roller means in the preceding process.

Summarizing the embodiments in FIGS. 1 to 5, the main elements of the present invention will be described below.

In displacing the path of travel of a tow in parallel form between the feed and take-up roller means with their axes substantially parallel to each other in a process for transferring the tow, a plurality of guide cylinders are arranged between the two roller means so that the axes of at least two guide cylinders among them are in nonparallel relation with the axes of the two roller means and a tow departure line and a tow arrival line on the adjacent roller and guide cylinder facing each other or on the adjacent guide cylinders facing each other are coplanar, and the travelling tow is engaged with the guide cylinders in turn after leaving the feed roller means and lead into the take-up roller means with changes in the direction of travel of the tow.

FIG. 6 is a side view showing a further embodiment of the present invention.

FIG. 7 is a plan view of that embodiment.

That is, FIGS. 6 and 7 show an embodiment in which the synthetic fiber tow stretched with a drawing machine is led into a crimping machine of stuffer box type for crimping by the division of the stretched tow into three subtows and the overlapping of the three subtows to form one thick tow having a width equal to that of the nip rollers of the crimping machine.

The stretched tow 1 is heat treated with a heater plate 6 disposed between a draw rollers 5 and the take-up rollers 2, under tension, a constant length or shrinkage, and divided into subtows 1*a*, 1*b* and 1*c* in almost equal width at the take-up rollers 2. The tow 1 may be divided at an optional place, before, during or after stretching. The subtows 1*a*, 1*c* at both edges pass through the guide cylinders 3*a*, 3*a*'' arranged in parallel with the take-up rollers 2, are urged against a pair of unrotatable guide cylinders 3*b*, 3*b*', 3*b*'', and 3*b*''' one time, respectively, given parallel displacement amount necessary for exactly overlapping the central subtow 1*b* and being stacked at the guide cylinders 3*c* located in parallel with a pair of nip rollers 4, 4' of a crimping machine into one tow and fed into the nip rollers 4, 4'. Since there is no need to displace the path of travel of the central subtow 1*b*, there is no need to advance it in contact with the unparallel guide cylinders. To make the length of travel of the subtow 1*b* between the take-up roller 2 and the nip rollers 4, 4' of the crimping machine equal to those of the subtows 1*a*, 1*c* for equalizing the temperatures among the subtows, it is necessary that the central subtow 1*b* is urged against a guide cylinder 3*a*' provided in parallel with the rollers 2.

FIG. 8 is a side view showing one embodiment of the present invention with the use of rotatable guide cylinders 3*b*, 3*b*', 3*b*'', 3*b*''' unparallel to the feed rollers 2 in the preceding process in dividing the drawn tow 1 into two subtows 1*a*, 1*b*, overlapping each other and feeding them to a crimping machine. FIG. 9 is a plan view of FIG. 8.

In FIGS. 8 and 9, the two drawn tows 1*a* and 1*b* passed through drawing rollers 5 and caused to meander on heated rollers 2 are respectively advanced with the engagement with two sets of guide cylinders 3*b*, 3*b*' and 3*b*'', 3*b*''' disposed in nonparallel relation with the guide cylinders 3*a*,3*a*' and the heated rollers 2, displaced in parallel form for overlapping each other and fed into the pair of nip rollers 4, 4' of the crimping machine. The use of these heated rollers 2 is not essential. The tow may be transferred directly from the drawing rollers 5 to the guide cylinders 3*a*, 3*a*' to attain the object of the present invention. In this case, guide cylin-

ders 3*b*, 3*b'*, 3*b''*, 3*b'''* are adapted to be unparallel with the drawing rollers **5**.

Further all the guide cylinders and rollers in FIGS. **6** to **9** are arranged such that a tow departure line and a tow arrival line are coplanar on the roller and the guide cylinder adjacent and facing each other along the direction of travel of the tow or on a pair of adjacent guide cylinders facing each other. And the pair of guide cylinders 3*b*, 3*b'* are parallel as are the pair of guide cylinder 3*b''*, 3*b'''*. Distortions of plane of the tow between the feed rollers and the take-up rollers and lateral uneven tow tension are thus prevented.

With reference to these embodiments of the present invention the effect of the present invention will be described in detail.

First, without a large space for conventional methods, a tow can be transferred from the feed roller means in the preceding process to the take-up roller means in the subsequent process without generating lateral uneven tow tension by displacing the path of travel of the tow in substantially parallel form. In conventional methods, the distance between the feed roller means in the preceding process and the crimping machine should be about 5 to 10 meters or above, but in the present invention the distance can be reduced to less than a half of that required in conventional methods and there is no need to have a large space for apparatus.

Second the above-described advantage of the present invention that the distance can be reduced is not limited to the compactness of apparatus but can elevate crimp performance and affect the quality of the product advantageously.

In stuffer box crimping, tow is usually preheated before it enters the crimping machine to elevate crimp performance and crimp properties; the tow after drawing is divided and the divided tows are overlapped to produce a thick tow and heated just in front of the crimping machine. In this case, uniform heating for the inside of the tow is defficult because of the thickness of the tow and a long period of time for heating is needed. In contrast, in the present invention the tows can be overlapped without lateral uneven tow tension in space less than a half of that in conventional methods; consequently as shown in FIGS. **6** to **9**, the tow **1** after drawing is heated in a thin layer before the overlapping of the divided tows and then the tows are overlapped and fed into the crimping machine as a tow having an appropriate temperature. Usually, a synthetic fiber tow is heated at elevated temperatures under tension, in the relaxed state or while keeping a constant length to improve properties of fibers in the tow such as strength, elongation and dimensional stability after drawing. If the present invention is applied to this case, the high temperature tow heated by the thermal energy at the drawing machine can be supplied to the crimping machine resulting in highly economical advantage.

In conventional methods, in order that a plurality of tows may be displaced in parallel form, overlapped and fed from the feed roller means in the preceding process to the subsequent take-up roller means without any lateral uneven tow tension, it is necessary to lengthen the distance between the feed roller means and the take-up roller means, that is, to prolong the time of travel of the tow between them. Thus even if a plurality of tows are heated before overlapping, the heated tows cool down at the time of overlapping and feeding to a crimping machine and such methods of heating cannot be effectively employed.

In the present invention, the temperature of a tow to be fed to a crimping machine varies slightly with a kind of fiber constituting the tow, the tow travelling speeds, and the distance between a heating device and the crimping machine. But in general, the tow drawn is heated to the glass transition point + 20°C to the melting point −10°C, whereby the tow temperature at the entrance to the crimping machine will be the glass transition point to the melting point −30°C resulting in imparting high crimp to the tow with the crimping machine.

Further another embodiment of the present invention is shown in FIGS. **10** and **11**.

FIG. **10** is a perspective drawing of the embodiment.

FIG. **11** is a plan view of the embodiment.

In the treatment of a tow of synthetic fibers, for the purpose of increasing productivity of the tow, one broad tow obtained with one drawing machine is divided into a plurality of subtows and each subtow is supplied into each crimping machine. That is, the tow produced with one drawing machine is divided into a plurality of subtows and each subtow is led into a plurality of crimping machines. As shown in FIGS. **10** and **11**, when a plurality of crimping machines are arranged in the axial direction of the nip rollers **4**, **4'**, the divided subtows are displaced in parallel form by the process of the present invention to enable the supply into each crimping machine.

In FIGS. **10** and **11**, the drawn tow **1** is divided into subtows **1***a*, **1***b* and **1***c* and the subtow **1***a* is caused to pass through draw roller **5** and feed rollers **2**, **2'** and is urged against a pair of rotatable guide cylinders 3*a*, 3*a'* parallel to each other but unparallel to the draw roller **5** and the feed rollers **2**, **2'**, and fed into the nip rollers **4***a*, **4***a'* of the crimping machine. In like manner, the subtow **1***c* is advanced with the engagement with the rotatable guide cylinders 3*c*, 3*c'*, and fed into the nip rollers **4***c*, **4***c'* of the crimping machine. The subtow **1***b* need not be transferred by parallel displacement and the rotatable guide cylinders 3*b*, 3*b'* need not be unparallel to the feed rollers **2**, **2'** in the preceding process.

In FIGS. **10** and **11**, all the guide cylinders, 3*a*, 3*a'*, 3*b*, 3*b'*, 3*c* and 3*c'* are all rotatable and so arranged that parts of each subtow in contact with the guide cylinders or the rollers are coplanar.

When the tow path is displaced by conventional methods, the collected state of the stacked tows just before the crimping machine is unsatisfactory because of lateral uneven tow tension; particularly, the tows cannot be uniformly stacked at both edges of the tows, with the result of poor operational stability of the crimping machine to be used therefor. However the present invention has no such drawback.

In the present invention, the distance of the parallel displacement of tow path for a tow can be optionally adjusted by the relative positions of guide cylinders to be used and the mounting angle of a guide cylinder unparallel to the feed roller in the preceding process. According to the present invention, tow path of any breadth can be displaced in parallel form.

In the present invention, the shape of a guide cylinder should be cylindrical and hour-glass or pot-bellied shape is not proper. The surface of it may be mirror-like or matte finished, but when a guide cylinder is unrotatable, a matte finished one is preferable.

FIGS. **12** and **13** show one embodiment of positioning guide cylinders **3**, **3'**. Three guide plates **13'**, are arranged in the front of a frame **13** and slide blocks **9**, **9'**

are slidably fitted at the intervals between the guide plates. Shafts **10, 10'** are secured to the slide blocks **9, 9'** in a given direction, and to the shafts are mounted guide cylinders **3, 3'** rotatably or unrotatably. The axes of the guide cylinders **3, 3'** are parallel to each other. The slide blocks **9, 9'** are respectively connected to screw shafts **11, 11'**, on the opposite side of the shafts **10, 10'**. The screw shafts **11, 11'** are mounted to the frame **13** with handles **12, 12'** attached to their ends so that the screw shafts **11, 11'** are parallel to the slide blocks **9, 9'**.

The adjusting device of guide cylinders in FIGS. **12** and **13** will be applied to one embodiment of the present invention in FIGS. **1** and **2**. In this case, an angle α_1 is assumed to be constant and the interval between the guide cylinders **3** and **3'** is just adjusted. In FIG. **13**, the position of the slide block **9** is maintained constant, and the position of the other guide block **9'** is moved by the operation of the handle **12'**. The intervals between the guide cylinders **3, 3'** are changeable. By this adjustment the distance of the parallel displacement of the tow δ_1 can be adjusted.

As described above, the distance of the parallel displacement of the tow can be adjusted by changing the angle α_1 made by the axis of the feed roller **2** and that of the guide cylinder **3**. This is shown in FIG. **14**. The slide block **9** is combined with the shaft **10**, which is supported with a spherical bearing **14** within the slide block **9**. To the end of the shaft **10** is fitted another spherical bearing **15**. The block **16** supporting the spherical bearing **15** is supported with bolts **17, 17'** at the upper part and the lower part thereof. The bolts **17, 17'** displace the block **16** up and down by means of screws. Thus the back and forth rotation of the shaft **10** is possible with the spherical bearing **14** as the supporting point. The application of the device in FIG. **14** to the device in FIGS. **12** and **13** permits the adjustment of the angle α_1 as well as the adjustment of intervals between the guide cylinders. The device in FIG. **14** is, of course, singly applicable without its combination with the device in FIGS. **12** and **13**. In this case only the angle of the guide cylinder is adjustable.

A further understanding of the invention will be had from a consideration of the following examples which are set forth for illustrating certain preferred embodiments.

EXAMPLE 1

In the embodiment as shown in FIGS. **1** and **2**, the relative positions of the unrotatable guide cylinders parallel to each other but unparallel to the feed roller in the preceding process are shown in FIG. **1**. Let the distance between horizontal axes of the guide cylinders l be 200 mm and the vertical distance thereof h_1 be 500 mm and the diameters r_1 of the guide cylinders be 100 mm. An angle α_1 of the guide cylinder **3** with respect to the delivery roller **2** in the preceding process is set to 30 deg. A 1,500,000 denier polyacrylonitrile tow having a width of 1,000 mm was handled with the apparatus, and the distance of the parallel displacement δ_1 as shown in FIG. **2** turned out to be 470 mm. Without irregular tension across the tow, the tow could be transferred from the feed roller **2** in the preceding process to the take-up roller **4** in the subsequent process while the tow path was being displaced in parallel form.

EXAMPLE 2

In another embodiment of the present invention as shown in FIGS. **3** and **4**, the relative positions of the guide cylinders **3, 3'** and the feed roller are given in FIG. **3**. The guide cylinders are rotatable and parallel to each other but unparallel to the feed roller **2**. The settings are $l_2 = 132$ mm, $h_2 = 150$ mm and $r_2 = 100$ mm where l_2 is the horizontal distance between the two guide cylinders, h_2 is the vertical distance and r_2 is the diameter of the guide cylinders **3, 3'**. And let the horizontal distance P between the guide cylinder **3** and the feed roller **2** in the preceding process be 250 mm and an angle α_2 made by these two elements be 11°30'. A 300,000 denier polyethylene terephthalate tow **1** having a width of 100 mm was passed through the apparatus in engagement with the guide cylinders. The distance of the parallel displacement of the tow was 86 mm in FIG. **4**. Without a lateral uneven tow tension, the tow could be very smoothly moved from the feed roller **2** to the take-up roller **4** by displacing the tow in parallel form.

EXAMPLE 3

In FIGS. **6** and **7**, a 3 million denier undrawn polyester fiber tow was drawn to 4.0 times the original length, and heated with a heater plate **6**. The tow 300 mm wide was divided into three subtows, **1***a*, **1***b* and **1***c*. These three subtows were advanced in engagement with the guide cylinders as shown in FIGS. **6** and **7** and fed into the nip rollers **4, 4'** of a crimping machine.

In this case, the guide cylinders **3***a*, **3***a'*, **3***a''* and the guide cylinders **3***b*, **3***b'*, **3***b'''* and **3***b''''* were arranged in such a way as

$l_1 = l_2 = 125$ mm
$h_1 = h_2 = 150$ mm
$\alpha_1 = \alpha_2 = 10°$
S = 10 mm

(The diameter of each guide cylinder was 100 mm.).

The distance between the feed roller **2** and the nip rollers **4, 4'** of the crimping machine was 2.5 m, and the width of the nip rollers was 90 mm. As a result, three subtows **1***a*, **1***b*, **1***c* were stacked 100 percent just behind the guide cylinders **3***b'*, **3***b'''* and there was no uneven tension across the tow. The crimped tow obtained by varying heating temperatures with a heater plate **6** and drafts between the roller **2** and a draw roller **5** was heat-treated at 140°C in the relaxed state and cut into a staple length of 38 mm.

The crimp performance of the fibers is given in Table 1.

TABLE 1

Experiment number	Tow temperature at exit of heater plate	Draft	Tow temperature just in point of crimping machine (° C.)	Degree of crimpness, percent	Number of crimps (crests/25 mm.)	Standard deviation of number of crimps
1	104	0.90	75	9.3	12.7	0.85
2	102	1.05	73	9.0	13.9	0.91

TABLE 1 – Continued

Experiment number	Tow temperature at exit of heater plate	Draft	Tow temperature just in point of crimping machine (° C.)	Degree of crimpness, percent	Number of crimps (crests/25 mm.)	Standard deviation of number of crimps
3	115	0.90	90	11.3	13.0	0.63
4	119	1.05	92	10.5	13.8	0.90
5	148	0.90	115	13.5	12.4	0.79
6	140	1.05	112	12.5	13.0	0.80
7	185	0.90	134	15.8	14.3	0.93
8	181	1.05	139	14.3	12.7	0.71
9	213	0.90	165	16.5	12.5	1.03
10	208	1.05	164	14.0	12.4	0.95
11	230	0.90	179	18.0	13.3	1.35
12	227	1.05	177	16.5	13.0	1.41

NOTE.—The degree of crimpness and the number of crimps are averages of 50 data measured by Japanese Industrial Standards, and the standard deviation is given with 50 data.

EXAMPLE 4

In FIGS. **8** and **9**, a 2,400,000 denier undrawn polyester fiber tow was divided into two tows before drawing and after drawing, two subtows **1***a*, **1***b* having a denier of 300,000 and a width of 100 mm each were obtained, distance W between the center lines of the two subtows being 120 mm.

After the engagement with the heated feed rollers **2** in the preceding process in the serpentine form, the two subtows were urged against a pair of parallel, rotatable guide cylinders **3***b*, **3***b'* and **3***b''*, **3***b'''*, respectively and fed into a pair of nip rollers **4**, **4'** of a crimping machine of stuffer-box type.

In this case, in FIGS. **10** and **11**, the guide cylinders **3***a*, **3***a'*, and **3***b*, **3***b'*, **3***b''*, **3***b'''* (The guide cylinders each were 100 mm in diameter.) were arranged such that

$h_1 = h_2 = 150$ mm

$l_1 = l_2 = 50$ mm

$\alpha_1 = \alpha_2 = 11°30'$

$P_1 = P_2 = 260$ mm

$S = 10$ mm

The distance between the last roller of the heated roller group and the nip rollers **4**, **4'** of a crimping machine was set to 1,500 mm and the width of the nip roller 90 mm.

As a result, the subtows **1***a* and **1***b* were stacked 100 percent just behind the guide cylinders **3***b'*, **3***b'''* without any tension irregularity across the tow, resulting is very stable operations of the crimping machine.

The test results are given in Table 2.

TABLE 2

Experiment number	Tow temperature at exit of last heating roller (° C.)	Tow temperature at entrance to crimping machine	Degree of crimpness, percent	Number of crimps (crests/25 mm.)	Standard deviation of number of crimps	Malfunction in crimping machine times/24 hr.
13	161	123	15.4	12.1	0.95	1
14	205	155	14.2	13.0	1.13	3

CONTROL

A 2,400,000 denier undrawn polyester fiber tow was divided into two tows in the apparatus of FIGS. **8** and **9** without the use of **3***a*, **3***a'*, **3***b*, **3***b'*, **3***b''*, **3***b'''*. After drawing, they were made into subtows **1***a*, **1***b* each having a denier of 300,000 denier and a width of 100 mm. With the use of one guide cylinder located between the last roller of the draw roller group **2** and the nip rollers **4**, **4'** of the crimping machine, one subtow was stacked on the other tow, made into one tow and fed into the nip rollers **4**, **4'** 90 mm in width. In this case, in order that one subtow may be stacked 100 percent with a minimum lateral uneven tow tension, the distance between the last roller of the draw roller group **5** and the nip rollers **4**, **4'** of the crimping machine was required to be 6.0 m or above.

With such a distance of 6.0 m or above, actual industrial production is very disadvantageous, and with a distance of 1.5 m, experiments were conducted. Distortions in the plane of the stacked tow occurred, and uneven tension across the tow could not be eliminated. Test results are given in Table 3.

TABLE 3

Experiment number	Tow temperature at exit of last heating roller (° C.)	Tow temperature at entrance to crimping machine	Degree of crimpness, percent	Number of crimps (crests/25 mm.)	Standard deviation of number of crimps	Malfunction in crimping machine times/24 hr.
15	158	57	6.3	12.3	2.13	11
16	200	68	4.0	11.9	2.05	7

We claim:

1. In a method for advancing and transferring tows through a plurality of guide cylinders between feed roller means and take-up roller means, the axes of said feed roller means and said take-up roller means being substantially parallel to each other, the improvement comprising arranging the axes of at least two of said guide cylinders in nonparallel relation with the axes of said feed and take-up roller means; arranging respectively in a plane each pair of a line defining a position where the tow departs from said feed roller means or one of said guide cylinders and a line defining a position where the tow arrives at one of said guide cylinders or said take-up roller means, said pair of lines being, respectively, on a pair of members consisting of (a) said feed roller means and one of said guide cylinders, (b) two of said guide cylinders, or (c) one of said guide cylinders and said take-up roller means, each pair of members being adjacent to each other along the path of travel of the tows; and moving the advancing tows from said feed roller means to contact in succession said guide cylinders and reach said take-up roller means while changing the advancing directions of the tows to

thereby displace the tows paths in parallel in a plane figure.

2. A method as set forth in claim 1 in which the parallel displacement of the tow paths is adjusted by changing the angle of said guide cylinders relative to the axes of said feed and take-up roller means.

3. A method as set forth in claim 1 in which the parallel displacement of the tow paths is adjusted by changing the intervals between at least two guide cylinders.

4. A method as set forth in claim 1 in which the parallel displacement of the tow paths is adjusted by changing the interval between one of said guide cylinders and one of said feed or take-up roller means.

5. A method of claim 1 in which there are only two of said guide cylinders, said two guide cylinders being disposed in substantially parallel relation to each other.

6. In apparatus for transferring tows from feed roller means to take-up roller means having substantially parallel axes of rotation by displacing tow paths in parallel form, the improvement comprising two guide cylinders disposed in substantially parallel relation to each other between said feed and take-up roller means, said two guide cylinders being disposed in nonparallel relation to said feed and take-up roller means.

7. An apparatus as set forth in claim 6 in which at least one of said two guide cylinders is movable in parallel with the other.

8. An apparatus as set forth in claim 6 in which angles between the axes of said two guide cylinders and axes of said feed and take-up roller means are adjustable.

9. An apparatus as set forth in claim 8 in which at least one of said two guide cylinders is movable in parallel to the other.

10. An apparatus as set forth in claim 6 in which said guide cylinders are rotatable.

11. An apparatus as set forth in claim 6 in which said guide cylinders are stationary.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,763,520 Dated October 9, 1973

Inventor(s) Nobuharu IZAWA ET AL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Heading -

First name of inventor "Nobuharo" is properly spelled --Nobuharu--

Insert --Claims priority, application Japan, 78326/70, filed September 7, 1970.--

Signed and sealed this 16th day of April 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents