A yarn traversing system of a rotary blades type is disclosed wherein an effective yarn traversing width is divided into two or more groups. Each group is provided with two superimposed and coaxially arranged blades rotating in opposite directions. The yarn is alternately moved in one traversing direction by the rotating blade and transferred from a blade of one group to a blade of the neighboring group. Directional change of the yarn traverse is performed by the cooperation between the two blades in the terminal groups of the effective yarn traversing width. The point shape of the rotary blade is so designed as to effect a smooth and stable transfer and the directional change of the yarn. Location and dimensions of the blades within the groups are so selected that the rotation thereof should not interfere with the rotation of the blades of the neighboring groups.
YARN TRAVERSING METHOD AND APPARATUS OF A ROTARY BLADE TYPE

The present invention relates to an improved yarn traversing apparatus of a rotary blade type, and more particularly relates to an improved yarn traversing apparatus wherein an effective yarn traversing width is divided along a yarn traversing direction into more than two groups, each group is provided with its own rotary blade mechanism and the yarn is traversed and transferred from group to group by the rotation of respective rotary blades having therebetween given phases difference.

Recently, there has been a great demand in the field of textile industries for increasing a yarn speed to be taken-up onto a yarn package and the available maximum yarn takeup speed has already exceeded the speed from 4,000 meters/min. to 5,000 meters/min. In order to takeup the yarn on the package, it is necessary to traverse the yarn along an axial length of a bobbin supporting the package with given relation to the yarn speed to be taken-up on the package. In this connection, it is well-known that the above-mentioned yarn traversing speed has a close relation to the takeup speed of the yarn. For example, in case of a drawn synthetic filamentary yarn, the yarn traversing speed is generally required to be larger than one-tenth of the yarn takeup speed. Consequently, the larger the yarn takeup speed becomes, the larger the requirement for the yarn traversing speed will be. From this viewpoint, various proposals have been given concerning the method and apparatus for carrying out such a considerably high speed yarn traversing operation.

One of the attempts is given in the form of a rotary traverse-type roll as disclosed in U.S. Pat. No. 2,736,506. In this mechanism, more than one yarn guide groove is peripherally formed on the roll in such a manner that the groove starts from one end of the roll, reaches another end of the roll and returns to the original end forming a return-route which is different from the forward-route. The roll is disposed adjacent to the yarn package with its axis parallel to the axis of the package, and with the simultaneous axial rotation of the roll and the package, the yarn is taken-up onto the package while being traversed by the guide of the groove of the roll. When the yarn is to be taken-up onto the package at a considerably high speed, that is, the yarn is to be traversed at a high speed, also, the yarn is apt to move without complete control of the above-described guide by the groove of the roll and jumping out of the groove. Consequently, the yarn traversing mechanism of this type can hardly assure a stable yarn takeup operation when it is purposed for a considerably high speed yarn takeup operation. Another of the conventional yarn traversing systems utilized a pair of yarn guides disposed on respective endless belts. Two sets of endless belts running in opposite directions are disposed in a superimposed arrangement in the path of the yarn to be takeup at a position close and upstream of the package. The yarn guides are disposed on respective endless belts in such a manner that one of the guides effects the yarn traverse of the forward-route and the other guide effects the yarn traverse of the return-route. When the yarn is processed through this mechanism at a considerably high takeup speed, it was also confirmed by repeated experiments that complete control of the yarn by the yarn guides is not always prevalent. So, the yarn traversing mechanism of this type is also not suitable for considerably high speed yarn takeup operation.

A pneumatic yarn traversing system is also another example of the conventional method. A cylinder is disposed in the path of the yarn at a position close to and upstream of the package. A yarn guide piece is adjacent to the cylinder in a condition slideable in the yarn traversing direction and both ends of the cylinder are provided with respective pressure chambers connected to given pneumatic sources. By alternately supplying compressed air to the respective chambers, the yarn guide piece is slid along the cylinder from one end to the other and vice versa, and the yarn is traversed accordingly. In case of this mechanism, because of the peculiarity commonly possessed by pneumatic operational systems, it is difficult, espe-

cially in the case of considerably high speed operations, to completely control the operational condition of the mechanism in a stable running condition. So, the yarn traversing mechanism of this type can also not be adapted for actual yarn takeup processes of considerably high speeds with reliable assurance of the resulting yarn quality.

In order to solve the troubles encountered in the above-described yarn traversing mechanism, a yarn traversing system utilizing a rotary blade mechanism has been developed. In this system, a pair of rotatable blade sets are coaxially disposed in the yarn path at a position close to and upstream of the package. The blades rotate in opposite directions. The yarn is moved in the traversing direction being urged by the rotating blades and the relative angular location of the two sets of blades is so selected that a partial rotation of one of the blades effects the yarn movement of the forward-route and a partial rotation of another of the blades effects the yarn movement of the return-route.

It is true that the yarn traversing system of this type (hereinafter will be called as the conventional rotary blade type yarn traversing apparatus) can well mitigate the troubles encountered in the above-described prior arts assuring a stable and smooth yarn traversing operation, it still has indispensable drawbacks caused by its mechanical structural features as follows. In this conventional rotary blade type yarn traversing apparatus, it is well understood that a blade has to take charge of moving the yarn from one end to the other of the effective traversing width. Besides, as briefly mentioned above, only a part of the rotation of the blade takes part in urging the yarn from one end to the other of the effective yarn traversing width. So, the larger the effective yarn traversing width, the longer must be the length of the blade. In conformity to the recent tendency for larger packages in the field of textile industry, the axial length of the package has a trend to be increased together with increase in package diameter. Increase in the axial length of the package inevitably induces increase in the effective yarn traversing width and accordingly increase in the length of the rotary blade. Thus, the total dimensions of the conventional rotary blade type yarn traversing apparatus can not help but be enlarged. Further, such an enlargement in the dimensions of the apparatus inevitably accompanies a difficulty in locating the yarn traversing apparatus as close to the package as possible which is a general requirement for the purpose of a stable, smooth and reliable yarn traversing operation.

Aside from the above-described drawbacks, the conventional rotary blade type yarn traversing apparatus entails further drawbacks due to its principal mechanism of moving the yarn by cooperatively rotating only two sets of blades. As above-mentioned, the processing yarn is urged laterally by the blades while advancing longitudinally, this means that the yarn advances longitudinally sliding over the edge portions of each blade at a considerably high speed. Besides, this sliding is carried out under a strong contact of the yarn with the blade edges because of the above-mentioned urging of the former by the latter. Such a sliding of the yarn over the blade edges under strong contact and at considerably high speeds is apt to damage the yarn surface and to cause a variation in the yarn takeup tension resulting in the lowering of the acquired yarn quality and undesirable deformation of the acquired package form. Furthermore, the yarn is traversed only by being urged by the blades but not caught definitely by the blades as in the case of the ordinary yarn guides. So, at the time of yarn transfer from one blade to another, the yarn sometimes has a tendency to escape from the control of the blade due to relatively unstable advancing conditions of the yarn at that time. In addition to this, it is known that the yarn has a tendency to return to the middle of its effective traversing width when the yarn path is biased towards the end portions of the traversing width. In the case of the rotary blade type yarn traversing system, the above-described tendency of the yarn after induces the escape of the yarn from the control of the rotary blade. This particularly happens when the yarn traversing
speed is very high. In this connection, a reliable transfer of the yarn from blade to blade and reliable protection of the yarn escaping from the control of the rotary blades have been a strong and intense requirement in the actual introduction of the rotary blade type yarn traversing system into the textile industry.

A principal object of the present invention is to provide a yarn traversing apparatus capable of being favorably adapted for considerably high speed yarn takeup operations in the textile industry field assuring a smooth and stable traverse of the yarn throughout the yarn takeup operation.

Another object of the present invention is to provide a yarn traversing apparatus capable of producing yarns of a high grade quality and a yarn package of desirable form.

A further object of the present invention is to provide a yarn traversing apparatus of compact construction and low manufacturing costs.

A still further object of the present invention is to provide a novel rotary blade type yarn traversing apparatus which can bring about a stable, smooth, troubleless and reliable transfer of the yarn from blade to blade together with a stable guiding of the yarn during the traversing operation.

A still further object of the present invention is to provide an improved rotary blade type yarn traversing apparatus which can eliminate almost all of the drawbacks possessed by the conventional yarn traversing systems of a rotary blade type.

A still further object of the present invention is to provide an improved yarn traversing apparatus wherein the yarn traversing mechanism can be located close to the yarn package without any contact of the mechanism and its related parts to the surface of the package.

A still further object of the present invention is to provide a yarn traversing apparatus using which will prevent the possible escape of the processing yarn from the control of the rotary blades found in the conventional system.

Still another object of the present invention is to provide an improved yarn traversing apparatus through which the yarn can be processed without inducing any processing troubles.

In conformity to the above-described objects of the invention, the effective yarn traversing width in the yarn traversing system of the present invention is divided into more than two groups. According to the length of the yarn traversing width and the positional relationship of the yarn traversing mechanism with the yarn package, the number of the groups can be selected as it fits the actual situation. Within a single group, the yarn is moved in the traversing direction being urged by the rotary blade of the group. When one yarn is brought to a termination of a group, the yarn is transferred from the rotary blade of the group to the corresponding rotary blade of a neighboring group. Thus, being moved from group to group, the yarn is traversed from one end to the other of the traversing width and vice versa in succession. Each group is provided with a pair of coaxially disposed rotary blade sets yarn rotating in opposite directions at a position close and upstream of the yarn package. Relative angular disposition of the blades of both sets is so designed that rotation of one set of blades partially takes charge of urging the yarn in one direction while rotation of another set of blades partially takes charge of urging the yarn in opposite direction.

The shape of the rotary blade is so selected as to assure a stable transfer of the yarn from blade to blade and a stable directional change of the yarn at the termination of the effective traversing width. Further, the shape of the rotary blade is so selected that the blade edge should not damage the passing yarn by its contact with the yarn. Besides, the relative positional and structural relationship between the blade set of one group and the blade set of the neighboring groups are so designed that the rotation of the former does not interfere with the rotation of the latter.

In order to assist the stable yarn urging and transferring action by the rotary blades, some auxiliary improvement and modification is involved concerning the yarn guide bar and the terminal yarn guides.

Further features and advantages of the method and apparatus of the present invention will be made apparent from the ensuing descriptions, reference being made to the accompanying drawings, wherein

FIG. 1 is a plan view, partly cutoff, of an embodiment of the yarn traversing apparatus of the present invention.

FIG. 2 is a vertical sectional view of the gear wheels rotation actuating mechanism used in the apparatus shown in FIG. 1.

FIG. 3 is a plan sectional view of the gear wheels rotation actuating mechanism, partly omitted, shown in FIG. 2.

FIG. 4 is a side view of the apparatus shown in FIG. 1 in a condition winding up the yarn.

FIG. 5 is a plan explanatory view showing the general mode of yarn urging by the rotary blade in the system of the present invention.

FIG. 6 is a plan explanatory view showing the general mode of yarn transfer from group to group in the system of the present invention.

FIG. 7 is a plan explanatory view showing the general mode of yarn directional change from forward to return-route in the system of the present invention.

FIG. 8A, 8B and 8C are plan explanatory views showing the mode of a yarn traversing operation in the system of the present invention.

FIG. 9 is a plan view, partly cutoff, of the point portion of the rotary blade having an inclined leading edge with an including angle α according to the present invention.

FIG. 10 is a sectional view, partly cutoff, of the rounded leading edge of the blade used in the present invention.

FIG. 11A is a plan view, partly cutoff, of an embodiment of the rotary blade having a point portion made of a wire and FIG. 11B is a cross-sectional view, partly cutoff, of the wire used in the embodiment shown in FIG. 11A.

FIG. 12 is a partial plan view of an embodiment of the rotary blade having a recessed point according to the present invention.

FIGS. 13A, 13B and 13C are plan explanatory drawings showing the operative mode of the blade shown in FIG. 12.

FIG. 14 is a perspective view of a stationary yarn guide preferably used in combination with the rotary blades in the yarn traversing operation of the present invention.

FIGS. 15A to 15F are plan explanatory drawings showing the cooperative mode of the stationary yarn guide shown in FIG. 14 with the rotary blades.

FIGS. 16A and 16B are partly omitted plan views of several modifications of the yarn traversing guide bar used in the present invention.

FIGS. 17A, 17B, 17C are plan, side and front views of an embodiment of the upper blades preferably used in the embodiment shown in FIG. 1.

FIG. 18 is an explanatory drawing showing the angular locational relation between the cooperating rotary blades in the embodiment shown in FIG. 1.

FIG. 19 is an explanatory drawing showing loci of the points of the blades measured as shown in FIG. 18.

FIGS. 20A and 20B are plan and sectional front view of another embodiment of the yarn traversing apparatus of the present invention.

Referring to FIGS. 1, 2 and 3, an embodiment of the yarn traversing apparatus is shown. In the case of this embodiment, the effective yarn traversing widths S is divided into three groups I, II and III of same length.

As shown in FIG. 1, on centers Q1, Q2 and Q3 of virtual hexagons having respective groups widths I, II and III as their one side S, pairs of shafts 1 and 2, 3 and 4, 5 and 6 are coaxially and rotatably disposed. A mechanism for rotatably actuating the shafts 1 to 6 is shown in FIG. 2 in detail. The shafts 1, 3 and 5 are provided with gear wheels 8, 10 and 12 respectively secured thereto in a mutually meshing arrangement. On the other hand, shafts 2, 4 and 6 are also provided with gear
wheels 7, 9 and 11 respectively secured thereto in a mutually meshing arrangement. All of the gear wheels 7 to 12 are provided with the same number of gear teeth. The centers of \(O_1, O_2, O_3\) lie in a common plane which extends parallel to a transversely extending guide bar 32, as seen in Fig. 1.

A mechanism for rotatably actuating the gear wheels 7 to 12 is illustrated in Fig. 3, wherein a driving shaft 13 is disposed within the gear casing 14 in a direction substantially perpendicular to the axial directions of the parallelly arranged shafts 1, 3 and 5. By being sandwiched by the gear wheels 7 and 8, 11 an 12, two additional gear wheels 16 and 17 are fixedly united to the shafts 1 and 6 by means of the gear wheels 8 and 11 as is clearly shown in Fig. 2. For the purpose of ensuring smooth rotation of all of the above-described shafts in the gear casing 14, bearings of an ordinary type are disposed adequately as shown in the drawing. On the driving shaft 13, a pair of worms 18 and 19 are fixedly mounted in meshing engagement with the additional gears 16 and 17. In this disposition, the direction of the teeth formed on the worm 18 should be opposite to that on the worm 19, that is, when the driving shaft 13 rotates, the rotat- ing direction of the additional gear wheel 16 meshing with the worm 18 is opposite to that of the gear wheel 17 meshing with the worm 19. One end of the driving shaft 13 is connected to a driving source (not shown).

In the above-described mechanical arrangement, when the driving shaft 13 starts to rotate, the pair of additional gear wheels 16 and 17 are rotated into opposite directions as afore-mentioned. By this rotation of the driving gear wheels 16 and 17, similar directional rotations of the shafts 1, 4 and 5 are ac- tuated and the shafts 2, 3 and 6 are rotated into similar direction but opposite to the rotating directions of the above- mentioned shafts 1, 4 and 5.

Coming back to Fig. 1 again, the respective grouped width sections I, II and III are provided with upper blades 21, 22 and 23 secured to the respective shafts 1, 3 and 5 and with lower blades 24, 26 and 27 secured to the respective shafts 2, 4 and 6. In the condition shown in Fig. 1, the angular phase of the lower blade 26 of the group II is delayed by 60° from that of the upper blade of the group I, the angular phase of the upper blade 23 of the group III is delayed by 60° from that of the lower blade 26 of the group II, the angle between the upper blade 21 and the lower blade 24 of the group I is 180°, the angular phase of the upper blade 22 of the group II is advanced by 60° from that of the lower blade 24 of the group I and the angular phase of the lower blade 27 of the group III is advanced by 60° from that of the upper blade 22 of the group II.

At a position upstream of the yarn package 29 (see Fig. 4), a roller bar 28 is rotatably disposed in a contact relation to the peripheral surface of the package 29 with its longitudinal axis substantially parallel to the longitudinal axis of a bobbin 31 supporting the package 29. In a parallel arrangement to the roller bar 28, a yarn traverse guide bar 32 is disposed and is slightly biased toward the package 29. The yarn 33 is taken on the package 29 passing through the yarn traversing apparatus of the present invention while being adequately traversed in the longitudinal axial direction of the package 29 along the traverse guide bar 32.

Being actuated by the above-described rotatably actuating mechanism, all the blades 21, 22, 23, 24, 26 and 27 rotate in the directions shown with arrows in Fig. 1 around the respective shafts 1, 3, 5, 2, 4, and 6 while preserving the above-described angular phase differences.

The general mode of yarn urging by the rotating blade is illustrated in Fig. 5, wherein the yarn 33 moves in the direction shown with an arrow along the guide bar 32 being urged by the leading edge of the counterclockwise-rotating upper blade 21.

The general mode of yarn transfer from blade to blade is illustrated in Fig. 6, wherein the leading edge of the counterclockwise-rotating lower blade 26 of the group II comes in contact with the yarn 33 before the yarn 33 is relieved from contact with the leading edge of the counterclockwise-rotating upper blade 21 of the group I. When the yarn 33 has completely relieved from contact with the upper blade 21, the transfer of the yarn 33 from the group I to the group II is completed and the yarn 33 is further moved in the traversing direction being urged by the leading edge of the lower blade 26 now in complete contact with the yarn 33.

Referring to Fig. 7, a general mode of yarn directional change from the forward-route to the return-route at one end, in the case of the drawing at the right end of group III, of the effective yarn traversing width is shown. At the moment when the yarn 33 is brought to the rightmost end of the effective traversing width being urged by the leading edge of the counterclockwise-rotating upper blade 23 and is relieved from contact therewith, the yarn 33 comes in contact with the leading edge of the counterclockwise rotating lower blade 27. As soon as the yarn 33 is completely relieved from the urging by the upper blade 23, the yarn 33 is now moved in the opposite direction along the guide bar 32 being urged by the leading edge of the counterclockwise rotating lower blade 27 now in a complete contact with the yarn 33 as shown with an arrow in the drawing. Thus the directional change of the yarn traversing can be attained by cooperative rotations of the upper and lower blades of the group located at the ends of the effective yarn traversing width S.

The mode of yarn traversing in the system of the present in- vention is shown in Figs. 8A, 8B and 8C in detail.

In the situation shown in Fig. 8A, all the blades are in angular locations advanced by 90 degrees from those shown in Fig. 1 and the yarn 33 is supposed to be located at the most left end of the effective yarn traversing width S, that is at the leftmost end of the group I.

In this situation, the blades 21 and 24 of the group I are placed in a condition the same with that shown in Fig. 7. With advance of the rotation of the upper blade 21, the yarn 33 is moved rightwards being urged by the leading edge of the counterclockwise-rotating upper blade 21 in a manner shown in Fig. 5. When the yarn 33 reaches the rightmost end of the group I, the angular locations of all the blades are as shown in Fig. 8B. In this condition, the locational relation between the blades 21 and 26 is just after that shown in Fig. 6 and the yarn 33 is now completely transferred from the upper blade 21 of the group I to the lower blade 26 of group II and is further moved rightwards being urged by the leading edge of the counterclockwise-rotating lower blade 26. When the yarn 33 comes to the rightmost end of group II, the yarn 33 is transferred from the lower blade 26 of the group II to the upper blade 23 of the group III and is further moved rightwards as the blade 23 rotates counterclockwise. At the rightmost end of the group III, the directional change of the yarn traversing is performed as already described in combination with Fig. 7. During the return-route of the yarn traversing, the yarn is moved leftwards and transferred from group to group in a manner the same with that in the forward-route of the yarn traversing.

As is apparent from the foregoing description, the funda- mental art of the present invention depends on the transfer of the yarn from blade to blade. In the case of the yarn transfer from group to group, the yarn has to be transferred from a blade of one group to a blade of the succeeding group. In the case of the directional change of the yarn traversing, the yarn has to be transferred from a blade to another blade of the groups located at the ends of the effective yarn traversing width. So, it is the essential requirement for the success of the art of the present invention that the above-described yarn transfer should be carried out smoothly in a stable condition without damaging the quality of the yarn.

From this viewpoint, in the groups located at the ends of the effective yarn traversing width S, it is desirable that the length of the blades urging the yarn towards the ends of the effective yarn traversing width S is slightly shorter than that of the blades urging the yarn away from the ends of the effective yarn traversing width S. For example, in the embodiment
shown in FIG. 1, the lengths of the blades 23 and 24 should be shorter than those of the blades 27 and 21 respectively. Because of such a change in length, the yarn can be urged away from the guide by one blade smoothly and transferred to the guide by another blade at the time of directional change.

For a similar reason, it is desirable to form the leading edge of the point portion of the blade is inclined with respect to the trailing edge line of the blade by an inclining angle \( \alpha \). In FIG. 9, an example of the blade having the above-described inclining leading edge is shown assuming that the blade rotates in the direction shown with an arrow. The value of the inclining angle \( \alpha \) should be defined by the following equation:

\[
\alpha = \arctan \left( \frac{5}{10} \right)
\]

An allowance of \( +5^\circ \) is acceptable in case of the blade urging the yarn to the terminations of the yarn traversing, that is, the blades 23 and 24 in the embodiment shown in FIG. 1, while an allowance of \( \pm 5^\circ \) is acceptable in case of the remaining blades. Thus, in the embodiment shown in FIG. 1, having three groups I, II, and III, the value of \( \alpha \) is \( 180^\circ \times \frac{5}{10} = 30^\circ \) degrees for group I, 5 degrees for the blades 23 and 24, and 30 degrees plus minus 5 degrees acceptable allowance for the blades 21, 22, 26 and 27. In case the effective yarn traversing width \( S \) is divided into four groups, the calculated value of the angle \( \alpha \) is 22.5 degrees. However, other values of \( \alpha \) are also employable.

As is already described, the yarn is advanced longitudinally while being urged laterally in contact with the blade's edge during the yarn taking-up operation. This means that the yarn is severely abraded by the blade's edge during its passage and such a severe abrasion of the yarn by the blade's edge often causes damage to or breakage of the yarn. In order to avoid such troubles, it is desirable to round the leading edge of the blade as is sectionally shown in FIG. 10.

Another modification of the blade shape for smooth contact with the passing yarn is shown in FIG. 11A, wherein the point portion of the blade is made of a wire 34 having a round cross-sectional profile as is partly shown in FIG. 11B. This also assures a smooth contact of the yarn with the blade edge even at a time of high speed yarn taking-up operation.

As is already explained, when the yarn is brought to the termination using the blade shown in FIG. 12, it is shown in the drawing, a cooperation of the blade 21 with the blade 24 in the embodiment of FIG. 1 is shown as an example. In the situation shown in FIG. 13A, the yarn 33 is still in contact with the leading edge of the blade 24 in the vicinity of the point thereof and is still urged leftwards. As the clockwise rotation of the blade 24 advances, the yarn 33 escapes away from contact with the leading edge of the blade 24 as shown in FIG. 13B and, finally, received by the recess 36 of the blade 21 as shown in FIG. 13C. Thus, the tendency of the yarn 33 to return towards the middle portion of the effective yarn traversing width \( S \) can be limited by the catch of the yarn 33 by the recess 36 of the blade 21 even when the mechanically defined yarn traversing speed cannot follow the self-returning speed of the yarn. This improvement in the point shape of the blade when applied to the constant wind ratio winding system.

Improvement for assuring a stable and smooth yarn traversing can be directed not only to the blade's constructions but also to the constructions of the auxiliary members in the apparatus of the present invention.

Referring back to FIG. 7 again, when the yarn 33 changes its moving direction by the cooperation of the blade 23 with the blade 27, it sometimes happens that the yarn 33 is undesirably nipped in between the leading edges of both blades 23 and 27. In order to avoid this trouble, it is desirable that the yarn 33 is relieved from the urging action by the leading edge of the blade 23 to an appreciable moment before it comes in contact with the leading edge of the blade 27.

Referring to FIG. 14, a stationary yarn guide 37 used for this purpose is shown. The stationary yarn guide 37 has a curved portion 38 for guiding the yarn 33 and is disposed to a framework of the apparatus in the vicinity of the effective yarn traversing width \( S \) with the curved portion 38 facing the package (not shown) at a position above the guide bar 32.

The cooperation between the stationary yarn guide 37 and the rotary blades 23 and 27 is shown in FIGS. 15A, 15B, 15C, 15D, 15E, and 15F. In the first place, the yarn 33 comes in contact with the curved portion 38 of the stationary yarn guide 37 being urged by the blade 23 as shown in FIG. 15A. Then the yarn 33 is further urged rightwards contacting the brim of the curved portion 38 as is shown in FIGS. 15B and 15C as the rotation of the blade 23 advances. When the yarn 33 comes to the position shown in FIG. 15D, the point portion of the blade 23 completely goes under the curved portion 38 relieving the yarn 33 from its urging action and the yarn 33 ceases its rightward movement. At this moment, the blade 27 comes into a position to take charge of urging the yarn 33 in the opposite direction. By further advancing the rotation, the point portion of the blade 27 protrudes from under the curved portion 38 to be in contact with the yarn 33 and the yarn 33 is urged leftwards along the brim of the curved portion 38 as shown in FIG. 15E. In the condition shown in FIG. 15F, the yarn 33 escapes away from contact with the brim of the curved portion 38. By the employment of the above-described stationary yarn guide, the yarn can be completely relieved from urging by one blade prior to the start of the urging by another blade and above-described unfavorable nipping of the yarn by the cooperating blades can be completely prevented.

Another modification for better yarn traversing function of the apparatus of the present invention can also be made to the construction of the yarn traverse guide bar 32. This modification is illustrated in FIG. 16A, wherein the side portion of the guide bar 32 facing the blade mechanism is wave-shaped. The tops of the convex portions 32a corresponds to the location on the traversing path of the yarn 33 whereas the yarn 33 is transferred from a group to the neighboring group. The center of the curvature of the concave portion 32b approximately falls on the center of the blade rotation of the corresponding group. This wave-form can be formed on the side of the guide bar 32 remote from the blades mechanism. In this case, the yarn 33 traverses along the side remote from the blade mechanism as is shown in FIG. 16B.

In the arrangement of the apparatus of the present invention, a group is provided with two blades rotating into opposite directions. In order to carry out this rotations of two blades without any interference between the two, it is necessary to arrange the two blades with different inclinations in the vertical level. Besides, as is apparently shown in FIG. 6, rotation of a blade of a certain group should not disturb the rotation of a blade of the neighboring group at the moment of yarn transfer from the former group to the latter group. So, the cooperating blades of the neighboring groups should also be arranged with different inclinations in the vertical level.

From this viewpoint, taking the embodiment shown in FIG. 1 as an example, it is desirable to form the upper blades 21, 22, and 23 as shown in FIGS. 17A, 17B and 17C, wherein the blade, for example the blade 22, includes a yarn guide portion 41, a base 42 to be secured to the shaft 1 and a connecting pole 43 for connecting the yarn guide portion 41 and the base...
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What is claimed is:

1. A yarn traversing apparatus for alternately traversing an advancing yarn back and forth along a guide bar comprising: a guide bar longitudinally disposed during operation of the apparatus transversely to the direction of advancement of the advancing yarn; and means for alternately traversing the advancing yarn along said guide bar comprising a first plurality of rotatable blades successively spaced apart along said guide bar and cooperating together in response to synchronized rotation thereof to alternately traverse the advancing yarn in one direction along said guide bar, first drive means for effecting synchronous rotation of said first plurality of blades in a first direction to effect alternate traversal of the advancing yarn in said one direction along said guide bar, a second plurality of rotatable blades successively spaced apart along said guide bar and cooperating together in response to synchronized rotation thereof to alternately traverse the advancing yarn in another direction opposite to said one direction along said guide bar, second drive means for effecting synchronous rotation of said second plurality of blades in a second direction opposite to said first direction to effect alternate traversal of the advancing yarn in said another direction along said guide bar, and means mounting each of said first and second plurality of blades for rotational movement about respective axes all of which lie in a common plane including means mounting all said blades for rotational movement within only two planes.

2. An apparatus according to claim 1 wherein said additional means comprising said first and second pluralities of blades are angularly positioned out of phase with respect to the remaining blades in that plurality by an amount sufficient to effect sequential transfer of the advancing yarn from blade to blade along said guide bar in response to rotational movement of said first and second pluralities of blades.

3. An apparatus according to claim 1 including means providing mounting each of said first plurality of blades coaxially with respective blades of said second plurality of blades.

4. An apparatus according to claim 3 wherein the end pairs of coaxially mounted blades disposed along said guide bar include means for changing direction of said blades for respectively changing the direction of traverse of the advancing yarn.

5. An apparatus according to claim 4 wherein both said end pairs of coaxially mounted blades comprise a long blade and a short blade shorter than said long blade, said short blade being the blade which transfers the advancing yarn to the end of its traverse along said guide bar whereby the longer blade commence the return traverse.

6. An apparatus according to claim 4 including means for removing the advancing yarn from one of the rotating blades constituting said end pair before same comes in contact with the other rotating blade of that end pair.

7. An apparatus according to claim 1 wherein said first and second drive means are both positioned on the same side of said guide bar.

8. An improved yarn traversing apparatus of the rotary blade type comprising, in combination: at least two yarn traversing groups arranged in succession along an effective yarn traversing width at a position upstream of a package on which said yarn is to be wound; each said yarn traversing group comprising a pair of coaxially disposed rotary blades each mounted on a separate rotatable shaft and each comprising a base portion secured to its respective shaft, a yarn guide portion, and a connecting portion connecting said base portion with said yarn guide portion and wherein selected ones of said connecting portions connect their respective guide portions in an elevated relationship with respect to their associated base portions to ensure that the rotatable blades of coaxial yarn traversing group do not interfere with rotation of said rotary blades of neighboring yarn traversing groups and wherein the effective length of the rotary blade effective traversal of said yarn towards termination of said effective yarn traversing width is slightly shorter than that of said other rotary blade of said group in each terminal yarn traversing group; a yarn traverse guide bar laterally extending along said
yarn traversing groups; and actuating means for effecting rotation of said blades of said respective yarn traversing groups while maintaining a predetermined angular disposition of said blades to effect traverse of said yarn in one direction along said guide bar by the cooperative action of one blade of each yarn traversing group and traverse of said yarn in an opposite direction along said guide bar by the cooperative action of the other blade of each yarn traversing group; whereby said yarn is transferred from a rotary blade of one of said yarn traversing group to a rotary blade of a neighboring yarn traversing group at a boundary between said two yarn traversing groups.

9. An improved yarn traversing apparatus as claimed in claim 8, wherein a leading edge line of a point portion of each said rotary blade is inclined with respect to a trailing edge line of said blade by an including angle $\alpha$ defined as follows:

$$\alpha = 180/N \times \frac{1}{2}$$

wherein $\alpha$ = said including angle in degrees

$N$ = total number of said yarn traversing groups.

10. An improved yarn traversing apparatus as claimed in claim 8, wherein each said rotary blade is provided with means defining a recess at a point thereof directing outwardly towards the trailing edge of said blade.

11. An improved yarn traversing apparatus as claimed in claim 8, wherein a yarn contacting side portion of said yarn traverse guide bar is wave-shaped and has convex and concave portions, and wherein the tops of convex portions of said wave-shape correspond to boundaries between said yarn traversing groups wherein said yarn is transferred from group to group while centers of curvature of concave portions of said wave-shape lie on centers of said blade rotation of said corresponding group.

12. An improved yarn traversing apparatus as claimed in claim 8, wherein said actuating means comprises two gear trains mutually related by a suitable connecting gear mechanism and, in a certain yarn traversing group, one of said pair of blades is actuated to rotate in one direction by one of said gear trains while another of said pair of blades is actuated to rotate in an opposite direction by the other of said gear trains.

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