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Cad Software Based Design of Yarn Guide Profile

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Abstract

The traversing mechanism on a winding machine causes the yarn guide and hence the yarn to reciprocate. This work is an attempt to eliminate the too and fro motion of the yarn guide wherein the guide profile ensures proper transfer of yarn with the desired pattern and pitch. The change in yarn direction after completing one axial traverse poses the most challenging aspect in designing an efficient guide profile. With idealizing assumption of the yarn behaving as a thin wire under the taut condition between three support points at the top ring, profile point on the guide and the bobbin, the ideal profile for consistent guidance of the yarn has been developed.

Introduction

On a winding machine the yarn needs to be traversed too and fro, for which here an endless chain has been used. The most important requirement for this system to work was to design a yarn carrier (guide) which can not only take the yarn from one side of the traverse to the opposite end but also efficiently transfers it from the top yarn carrier to the bottom one and vice versa.

Yarn Guide Requirements

As mentioned earlier an endless chain has been used on which the yarn guide is mounted due to its positive nature. When the guide reaches its extreme the same guide does not reverse. This can avoid the problems due to guide reversal. So with this background the arrangement for achieving this objective had to be decided upon. Out of several options figure1 shows the arrangement finalized.

As seen in the figure1, the driver sprocket (D1) drives the chain. The top chain travels towards the left in the diagram. The other sprockets namely the one at the extreme and the other two sprockets in the bottom line are carrier /driven sprockets have been named (D2). A represents the guide that have been placed at equal intervals from each other. With reference to the above figure, the working of the proposed traversing mechanism can be understood.

The top chain travel is towards the left side of the sketch, so the yarn guide mounted on it also moves towards the left and hence the yarn. The bottom chain is moving towards the right which is exactly in the opposite direction to that of the top chain. Hence the guide on it also moves along with it. So the entire traverse can be divided into three main divisions viz, the two extremes and the central. The two extreme zones can be called as the transfer zone whereas the central can be called as the traverse zone. The transfer zones have been very critical and the profiles have been designed as per the geometry in that region.

When the top chain enters the transfer zone another yarn guide mounted on the bottom chain also enters the transfer zone on the lower side. In this zone the yarn should get transferred from the top yarn guide to the bottom one and the point at which this occurs is the transfer point. After the transfer the yarn is now in the guide on the bottom chain which moving towards the right, thus causing reversal of the yarn. This system does not contain any reciprocating element, which is an added advantage. Now with the basic set-up ready, the next important challenge was to design a yarn guide which would give a smooth yarn transfer when the yarn reached the transfer zone.

Various designs of guides

On the commercial winding machines, to traverse yarn only one guide is used since it is of reciprocating type. So the guide is normally a piece which has a hole at center lined with ceramic, through which the yarn passes. There are others which resemble 'U' of English alphabet.

But for the above application a similar type of guide would not serve the purpose since the yarn has to be transferred from one guide to another one. As it can be seen in the figure 2 that the shape of the guide profile selected was similar to English alphabet S, when seen from the top, flipped by 90°. The trough portion would hold the yarn. The following considerations would have to be made before the exact profile of the guide can be designed:

a. The yarn guide would have to be open from its front side.

b. The guide would have to be anchored to the reciprocating element (chain).

c. At the transfer point the yarn needed to be removed from top guide and made to sit in the bottom guide or vice versa. So it was imperative to device a mechanism whereby the yarn could be gradually ejected from one of the guides and smoothly transferred to the other one.

There were two options, either to make use of a profiled guide which would do two fold function that is firstly to carry the yarn too and fro and secondly its profile would cause the yarn to be ejected from the giver guide at the same time help the receiver guide to receive the yarn, and can be called self acting. The profiles in figures 3, 4, 5 & 6 are some examples cited in other patents are shown below:

In the figures 3 [1] and 4 [1], the sub titles (a), (b), and (c) show the step wise transfer taking place due to the profiled guides. Even though the patent for figure 3 and figure 4 is same, the profile of the traversing element is different. The same element is shown with minor modifications. This system has been specially developed for the yarn on solidification from the melt spinning process. There are at least two

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guiding members who take yarn too and fro. This mechanism also used co-axial sprockets and chains due to which reversal of the traversing mechanism does not occur as shown in figure 5 [2].The Figure 6 [3] shows the guide profile for rotating wings.

Figure 7 [4] is related to belt traverse. This system makes use of endless belt, each of which carries yarn traversing fingers arranged to move in the opposite directions to traverse the yarn axially of a winding package. Auxiliary yarn engaging members are positioned to facilitate reversal of the yarn at the package ends.

The second option would be to make use of a yarn guide and a separate tapered profile. The tapered profile would be helpful to

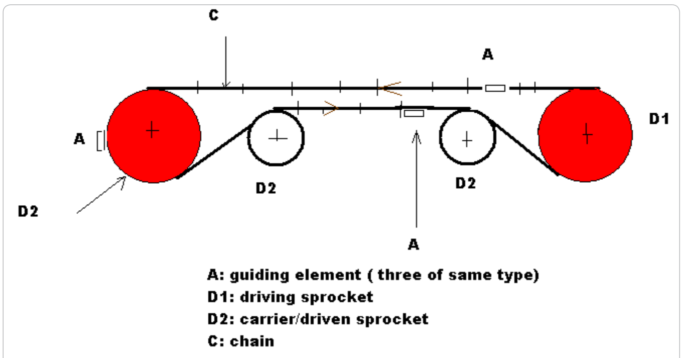

Figure 1: Design of a yarn carrier (guide).

Figure 2: The shape of the guide profile.

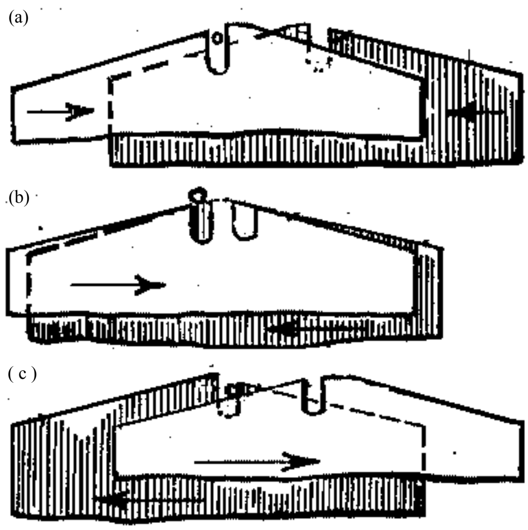

Figure 3: The sub titles (a), (b), and (c) show the step wise transfer taking place due to the profiled guides.

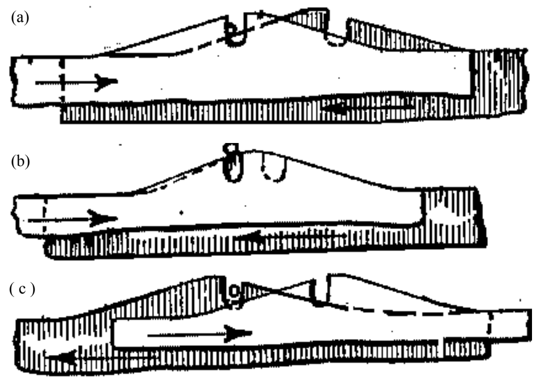

Figure 4: The step wise transfer taking place due to the profiled guides.

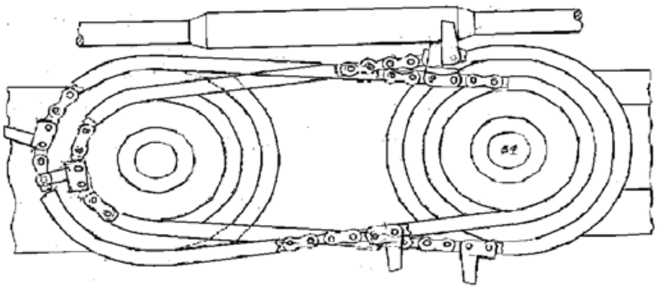

Figure 5: Co-axial sprockets and chains.

Figure 6: The guide profile for rotating wings.

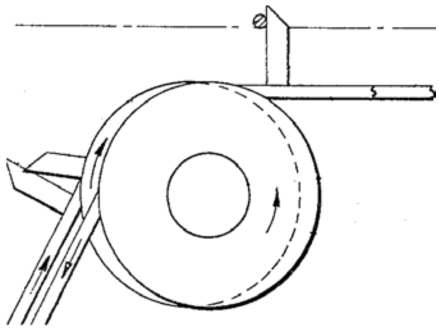

Figure 7: Model of Traversing Assembly.

bring the yarn gradually out of the giver guide and transfer it to the taker guide. While finalizing the guide designs various shapes were practically tried. Some of which have been shown below:

It was finally realized that number of such profiles could be devised.

Hence it was decided to take help of the software (Pro Engineer 4.0) available to design the yarn guide and the profile by actually simulating the situation as it existed on the machine. The traversing assembly was modeled to scale as shown in Figure 7. The blue color line indicates the yarn, which is coming from the supply package mounted at the back of the machine. Just before the yarn enters the traversing guide it passes through a stationery yarn guide. The position of this guide is offset from the yarn guide axis and is 10” above the machine frame which supports the sprockets.

The guides are placed at the beginning and end points of transfer zone as indicated in Figure 8. The yarn, modeled in form of a wire of same diameter as the yarn is also modeled at the initial and final position of the transfer zone. As mentioned earlier also that the top guide in the given system moves from right to left, and the bottom one from left to right.

While carrying out this work, the total transfer zone distance had been divided into equal distances with the assumption that the yarn

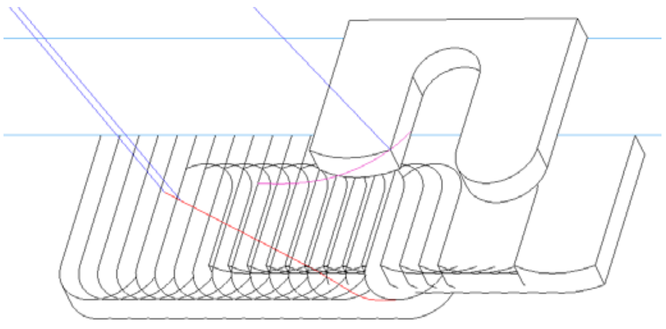

Figure 8: Successive Guide Locations in Transfer zone at the beginning.

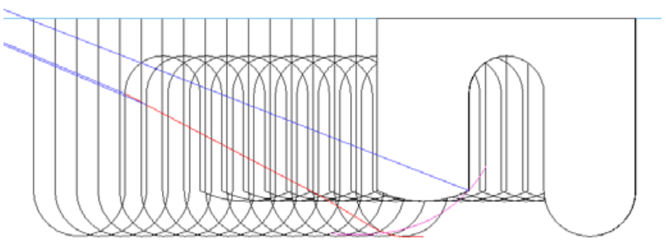

Figure 9: Profiles of Stationary Guides at end of transfer.

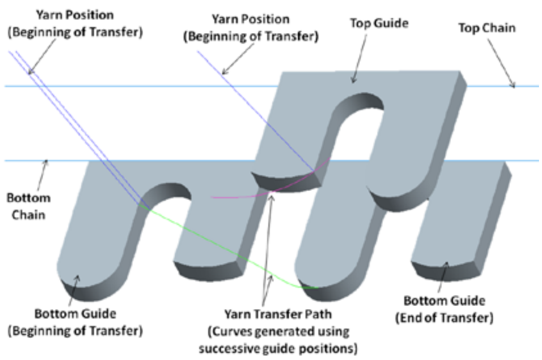

Figure 10a: The extreme left position of the guides in the transfer zone (beginning of the transfer).

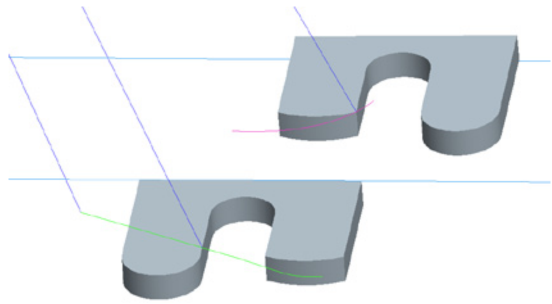

Figure 10b: The intermediate position of the top and bottom guide in transfer zone.

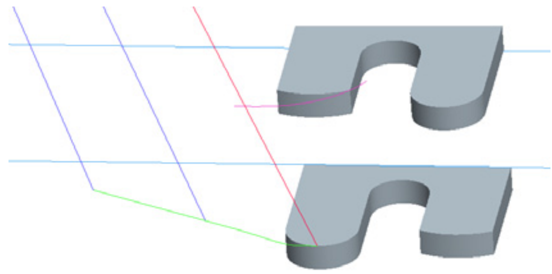

Figure 10c: The extreme right position of the guides in the transfer zone.

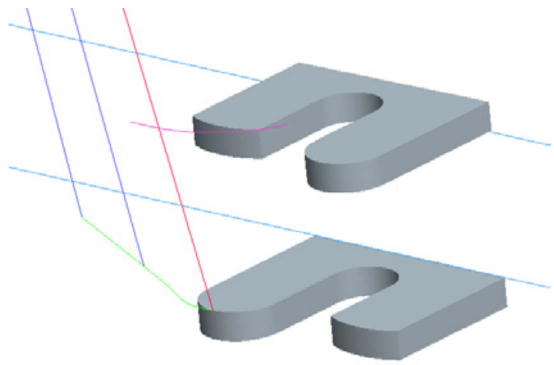

Figure 10d: The same position as 8c only show at a different angle.

will be guided out of the trailing edge of the bottom guide to be taken into the leading edge of the top guide. Guides were located at each of these interval points as shown in Figure 8.

The above figure shows the yarn whose initial position is inside the groove. The yarn would progressively move out to the semi-circular edge of the bottom guide leg if a stationary guide is positioned as indicated by red curve. By this time the yarn would become uncontrolled if the upper guide does not take control of the yarn. For this reason the pink curve, indicating the profile of another stationary guide is made to overlap the red curve. This profile of the upper stationary guide starts to push the yarn inside the groove of the top guide. Moving from left to right the figure 9 is reached which indicates the end of transfer. So in short it can be said that the yarn at the start of the transfer would be pushed out of the lower guide due to the stationery red profile. But the task of pushing the yarn inside the groove of the top guide is done by the pink stationery profile. When this top guide reaches the transfer zone on the left side the same procedure will be followed only this time

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the yarn will be pushed out from the top guide and into the bottom guide.

The points on the red profile, representing the bottom stationary guide, are important from the point of view of distance covered during each interval in order to maintain stability of the yarn. Hence, points are generated on the path to fit a curve. While for the upper stationary guide, maintaining an overlap with the red curve a cubic profile is fitted to guide the yarn into the groove of the top guide.

The figure 10 shows the position of bottom guide at its extreme which is when it reaches the right side, but there is difference in their relative positions which can be clearly seen. The guide is having certain amount of depth, so when guide enters the transfer zone, the profile should be able to move the yarn up to the position indicated in the figure 10, which is up to its tip of the long leg of bottom guide. Now as the yarn travels up to the straight 'U' portion of the guide, the curved profile helps to push the yarn out of the depth of the guide. Figure 10a shows the extreme left position of the guides in the transfer zone (beginning of the transfer).The following figures give an idea about step wise transfer sequence of the yarn in the transfer zone. Figure 10b shows the intermediate position of the top and bottom guide in transfer zone. Figure 10c shows the extreme right position of the guides in the transfer zone. Figure 10d is the same position as 8c only show at a different angle.

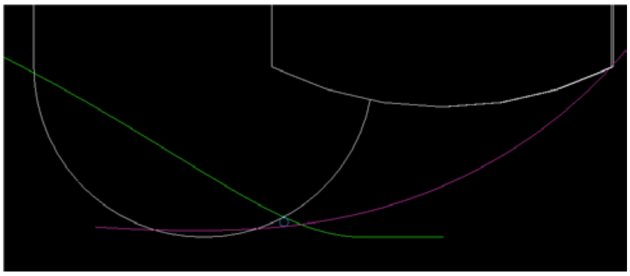

Figure 10e: Top view of the two guides along with the profiles and yarn at the end of the transfer.

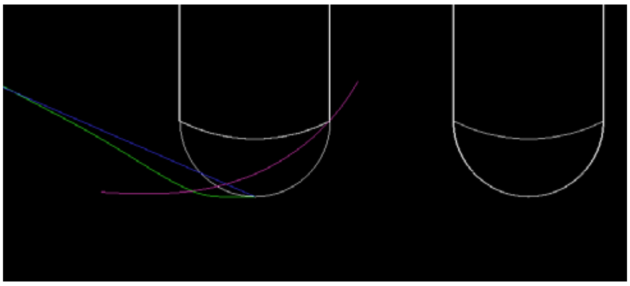

Figure 10f: The position when the guides are exactly one below the other.

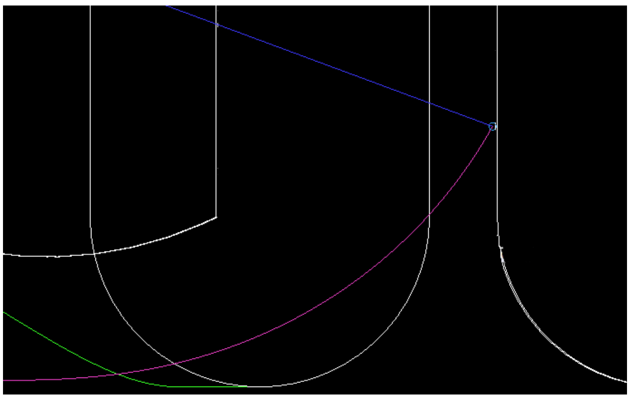

Figure 10g: Position when complete transfer has taken place. The yarn has safely been deposited into the 'U' of the top guide.

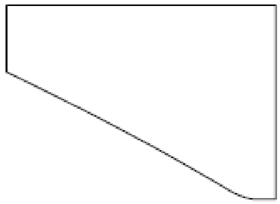

Figure 11: Bottom Stationary Guide.

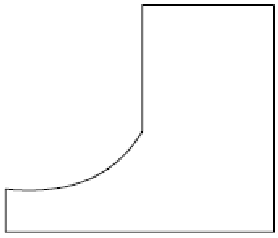

Figure 12: Top Stationary Guide.

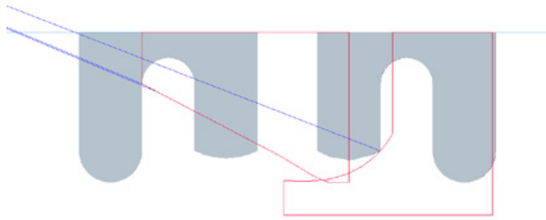

Figure 13: Location of Bottom and Top Stationary Guide.

Figure 10e is the top view of the two guides along with the profiles and yarn at the end of the transfer. The yarn on one side is being guided by the green profile to be pushed outside the lower guide profile whereas the pink guide at the top is guiding it to be pushed inside top guide. Yarn in this position has come in the interference of both the guides. Figure 10f shows the position when the guides are exactly one below the other. Figure 10g shows the position when complete transfer has taken place. The yarn has safely been deposited into the 'U' of the top guide.

Based on the profiles obtained in this form, the bottom and top stationary guides are developed as shown in Figure 11 and Figure 12 respectively.

The positions of the top and bottom guides on the machine to scale are indicated in red in Figure 13 with respect to the bottom and top guides.

Results and Discussions

The scheme with two moving guides poses the problem of uncontrolled yarn during the end of the traverse at the left and right extreme positions. This leads to inconsistency in winding on the bobbin. In order to control the yarn during the extreme positions of direction reversal, the option of providing stationary guides has been developed using ideal positioning of the yarn.

The case of transfer at the right hand side of the traverse is considered and the profile of the stationary guides is developed to move the yarn from the bottom guide into the top guide. The relative position of the guides on the machine is also developed to scale in order to have proper control on the yarn.

The guide profiles are developed considering that the yarn remains taut during transfer of control. The addition of stationary guides leads to additional support point for the yarn between the top stationary guide and the winding point on the bobbin and actually helps in keeping the yarn taut during transfer. However, on account of the elasticity and dynamic forces, the yarn will deflect. To predict the domain of yarn movement requires an in-depth study involving implementation of simulation techniques like monte-carlo simulation with development of a random-order model to find the envelope of movement of the yarn. A flexible profile can be developed and superimposed on the mean profile developed considering the yarn to be taut.

Conclusions

The profile so developed has been found to work for both the two options mentioned. With the guide and tapered profile arrangement though the transfer success rate increased, the yarn came under lot of tension. In the transfer zone the yarn came under the influence of both the stationery profiles exerting pressure in the opposite directions. This problem could not be visualized at the time of simulating, since the work has been done considering the yarn to be a taut wire, which it is not. Therefore during the dynamics of the yarn transfer at the transfer zone, it comes under lot of tension which can lead to change in yarn profile, surface damage along with stretch.

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