

Application No.: 93 102 948.2

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PROCEDURE FOR THE PRECISION CROSSWINDING
OF RIBBON-LIKE OR YARN-LIKE MATERIAL

The invention refers to a procedure for the precision crosswinding of ribbon-like or yarn-like material in which the integrals of the angular velocity (impulses) of the bobbin are recorded by a first sensor and added in a first allocated counter and integrals of the angular velocity (impulses) of the drive for the traversing thread guide are recorded by a second sensor and added in a second allocated counter, the sums of the integrals of the angular velocity are compared with each other and the drive for the traversing thread guide regulated depending on this. At the same time, the invention demonstrates a bobbin winder for executing the procedure. A filamentary material which is to be wound is understood to include, in particular, threads and yarns or ribbons.

A procedure of the aforementioned type is known from US-PS 4 093 146. Here, specific sensors supplying impulses are employed. A transmission is provided between the bobbin drive and the pulse generator, and this determines the bobbin ratio. The impulses registered are used exclusively for triggering a stepping motor which drives the traversing thread guide. The use of a stepping motor serves for altering the width passed over by the traversing thread guide. As a consequence of using a transmission having gear wheels, the winding procedure is encumbered with all the disadvantages which will be explained in detail.

A procedure and a bobbin winder are known from EP-PS 55 849 in which cross winding in staged precision winding is employed. A first speedometer, which detects the bobbin r.p.m. per unit of

time and transmits this to a regulator, is allocated to the bobbin or the bobbin spindle respectively. The drive for the traversing thread guide is also equipped with a speedometer. The two values of the speedometers are compared and fed to a regulator which itself in turn influences the drive for the traversing thread guide. The use of speedometers has various disadvantages. They must be adjusted at regular chronological intervals, they are temperature-dependent when in use and the accuracy with which they maintain a specific bobbin ratio is not perfect. A speedometer is an analogue instrument, the accuracy of which depends on its design and construction.

EP-OS 194 524 also demonstrates a procedure for winding up threads in cross winding with stages precision winding. In order to achieve optimum thread placement on the bobbin, the bobbin ratios must not only be calculated in advance with great accuracy, but they must also be adhered to. As there is a limit to the electrical and electronic measuring and regulating technology for determining the rotational speeds and maintaining the proportion between the drive for the bobbin spindle and the drive for the traversing thread guide, it is proposed that in order to improve the winding build-up, the bobbin ratio be modulated in each winding phase. The modulation width should be less than 0.1%.

In order to illustrate the problem with which the present invention is concerned, attention is to be drawn to the following details:

From the material fed to it, the bobbin winder produces a bobbin which, depending on the construction of the bobbin winder, can have the most diverse forms, as shown in Figs. 1 to 11.

Here, Figs. 1 to 4 show bobbins in parallel winding: the material is wound on in windings lying directly adjacent each other, the angle of the material to be wound on the holder or

bobbin respectively roughly corresponds to the diameter/width of the material to be wound. To prevent the material to be wound from slipping down the sides of such a bobbin, special measures are necessary such as supporting the windings by means of flanges on the bobbin holder, as shown in Fig. 1, and/or by means of a special form of winding build-up, for example, bevelling the front side of the bobbin, as shown in Figs. 2, 3 and 4.

Figs. 5 to 11 show bobbins in cross winding: the material to be wound is placed on the holder or bobbin respectively with a large angle relative to the diameter/width of the material to be wound. In this way, more or less severely rounded change points in the material to be wound occur on the front face of the bobbin. As these are covered by successive windings of the material to be wound, said material is prevented from slipping down the front face. The front faces of the bobbins can also have a special shape for particular application purposes, for example, a bevel, as shown in Figs. 6 and 7.

Neither the holders nor the bobbins need be cylindrical in shape; they can be tapered for example, as shown in Figs. 8 to 11.

A bobbin winder in the main has a spindle, whereby said spindle, i.e. the bobbin spindle, winds up the material, possibly on a bobbin holder if required. Said bobbin winder also has a traversing unit which moves the material to be wound to and fro in the longitudinal direction of the bobbin spindle within a certain range, the wind-on width or stroke.

The bobbin spindle can be driven by means of a circumferential drive on the bobbin forming on the bobbin spindle, as shown schematically in plan and front views in Fig. 12, or by means of a direct drive to the bobbin spindle, as shown schematically in plan and front views in Fig. 13.

With a circumferential drive on the bobbin 2 forming on the bobbin spindle 1 by means of a slubbing roller 4, the constant r.p.m. of the slubbing roller 4 driven by motor 3 inevitably results in a constant circumferential speed for the bobbin and, consequently, an almost constant winding speed for the material to be wound 5.

With a direct drive to the bobbin spindle 9 by means of the motor 10, to reach a constant winding speed for the material to be wound 11, the r.p.m. of the motor 10 must be continuously regulated as the diameter of the bobbin 12 grows.

The rotations of the bobbin spindle 1 or 9 respectively and the linear movement of the traversing thread guide 7 or 13 respectively in the traversing unit 6 or 14 respectively can have differing relations with respect to each other. This results in basic differences in the build-up of the bobbin.

If, as Fig. 12 shows, the traversing unit 6 with traversing thread guide 7 is driven by means of a motor 8 having a rotational speed which is independent of the rotational speed of the bobbin spindle 1, this results in a bobbin build-up according to Fig. 14; this is designated as cross winding with random winding.

The chosen initial slant angle 16 for the material to be wound onto the bobbin holder 17 - beginning of the winding process, winding operation - remains constant until the end of the winding operation, the largest diameter of the bobbin 18 - final slant angle 19 - , the number of windings 20 or 21 respectively on the wind-on width 22 reduces all the time. A bobbin with a different packing density for the material to be wound for each bobbin diameter is the result.

If, as Fig. 13 shows, the traversing unit 14 with traversing thread guide 13 is connected via a transmission to the bobbin spindle 9, for example, by means of a spur gear 15, this results in a bobbin build-up according to Fig. 15; this is designated as cross winding with precision winding.

The initial slant angle 23 for the material to be wound onto the bobbin holder 24 - beginning of the winding operation - decreases all the time up to the end of the winding operation, the largest diameter of the bobbin 25, the number of windings 27 or 28 respectively on the bobbin wind-on width 29 remains constant. A bobbin with a consistent packing density for the material to be wound for each bobbin diameter is the result.

A corresponding ratio of one to-and-fro cycle of the traversing thread guide 13 to the number of revolutions of the bobbin spindle 9 is obtained from the choice of translation for the, for example, spur gear 15 from Fig. 13. The path of the traversing thread guide 13 from one end of the wind-on width 22 (in Fig. 14) to the other end and back again is designated a to-and-fro cycle. The ratio of one to-and-fro cycle to the number of bobbin spindle revolutions is called the bobbin ratio.

The bobbin build-up differs depending on the bobbin ratio selected. For example, Fig. 16 shows, schematically, a bobbin 23 with bobbin holder 24 and several layers of the material to be wound 25 in closed precision cross winding: the material to be wound 25 is placed on the bobbin 23 in the sequence of the points 26 to 32 after each to-and-fro cycle. The points 26 to 32 represent the changes of direction of the material to be wound on one front face of the bobbin 23. The nominal bobbin ratio might be, for example, 1:5 here. In order to establish the actual bobbin ratio, the component which result from the thickness or width of the material to be wound has to be calculated so that the individual layers of the material to be wound lay exactly adjacent to each other instead of only precisely one on top of the other.

As a further example, Fig. 17 shows a bobbin 33 with bobbin holder 34 and some layers of the material to be wound 35 in precision diamond (rhomboidal) winding. The individual layers of the material to be wound 35 are placed here on bobbin 33 in the sequence of the points 36 to 40. The dotted line indicates the sequence in which the material to be wound 35 is placed on the front face of the bobbin 33: beginning at point 36, four further changes of direction are first passed through before the material to be wound 35 is placed at point 37, i.e. before it returns to the area of the starting point, point 36. In addition, during the continuing course of the winding process, a further layer of the material to be wound 35 is placed between points 36 and 37, at point 39. A defined distance (separation) exists between the individual, adjacent layers of the material to be wound. This means that an open build-up of the bobbin bundle is achieved, something that is necessary for dyeing bobbins. The nominal bobbin ratio might be, for example, 1:5.2 here. Once again, in order to establish the actual bobbin ratio, the component which results from the thickness or width of the material to be wound has to be calculated so that the individual layers of the material to be wound lay exactly adjacent to each other as desired instead of only exactly on top of each other.

The component which results from the thickness or width of the material to be wound so that the successive layers of the material to be wound lay exactly adjacent to each other as desired is called the σ -value. With a negative σ -value, a forward-running placement of the material to be wound is obtained, as shown in Fig. 18. The material to be wound on 43 is placed in front of the material already wound 46 onto the bobbin 45 rotating in the direction of the arrow 44. With a positive σ -value, a backward-running placement of the material to be wound is obtained, as shown in Fig. 19. The material to be wound on 47 is placed behind the material already wound 50 onto the bobbin 49 rotating in the direction of the arrow 48.

In order to explain Figs. 21 to 24, Fig. 20 shows a bobbin 51 in cross winding with precision winding having a bobbin holder 52 and rotating in the direction of arrow 53. The material to be wound is placed on the holder with the initial slant angle 54 and, at the outer bobbin diameter, with the final slant angle 55.

Fig. 21 shows a close-up of two directly adjacent ribbons, as an example of the material to be wound, on the bobbin holder with the initial slant angle 56 and a width of ribbon 57. The required σ -value results from these two values.

As was already clear from the description of Fig. 17, two successive layers of the material to be wound need not necessarily lie directly adjacent each other; there can be a gap between, as shown in Fig. 22, or they can - specifically in the case of ribbon - also be arranged partly on top of each other, as is illustrated in Fig. 23 for backward-running placement of the medium to be wound and in Fig. 24 for forward-running placement.

Taking into account the σ -value, the above-mentioned example of the nominal bobbin ratio of 1:5 now gives, for example, an actual, required bobbin ratio of 1:5.13256479834..., and this must be reproduced as accurately as possible by means of, for example, spur gears. In practice, it has been shown that a deviation in the fifth or even the sixth decimal place of the bobbin ratio has a considerable influence on the bobbin build-up.

From these embodiment versions it is clear that the bobbin ratio depends on the targeted bobbin build-up, the width or the thickness respectively of the material to be wound and the dimensions of the bobbin holder and bobbin. Therefore, a positive drive for the bobbin transmission such as the spur gear 15 cited as an example, is as a rule only suitable if all the parameters

mentioned remain unaltered; a modification to even just one of these parameters will in most cases mean that the spur gears in the transmission have to be exchanged, entailing considerable costs, because a bobbin machine can comprise a large number of bobbin winders. Last but not least, such a transmission is only a compromise because in most cases the calculated bobbin ratio cannot be realized using the spur gears which are available.

In order to solve the problems which have been mentioned, a controlling mechanism, for example, a conoid gear, is often employed as a bobbin transmission in practice, as is schematically illustrated in Fig. 25. The bobbin ratio can be varied continuously within certain limits by lateral displacement of the flat belt 62 on the two conical pulleys 63 and 64 working in opposing directions. The disadvantageous effect with this transmission is that it is non-positive and, hence, is afflicted by slip, and is, therefore, not sufficiently accurate. Setting to the necessary accuracy can only be guaranteed on rare occasions and can hardly ever be transmitted to all the bobbin winders of a bobbin machine, which can comprise a great number of bobbin winders. In addition, the tight limits, within which the bobbin ratio can be varied, have a disadvantageous effect.

Newer techniques measure the r.p.m. of the bobbin spindle and traversing unit, compare the measured r.p.m. ratio with the required bobbin ratio and readjust the, for example, conoid transmission, correspondingly upon reaching a certain value for the deviation in the r.p.m. The same method is also employed if the traversing unit is driven by means of a separate motor instead of a conoid transmission. Therefore, in order to implement the readjustment, a certain deviation in the r.p.m. between target and actual value must first be reached. Until the permissible r.p.m. deviation is reached and afterwards until by controlling coincidence of target and actual value is reached, winding will consequently take place with an inaccurate bobbin

ratio which, even if not over the entire bobbin, leads to a poor bobbin build-up over at least some of the bobbin diameter ranges.

In order to demonstrate the size of the error with this known method, let it be assumed that the ratio between the r.p.m. of the bobbin spindle drive and the r.p.m. of the traversing unit drive exhibits the typical permissible deviation of 1 o/oo. With a rotational speed for the traversing unit drive of, for example, 3000 r.p.m., this results in an error of up to 3 r.p.m. If the winding operation takes, for example, 12 hours, then this gives an error of up to 2160 revolutions or up to 777,600 angular degrees.

It is the object of the invention to make available a procedure of the aforementioned type in which bobbin ratios can be realized and maintained with an accuracy of at least seven decimal places.

According to the invention, this is achieved with a procedure of the aforementioned type in that the impulses of the first sensor and the impulses of the second sensor are added each in their allocated counters during the entire winding operation, and that the ratio of sums so produced are constantly compared with one or more successive, preselectable bobbin ratios, and that the drive for the traversing thread guide is regulated in such a way that the ratio of the sums of the two allocated counters corresponds to the predefined bobbin ratio or ratios respectively during the entire winding operation.

According to the invention, the analogue, instantaneous detection of the rotational speeds of the drives is replaced by digital detection (impulse registration). This means that, during a winding operation, no error in the bobbin ratio deviation is added accumulatively but, on the contrary, the regulation is carried out in such a way that this error is

eliminated and the exact, precalculated bobbin ratio is maintained precisely over the entire winding operation. Thus, the theoretically necessary yarn length is achieved exactly and in fact over the entire bobbin build-up. The achievable accuracy is considerably greater than, for example, with expensive, continuously variable transmissions. The procedure can also be carried out relatively more easily and all the disadvantages linked with the use of gear wheels are in any case eliminated. The number of bobbin ratios which can be realized is almost infinite.

A multiplicity of angular velocity integrals (impulses) are processed per revolution of the bobbin and per revolution of the drive for the traversing thread guide. The accuracy rises due to the increase in the number of impulses. For example, 1024 impulses can be generated and processed per revolution. The drive for the traversing thread guide can be regulated in such a way that an accuracy of $\pm$ angular degree (corresponding to 3 impulses) is permissible or is compensated for, respectively.

The integrals of the angular velocities of the bobbin spindle and the traversing thread guide, i.e. the angular steps (impulses), are recorded individually, in sufficiently high resolution, through separate addition of all impulses from the bobbin spindle drive and the drive for the traversing thread guide recorded during a winding operation. The counters used are independent of each other and can be designed as hardware and/or software counters. Using a computer, which influences the drive for the traversing thread guide via a regulator, the summation ratios are constantly checked for coincidence with the selected bobbin ratio. The influencing or the control respectively ends as soon as the ratio of the sums of the two counters once again corresponds to the bobbin ratio.

According to the invention, the bobbin winder for executing the procedure is characterized in that the pulse generators are provided as sensors, that counters are arranged downstream of the pulse generators, that a computer is provided for processing the counts of the two counters, and that said computer is connected to the regulator for regulating the drive for the traversing thread guide. The counters have adequate capacity for the entire winding operation.

The main elements of a bobbin winder are illustrated schematically in Fig. 26. A front view and a plan view are illustrated with the bobbin spindle 65, the bobbin 66, the drive motor 67 for the bobbin spindle, the first allocated sensor 68, the first allocated counter 69, the traversing unit 70, the traversing thread guide 71, the material to be wound on 72, the drive motor 73 for the traversing unit, the second allocated sensor 74, the second allocated counter 75, computer 76 and the regulator 77.

At the start of a winding operation, the two allocated counters 69 and 75 have the value 0. As soon as the drive motor 67 sets the bobbin spindle 65 rotating, the first allocated counter 69 receives, for example, 1024 impulses per revolution of the bobbin spindle from the first allocated sensor 68 and registers them. Directly after the bobbin spindle begins to rotate, the second allocated counter 75 still has the value 0. As soon as the computer 76 evaluates the value of the first allocated counter 69, it places this in the ratio to the value of the second allocated counter 75 and compares this ratio with the predefined bobbin ratio. As a deviation is inevitably present here, the computer immediately activates the regulator 77. This thereupon triggers the drive motor 73, whereupon the second allocated counter 75 also receives, for example, 1024 impulses per revolution of the drive for the traversing unit 70 from the second allocated sensor 74. This value is again picked up by the computer which evaluates it as described previously and synchronizes the drive for the traversing unit 70, via the

regulator 73, in the sense of the desired bobbin ratio. This procedure is repeated constantly, in fact with a clock rate which only permits a deviation from ± 0.35 to max. 1 angular degree. As the impulses of the two allocated sensors 68 and 74 are added accumulatively and constantly in the two allocated counters 69 and 75 during a winding operation, and these sums are evaluated by the computer 76 and compensated for in the sense of the predefined bobbin ratio via the regulator 77 and the drive motor 73 for the traversing unit 70, a one-off error occurring within the limits from ± 0.35 to max. 1 angular degree is corrected immediately; the deviation between target and actual bobbin ratio is, therefore, at no time during the winding operation greater than ± 1 angular degree. Almost any accuracy of bobbin ratio can be represented by appropriate dimensioning of the microprocessor(s) which is/are integrated in the computer 76; the bobbin ratio does not depend on the usage of any particular parts, for example, spur gears, it can correspond to the calculated value.

LIST OF REFERENCE NUMERALS

- | | |
|---|--|
| 1 - Bobbin spindle | 11 - Medium to be wound |
| 2 - Bobbin | 12 - Bobbin |
| 3 - Motor | 13 - Traversing thread guide |
| 4 - Drive roller | 14 - Traversing unit |
| 5 - Medium to be wound | 15 - Spur gear |
| 6 - Traversing unit | 16 - Initial slant angle |
| 7 - Traversing thread guide | 17 - Bobbin holder/tube |
| 8 - Motor | 18 - Bobbin |
| 9 - Bobbin spindle | 19 - Final slant angle |
| 10 - Motor | 20 - Windings |
| 21 - Windings | 31 - P. of change of direct.
for material to be wound |
| 22 - Wind-on width | 32 - P. of change of direct.
for material to be wound |
| 23 - Bobbin | 33 - Bobbin |
| 24 - Bobbin holder/tube | 34 - Bobbin holder/tube |
| 25 - Medium to be wound | 35 - Medium to be wound |
| 26 - Point of change of direction
for material to be wound | 36 - P. of change of direct.
for material to be wound |
| 27 - Point of change of direction
for material to be wound | 37 - P. of change of direct.
for material to be wound |
| 28 - Point of change of direction
for material to be wound | 38 - P. of change of direct.
for material to be wound |
| 29 - Point of change of direction
for material to be wound | 39 - P. of change of direct.
for material to be wound |
| 30 - Point of change of direction
for material to be wound | 40 - P. of change of direct.
for material to be wound |

- | | |
|---|---|
| 41 - Point of change of direction
for material to be wound | 51 - Bobbin |
| 42 - Point of change of direction
for material to be wound | 52 - Bobbin holder/tube |
| 43 - Medium being wound on | 53 - Arrow showing direction
of rotation |
| 44 - Arrow showing direction | 54 - Initial slant angle |
| 45 - Bobbin | 55 - Final slant angle |
| 46 - Medium already wound on | 56 - Initial slant angle |
| 47 - Medium being wound on | 57 - Width of ribbon |
| 48 - Arrow showing direction | 58 - σ -value |
| 49 - Bobbin | 59 - σ -value |
| 50 - Medium already wound on | 60 - σ -value |
| 61 - σ -value | 71 - Traversing thread guide |
| 62 - Flat belt | 72 - Medium being wound on |
| 63 - Pulley | 73 - Drive motor |
| 64 - Pulley | 74 - Second allocated sensor |
| 65 - Bobbin spindle | 75 - Second allocated counter |
| 66 - Bobbin | 76 - Computer |
| 67 - Drive motor | 77 - Regulator |
| 68 - First allocated sensor | |
| 69 - First allocated counter | |
| 70 - Traversing unit | |

C L A I M S :

1. Procedure for the precision crosswinding of ribbon-like or yarn-like material in which the integrals of the angular velocity (impulses) of the bobbin are recorded by a first sensor and added in a first allocated counter and the integrals of the angular velocity (impulses) of the drive for the traversing thread guide are recorded by a second sensor and added in a second allocated counter, the sums of the integrals of the angular velocity are compared with each other and the drive for the traversing thread guide regulated depending on this, wherein the impulses of the first sensor and the impulses of the second sensor are added each in their allocated counters during the entire winding operation, and the ratio of sums so produced is constantly compared with one or more successive, preselectable bobbin ratios, and the drive for the traversing thread guide is regulated in such a way that the ratio of the sums of the two allocated counters corresponds to the predefined bobbin ratio or ratios respectively during the entire winding operation.
2. Procedure according to claim 1, wherein a multiplicity of angular velocity (impulse) integrals are processed per revolution of the bobbin and per revolution of the drive for the traversing thread guide.
3. Procedure according to claim 2, wherein 1024 impulses are generated and processed per revolution.
4. Procedure according to one or several of the claims 1 to 3, wherein the drive for the traversing thread guide is regulated with an accuracy of ± 1 angular degree.



5. Bobbin winder for executing the procedure according to one or several of the claims 1 to 4, having a drive (67) for the bobbin (66), a first allocated pulse generator (68), a topped counter (69), a drive (73) for the traversing thread guide (71), a second allocated pulse generator (74) and a topped second counter (75), and having a regulator (77) for processing the signals of the two sensors in order to regulate the drive (73) for the traversing thread guide (71), wherein the counters (69, 75) have a sufficient capacity for the entire winding operation, and a computer (76) permanently sets into ratios the occurring total counts of both counters and compares them with pre-selectable bobbin ratios, and is connected to the regulator (77) for regulating the drive for the traversing thread guide (71).

