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ATTORNEYS
PROCESS AND APPARATUS FOR REDUCING YARN WASTE IN DRAW-TWISTERS

Figure 2a

Figure 2b

Figure 2c

Figure 2d

Figure 3a

Figure 3b

Figure 3c

Figure 3d

Figure 4a

Figure 4b

Figure 4c

Figure 4d

Figure 5a

Figure 5b

Figure 5c

Figure 5d

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This invention relates to a process and apparatus for reducing yarn waste in draw twisters. More particularly, this invention relates to a process and apparatus for reducing yarn waste during the starting and stopping phases of operation of a draw twister.

In the process of drawing continuous synthetic filaments, maintaining the process conditions constant is of utmost importance with regard to the quality of the end product. However, in using a draw twister in the process, the drawing speed, the retention times on heating, the preparation devices or on other devices improving thread cohesion, and the yarn balloon tension during the starting and stopping periods of the draw twister differ considerably from the same respective conditions during the production period of the draw twister. Consequently, it has been necessary during the starting and stopping periods, especially in the case of heat-drawn filaments, that the yarn which is treated under unsatisfactory production conditions be wound as a waste product at a separate location from the yarn package. This resultant waste product, however, not only is costly due to the amount of yarn lost in the process but also is costly since such requires periodic removal as well as the maintenance of more or less automatic waste removal systems.

Hereinafter, attempts have been made to reduce the amount of waste in draw-twisters by shortening the starting and stopping periods through the use of powerful oversized drives and braking devices. However, such attempts have had the following drawbacks:

(a) The initial cost of the oversized drives has been unnecessarily high while the drives have seldom been used at full capacity during the production period. This has been especially true in the case where separate drives are used for the delivery mechanism and for the spindles and wherein the spindles with their higher moment of inertia are preferably actuated by a variable motor, for example a D-C motor which is of itself expensive.

(b) The reduction of the stopping period through reinforcement of a central braking device and the drive has been limited by the maximum braking couple that can be transmitted without slippage to the spindles through the spindle drive belts. In order to obtain a more extensive reduction, individual spindle brakes which are centrally controlled have been used. However, on account of the large number of spindles, such a use of individual brakes has been very expensive.

(c) The reduction of the starting and stopping periods by intense acceleration or braking of the spindles including the spindle drives has resulted in increased stresses in the twister machine as a whole which have been detrimental to the life of the machine.

Further, it has been known to reduce the amount of waste generated during the starting and stopping periods by actuating the delivery mechanism feeding the yarn to the spindles later than the spindles or by stopping the delivery mechanism prior to stopping of the spindles. However, the results of such measures have been strictly limited due to the fact that the yarn, as a result of the extensive over-twisting occurring during the stoppage of the delivery mechanisms, tends to roll laterally off the drawing rolls and to crinkle. Therefore, the time interval between the starting and stopping the delivery mechanism and spindles must remain very small.

Accordingly, it is an object of the invention to reduce the amount of waste during the starting and stopping of a draw-twister.

It is another object of the invention to increase the drawing-in time of yarns on a draw-twister without exhausting the waste take-up capacity of the spindles.

It is another object of the invention to prepare a number of successive yarn packages on a spindle of a draw-twister without removal of waste from the spindle.

It is another object of the invention to reduce the amount of waste in a draw-twister in a relatively inexpensive manner.

It is another object of the invention to reduce the waste in a draw-twister without detrimentally affecting the life of the ring twister.

It is another object of the invention to reduce the waste in a draw-twister without unduly substantially over-twisting the yarn.

It is another object of the invention to reduce the waste in a draw-twister in the starting and stopping periods by increasing the ratio of the spindle speed with respect to the delivery speed.

Briefly, the invention provides a process for reducing the amount of waste in draw-twisters during the starting and stopping phases of the draw-twisters. The process includes the feeding of a yarn to a rotating spindle during the starting period at a delivery speed which varies at a rate with respect to the spindle speed such that the rate decreases from a value which is below the critical value of the yarn twist (e.g. a critical value of about 700 turns per meter of yarn produced) and at a multiple of the production speed. During the starting period both the delivery speed of the yarn and the spindle speed rise or fall at constant rates. By controlling the ratio of these speeds the amount of waste prior to and after formation of a yarn package is kept to a minimum.

In one embodiment, as the spindle speed increases to the production speed at a constant acceleration rate, the yarn delivery speed is brought from rest to a low speed and held constant. After a time delay, the yarn delivery speed is again increased at a constant rate up to the production speed. The respective speeds of the yarn delivery and spindles are held to a ratio of spindle speed to delivery speed which varies at a rate which at first increases at a constant rate up to a given rate limit and then decreases at a constant rate until production of a package is started. During stopping of the machine, this ratio variation is followed in a reverse sequence. Also, the ratio of speeds during starting and stopping is maintained above the ratio of
speeds existent during production of the yarn package but at all times below the critical speed ratio of the yarn.

In other embodiments, the yarn delivery speed and spindle speeds are initially running at a low constant speed before the above described cycles are started and are run-down to such low speeds upon breaking of the machine. Also, in some embodiments, the delivery speed instead of being increased to a low constant speed at the start, is gradually increased at a low constant rate and then is rapidly increased at a high constant rate to the production speed. In all these embodiments the sequence of speeds of the delivery mechanism is conducted in a reverse manner during the stopping of the machine.

The apparatus of the invention which is incorporated into a draw-twister having a delivery mechanism for feeding the yarn to a spindle and a drive mechanism for driving the spindle and delivery mechanism includes a means for driving the delivery mechanism at a reduced speed during portions of the starting and stopping periods. This means for driving the delivery mechanism is activated at predetermined times, so that the rate of delivery speed can be varied with respect to the delivery speed to effect the waste reduction.

In one embodiment of the apparatus, the delivery mechanism is driven by a separate motor from the spindles.

In addition, an auxiliary drive is provided to drive the delivery mechanism at reduced speeds during the initial phase of the starting periods and during the later phase of the stopping periods. In other embodiments, various drives are provided to run the delivery mechanism at various selected constant speed levels while the spindles are driven by separate drives or by the same drive through independent gearing. In all these embodiments, suitable switching controls are used to activate the respective drives to drive the delivery mechanism and spindles at the required speeds according to the various process embodiments of the invention.

Apart from the actual reduction in the amount of waste, other advantages are obtained by the invention.

For example, with a slow intermediate period, that is, at creep rate, the creep time during which the yarn is initially drawn in can be substantially lengthened until the yarn take-up capacity for the waste is exhausted. This allows a longer time period for drawing-in of the yarn and, thus, the threading or drawing-in of the yarn on the spindles of the twister can be effected by less personnel. Further, where the drawing-in of the yarn is not accomplished during a slow intermediate period, the amount of waste wound up, for example, on a waste cone, adjacent the yarn package can be kept low. This provides a greater take-up capacity on the waste cone for the next yarn package which capacity is sufficient to permit production of several yarn packages without any need for removal of the accumulated waste between successive production packages.

These and other objects and advantages of the invention will become more apparent from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

FIG. 1 schematically illustrates a conventional draw-twister;

FIGS. 2a to 2d graphically illustrate the chronological sequence of the delivery speed, spindle speed, ratio of spindle speed to delivery speed, and amount of waste generated per unit of time during the starting and stopping periods of conventional draw-twisters;

FIGS. 3a to 3d graphically illustrate the same chronological sequence as in FIGS. 2a to 2d of a conventional draw-twister using a delivery mechanism actuated independently of the spindle;

FIGS. 4a to 4d graphically illustrate the same chronological sequence as in FIGS. 2a to 2d of a draw-twister utilizing the process of the invention;

FIGS. 5a to 5d graphically illustrate the same chronological sequence as in FIGS. 4a to 4d of the draw-twister operated with an intermediate period in which the draw-twister runs at a reduced constant speed according to the invention;

FIGS. 6a to 6d graphically illustrate the same chronological sequence as in FIGS. 4a to 4d of a draw-twister having a delivery speed proportional to the spindle speed during starting and stopping according to the invention;

FIGS. 7a to 7d graphically illustrate the same chronological sequence as in FIGS. 5a to 5d of the draw-twister operating with an intermediate period of reduced constant speeds and with starting and stopping periods wherein the delivery speed is proportional to the spindle speed;

FIG. 8 schematically illustrates a draw-twister having an apparatus of the invention;

FIGS. 8a and 8b illustrate respective modifications of the apparatus of the invention;

FIGS. 9 to 13 schematically illustrate other modifications of the apparatus of the invention,

FIG. 14 illustrates a comprehensive circuit diagram for actuation of various switches in the various embodiments of the invention.

In order to clarify the understanding of the invention reference will be made to a conventional draw-twister as shown in FIG. 1. In this draw-twister, a yarn 1 in the form of an undrawn endless filament or a strand of continuous filaments is drawn off a package 2 by means of feed rollers 3 and fed to a drawing area formed by drawing rollers 4 which run at a greater speed than the feed rollers 3. The feed rollers 3 and drawing rollers 4 are driven at a fixed ratio with respect to each other and together constitute a delivery mechanism 5. A motor 6 drives both the feed rollers 3 and drawing rollers 4 through a gear box 7. During operation, the yarn 1 is transmitted by the drawing rollers 4 at a delivery speed \( V_d \), via a yarn guide 8 to a traveller 9 of a vertically reciprocal ring 10 disposed around a spindle 11. The yarn 1 is then wound onto a bobbin 12 mounted on the spindle 11 or onto a waste cone 13 situated beneath the bobbin.

The spindles 11 are driven by a drive pulley 14 via a belt 15, the drive pulley 14 being secured on a spindle drive shaft 16 which runs longitudinally of the machine and which is driven by the motor 6 through connection with the gear box 7. As a rule, in starting the draw-twister, the waste yarn is first wound onto the waste cone 13 on the spindle 11 and, in stopping or running-out of the draw-twister, is wound either onto an upper collar 19 on the bobbin which is separated from the yarn package or again onto the waste cone 13.

Referring to FIGS. 2a to 2d, the ratio of the spindle speed \( n_s \) to the delivery speed \( V_d \) (FIG. 2c) during the starting period, \( A = t_1 \) to \( t_2 \) and in the stopping period, \( B = t_3 \) to \( t_4 \), is constant and identical to the one during the production period, \( P = t_2 \) to \( t_4 \). The amount of waste, \( Ab \), as illustrated in the shaded area in FIG. 2d, can be reduced only if the production period \( P \) could be extended to the maximum possible, for instance, to \( P_1 \). However, certain deviations from normal process conditions would have to be accepted. While such deviations in some cases, such as the cold-drawing of nylon, could possibly be acceptable; such deviations would not be admissible under normal conditions, for instance in the case of heat-drawn filaments.

In those cases where the delivery mechanism has been engaged later than the spindle drive and disengaged prior to the disengagement of the spindle drive, a clutch 17 as illustrated in dot-and-dash lines in FIG. 1 has been used to carry out these steps by a delayed engaging or premature disengaging. Another solution consists in actuating the delivery mechanism 5 by means of a separate motor 18 likewise shown by a dot-and-dash line in FIG. 1. These embodiment variants correspond to the diagrams of FIGS. 3a-d. In view of the fact that, during the delay, D, after which the delivery starts for reasons further detailed below (FIGS. 3a-b), the traveller 9 rotated and the threaded-
through yarn 1 is, as a result of the absence of delivery, twisted only. This duration D must be short enough so that the resultant twist in the section of the yarn FS between the drawing roller 4 and the traveller 9 will not exceed the critical ratio above which the normal course of the yarn and the drawing roller 4 would be disturbed. The delay in the start of the delivery is thereby greatly limited and the amount of waste resulting during starting can thereby only be reduced to a limited extent unless an extension of the production phase to P1 is also accepted as admissible.

In the case where separate drives for the delivery mechanism and the spindles are used through respective motors 6 and 18 (FIG. 1), the acceleration period A2 of the spindle can—due to the low inertia of the spindle and their drive mechanism, and especially if a variable, not over-dimensionalized drive motor is used for the spindle drive—on account of the mentioned critical ratio, exceed the acceleration period A1 of the delivery mechanism by the period D only. On account of the impairing of the course of the yarn, elongation in the delivery speed speeded up will but the acceleration A2 must also be increased. In other words, if A2 is increased to A2', then, necessarily, A1 must also be extended to A1'. However, in this case, until the onset of the production period P there again a greater amount of waste is generated if an extension of the production period P to P1 is unacceptable.

In view of the fact that the shortest possible braking period B2 (FIG. 3b) of the spindles 11 is also obtained in the case of a separate drive of the delivery mechanism and the spindle by the maximum braking couple transmittable via the drive belts, and since, in theory, the delivery mechanism must after the braking period B1 (FIG. 2a) come to a stop simultaneously with the spindles or, if necessary, practically only after a very brief and negligible delay prior to the stoppage of the spindles, it is also not possible to reduce the amount of waste occurring during the stopping period when an extension of the production period P to P1 is unacceptable.

Referring to FIGS. 4a to 4d, in the process of the invention, during the first and very short phase A0 (from t1 to t2) of the starting period A1 of the delivery mechanism and A2 of the spindles (FIGS. 4a-b), the delivery mechanism is accelerated substantially proportionally to the spindles in such a way that the ratio n0/V0 of the speed at the beginning of the delivery mechanism reaches a higher value than the one achieved during the production period P and remains constant for a short period until t2 (FIG. 4c). During this second, substantially longer phase from t2 to t4 of the spindle starting period A3 (FIG. 4b), the delivery speed V0 is held constant and the acceleration of the delivery mechanism in the third part of the starting period (from t2 to t4) at maximum possible acceleration to operating speed at the onset of the production period P, at the moment t5. The delivery speed V0 during the second phase of the starting period from t5 to t6 and the duration of the acceleration D must be limited so that the speed at the end of the delivery speed, until then reaches a higher value than the critical ratio K = n0/V0 shown in FIG. 4c at no time exceeds the critical ratio of K = n0/V0 with regard to the overtwisting of the yarn. With regard to most yarn counts, the critical ratio K has a value corresponding with a yarn speed of 700 turns per meter.

During the braking period B1 of the delivery mechanism and B2 of the spindles (FIGS. 3a-b), the above-mentioned process occurs in reverse sequence. Following a braking of the delivery mechanism, at a maximum possible speed, in the first part (t5 to t6) to a lower speed, the delivery mechanism is actuated constantly at that speed in the second part (t6 to t7) to t1 and in the third part of the starting period, from t1 to t3, is disconnected and braked proportionally to the spindle speed until stoppage. The obviously smaller amount of waste resulting therefrom is shown shaded in FIG. 4d.

The same procedure as above is followed in accordance with FIGS. 5a to 5d where the draw-twister machine continues to be actuated at a slower speed (creep rate) in an intermediate period Cr between the purpose of performing the operation procedures. In that case, the delivery mechanism and the spindles are actuated at constant speed during the period Cr1 or Cr2, respectively, in such a way that the ratio n0/V0 in these periods Cr1, Cr2 will be higher than the ratio during the production period P. This period Cr1 or Cr2 may of course be interrupted by a stoppage (not shown).

The acceleration from the intermediate period Cr1 or Cr2 to the production period P and the braking from the latter one to the period Cr1 or Cr2 occurs, as in the case above, in accordance with the critical ratio of K. In this case, however, the delivery speed V4 after the interval t2 or before the interval t0, and with respect to the spindle speed n0 after t2 or prior to t2 (FIGS. 5a, b).

Referring to FIGS. 6a to 6d and 7a to 7d, the process of the invention can be varied in that the delivery mechanism in a first part starts, in contrast to the intermediate period A1, accelerated out of its stopped condition (FIG. 6a) or out of a lower constant delivery speed (creep rate) (FIG. 7) of an intermediate period Cr1 in proportion to the spindle in such a way that the ratio n0/V0 is constant and at a multiple above the ratio n0/V0 of the production period P (FIG. 6c and 7c, respectively) and below the critical ratio of K. In the second phase (t4 to t5) of the starting period A1, an acceleration, as described above, occurs to production speed. The braking following the production period P likewise occurs as described above, whereby the speed of the delivery mechanism V4 in the first phase (t4 to t5) of the stopping period B1 is quickly lowered, and in the second phase (t5 to t6) is lowered proportionally to the spindle speed in such a way that the ratio n0/V0 is kept constant at a multiple of the ratio during the production period P. This speed reduction is continued until t6 (FIG. 6e), that is, until stoppage of the delivery mechanism and the spindles or (FIG. 7a) until the beginning of an intermediate period Cr1 at the moment of t0, during which the machine is operated at reduced speed.

The illustrated modes in accordance with the invention of the increase in the ratio n0/V0 during a substantial part of the starting and stopping periods A and B to a multiple of the ratio due to the delivery speed and thereby examples of the possible course of the curve which course, according to prevailing conditions, can be adapted as desired within the scope of the invention.

Referring to FIG. 8, a draw-twister equipped for the execution of the process described according to FIGS. 4 and 6 has a draw-twister 21, a drive motor 22 and a drive motor 23 for spindles 24. The machine has an additional auxiliary motor 25 which actuates a feed roller 28 via an electrically driven clutch 27. The drive motor 23 is started by n4 at closing of the switch C1. During the first part of the starting period A1, in other words during the period t6 to t7 (FIGS. 4a, b) or of the starting period A2 (FIG. 6e), the clutch 27 is engaged through the closing of the switch C3, and the auxiliary motor 25 drives the delivery mechanism 22 comprising the feed roller 28 and the delivery mechanism gear 29 including the drive for the drawing rollers 30. The delivery mechanism motor 21 which is disconnected through the opening of the switch C3 runs along in idle condition (see also FIG. 14).

During the last part of the starting period A2, that is, in the interval t5 to t4 (FIG. 4c) or t6 to t7 (FIG. 6a) the delivery mechanism motor 21 is connected by the closing of the switch C2, the auxiliary drive 25, 26, 27 is disengaged or overrun by the opening of the switch C2 and the delivery mechanism is rapidly accelerated to full operating speed speed until the production period whereby the ratio n0/V0 of the spindle speed to the delivery speed drops to the value desired for the product. Through a lifting of the rings 10 out of the waste cone position (illus-
trated in dash-and-dot line in FIG. 8), the yarn 1 is wound onto the bobbin 12 at the beginning of the production period P and the package 20 is built up in customary fashion.

Following termination of the production period P, at the beginning of the running-down phase B1 or B2, the spindle drive motor 23 is disconnected by opening of the switch C2 at the moment (FIG. 4c) and t2 (FIG. 6e) and the spindles are braked by means of a known braking device (not shown). At the same time, the delivery mechanism motor 21 is disconnected by the opening of the switch C3 and the delivery mechanism 22, through the effect of the yarn drawing forces or additionally after closing of the switch C5 and engaging of the clutch 27 by the gear 26, is braked in such a way that the lower speed of the auxiliary drive is reached. Thereupon the delivery mechanism 22 continues to be actuated at this speed by the auxiliary drive 25, 26, 27 (FIG. 4e-d) or is further slowed down proportionally to the speed of the spindle (very fast V4) in such a way that the ratio n2/V4 will always amount to a multiple of the ratio during the production period P.

In using the process as illustrated in FIG. 4, the auxiliary motor 25 is constructed as a standard asynchronous motor and the gear 26 as a reduction gear, the reduction ratio of which can be adjusted through change gears. With regard to other modes of the procedure, for instance those illustrated in FIG. 6, the auxiliary drive is provided with a variable speed motor 31 (FIG. 8a), preferably a direct-current motor, and a gear 32 with a fixed reduction ratio. Also, an asynchronous motor 33 connected to a gear 34 (FIG. 8b) that is infinitely variable during operation, can be used. The clutches 27 can be designed as overriding clutches or as controlled, preferably electromagnetically, engageable and disengageable clutches or even as controlled slip clutches.

Referring to FIG. 9, another device for the execution of the process according to FIGS. 4 to 6 has a delivery mechanism drive motor 35 which is operated as a two-speed pole-reversible motor by means of switches C2 and C3. In its lower speed (switch C3), the drive motor 35 drives as an auxiliary drive the delivery mechanism via a gear 36 designed as a change gear for the mode of operation illustrated in FIGS. 4 and 5. With respect to the type of process illustrated in FIG. 6, the gear 36 is designed so that its speed is infinitely variable during operation. For the last part of the starting period, the motor 35 is changed over to the higher speed (switch C3, C2 open) so as to accelerate the delivery mechanism 37 as a main drive until the onset of the production period P. The drive of the spindles is effected in the same manner as with the devices illustrated in FIG. 8 and is not further described.

Following completion of the production period P, the spindle drive motor 38 is disconnected by opening of the switch C2 and the spindles are braked. At the same time, the delivery mechanism motor 35 drives as a main drive by a change in the gear 36 (C2 closed, C3 open) that the n2/V4 ratio increases to a multiple of the ratio during the production period. Where the gear 36 is designed as an infinitely variable reduction gear (FIG. 6), the delivery speed is proportionally reduced according to FIG. 6e so that the ratio n2/V4 remains constant until the stopping of the machine.

While the above description relates to devices for the execution of the process on draw-twisters having separate drives for the delivery mechanism and the spindles, the following describes devices for draw-twisters having only a single main drive motor.

Referring to FIG. 10, an asynchronous main drive motor 39 is used to actuate the ring twister via a reduction gear 40 which serves for the adjustment of the machine speed. The spindles 41 are driven directly from the reduction gear via drive belts 42 and a shaft 43, whereas the drive 44 of the delivery mechanism is engaged or disengaged during operation through a clutch 45 by means of switch C3. In addition, an auxiliary drive delivery mechanism comprising an auxiliary motor 46, gear 47 and clutch 48 is designed identically to the arrangement illustrated in FIG. 8 for driving the delivery mechanism and therefore is not further described.

In operation, during the first part of the starting period A, the delivery mechanism is disengaged from the main drive motor 39 by opening of clutch 45 (switch C2 open) and is driven at a constant reduced speed by the auxiliary drive 46, 47, 48 (switch C2 closed) according to FIG. 4e, or proportionally to the increasing spindle speed according to FIG. 6e. During the last part of the starting period A, the clutch 45 is engaged (switch C2 closed) and the delivery mechanism is rapidly brought to full operating speed through the drive 44 while the auxiliary drive 46, 47, 48 is overrun or disengaged by means of the clutch 48.

Similarly, during the stopping period B, the main motor 39 is disconnected (switch C2 open) and the spindles 41 are braked. At the same time, the clutch 45 is disengaged (switch C2 open) whereas the delivery mechanism is slowed down to such an extent by the yarn draft forces that its actuation is taken over by the auxiliary motor 46 in the manner described above.

Referring to FIG. 11, the drive can also be laid out without an auxiliary motor to run the delivery mechanism and the spindles according to the programs shown in FIGS. 5 and 7. In this case a motor 49 which is pole-reversible, for example, by means of switches C2 and C3 drives the spindles via the gear 50 at its lower speed (switch C2 closed) at the reduced spindle speed during the creep rate intermediate period Cr (corresponding to FIGS. 5 and 7) between two production periods. At its upper speed (switch C2 closed) the motor 49 drives the spindles at full operating speed. The auxiliary drive of the delivery mechanism 51 is provided by a gear 52 through a slip clutch 53 which is controlled by a slip control 52 which reduces the delivery speed during the first part of the starting period A (FIGS. 4 to 7) to such an extent (switch C2 closed) that the ratio n2/V4 of the spindle speed with respect to the delivery speed, continues to be a multiple of the ratio during the production period. During the last part of the starting period, the clutch 53 is completely engaged (switch C2 closed) so that the delivery mechanism 51 is accelerated to full operating speed until the beginning of the production period P. Conversely, during stopping period B, the spindle speed n2 is lowered to a value necessary for the intermediate period Cr (FIGS. 5, 5b and 5e) by shifting of the motor 50 to the lower speed (C2 closed, C3 open), see dot-and-dash lines in FIG. 14, and by braking of the spindles or else the spindles are stopped after disconnecting of the motor 49 (C2 and C1 open) in accordance with FIGS. 4b and 6b. At the same time, the delivery speed V4 is lowered by controlled opening of the clutch 53 (C2 open, C3 closed) through the slip control 52 as well as a brake 54 such as an electromagnetic brake, which is applied against the delivery mechanism so that the n2/V4 ratio rises as desired in accordance with FIGS. 4c to 7c.

The execution of the above process can also be carried out exclusively through electric handshaking of the speed control by means of one controlled D-C motor for actuation of both, the delivery mechanism and the spindle drive, as well as for the operation in the intermediate creep rate period Cr. For example, referring to FIG. 12, an adjustable D-C motor 55 is used to drive the delivery mechanism 56 via a rigid transmission gear 57. The motor 55 is provided with a control 58 and an electric speed indicator 59. The spindles are driven by means of an adjustable D-C motor 60 which is provided with a control 61 and an electric speed indicator 62 similar to the one mentioned above. The control voltages of the two controls 58 and 61 are tapped off by setting means 63 and 64 through switches C2, C1, C2 and C3. In addition
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9 to the circuit for the execution of the program according to FIG. 4 (solid lines) the setting means 63, 64 also include the circuit required for the program according to FIG. 5 (dash-and-dot lines). In operating the draw-twister according to the program in FIG. 4 or 5, the respective positions of the switches C5, C1, C2 and C3 are programmed as shown in the circuit program of FIG. 14. In order that this circuit program be applicable not only with regard to FIG. 12 but generally also for all described embodiment variants, the switches are, for simplicity's sake, provided on all figures with identical reference numbers.

Reffering to FIG. 13, two adjustable D-C drives which are independent of one another are provided in the draw-twister for the execution of the program shown in FIGS. 6 and 7. These drives include D-C motors 65 and 66 for the delivery mechanism 67 as well as for the spindle drive 68 which are each provided with an electric speed indicator 69, 70 and a control element 71, 72 as well as a setting device 73, 74 for transmitting the control voltage of the control element. The voltage of the electric speed indicator 69 influences not only the control element 71 proper to the spindle drive 68, as is a FIG. 12, but also serves as an output value for the setting means 74 controlling the delivery mechanism control element 72. As shown in the drawings in some cases are provided for the programs as set forth in FIG. 6 and the dash-and-dot lines for the program as illustrated in FIG. 7. The circuit program of the switches C5, C1, C2, C3 that is, their closing times, is again evident from the diagrams shown in FIG. 14 and does not require any further explanation.

The invention provides a process and apparatus for a draw-twister which, for example, in normal operation, that is, in the production period P has a n2/V1 value corresponding to 10–15 turns per meter in the yarn. While this value is required in order to achieve a sufficient yarn tension in the building up of a package, a ratio of n2/V1 equal to about 20 to 30 turns per meter or, in other words, a multiple of the normal operation ratio, can be used in the main period of the starting or stopping periods, whereas these values are considered as the upper limit for normal operation. As already mentioned, the critical ratio K corresponding to a yarn manufactured at 700 turns per meter must not be exceeded so that, in accordance with the invention, the draw-twister can operate during a major part of the starting and stopping period in the range between 20 to 30 turns per meter and the critical ratio K. In the case of the process in accordance with FIGS. 6 and 7, which may be referred to as preferred modes of realization, the relationships n2/V2 are between 100 and 200 turns per meter.

It is noted that all spindle speed and delivery speed curves referred to above were assumed to be in a constant slope relationship with respect to time; however, slight deviations in the relationships which can occur are considered to be admissible as a matter of course.

What is claimed is:

1. A process for reducing yarn waste in a draw-twister having a spindle for winding of a yarn into a package and a delivery mechanism for feeding the yarn to the spindle comprising the steps of rotating the spindle during a starting period at a constant rate of acceleration to a production speed for winding of the package during a subsequent production period, and of driving the delivery mechanism during said starting period at an increasing rate of speed to a production speed corresponding to a ratio of spindle speed to delivery mechanism speed which decreases from a first value below a predetermined critical value corresponding to a twist maximum in the yarn causing irregularities in the yarn path to a second value equal to the value of said ratio during said production period.

2. A process as set forth in claim 1 which further comprises the steps of rotating the spindle during a stopping period subsequent to said production period at a constant rate of deceleration from the production speed, and driving the delivery mechanism during said stopping period at a decreasing rate of speed from the production speed to increase said ratio from said second value while remaining below said critical value during said stopping period.

3. A process as set forth in claim 1 wherein said critical value corresponds to the critical number of turns per meter in the fed yarn.

4. A process as set forth in claim 1 wherein said first value is a multiple of said second value.

5. A process as set forth in claim 1 wherein the delivery mechanism is initially driven in said starting period at a constant speed prior to said increasing rate of speed to produce a ratio of spindle speed to delivery mechanism speed which initially increases to said first value.

6. A process as set forth in claim 1 wherein the delivery mechanism is initially driven in said starting period at a first acceleration rate to produce a constant ratio of spindle speed to delivery mechanism speed and is subsequently driven in said starting period at a second higher acceleration rate to said production speed to reduce said ratio from said first value to said second value.

7. A process as set forth in claim 6 wherein the delivery mechanism is initially driven at said first acceleration rate for a major portion of said starting period.

8. A process as set forth in claim 1 wherein the delivery mechanism is driven at said initial deceleration rate during said stopping period for a major portion of said stopping period.

9. A process as set forth in claim 8 wherein said delivery mechanism is driven at said initial deceleration rate during said stopping period for a major portion of said stopping period.

10. A process as set forth in claim 8 wherein said constant ratio is of a value at least twice the ratio during said production period.

11. A process as set forth in claim 8 wherein said constant ratio is of a value slightly below the critical value corresponding to a yarn twist of 700 turns per meter.

12. A process as set forth in claim 8 which further comprises the step of maintaining the spindle speed and delivery mechanism speed at said constant ratio after said stopping period during an intermediate period until a subsequent starting period.

13. In combination with a draw-twister having a spindle for winding yarn and a delivery mechanism for feeding the yarn; an apparatus comprising first means for driving said spindle, second means for driving said delivery mechanism at a first speed, an auxiliary means for driving said delivery mechanism at a reduced speed from said first speed, and means for successively actuating said second means and said auxiliary means whereby the delivery mechanism is driven at reduced rates after starting and before acceleration to production speed and after deceleration from production speed and before stopping.

14. The combination as set forth in claim 13 wherein said auxiliary means includes a drive motor, a gear operationally connected to said drive motor and a clutch operationally connected to said gear and said delivery mechanism.

15. The combination as set forth in claim 14 wherein said drive motor is speed adjustable.

16. The combination as set forth in claim 14 wherein said gear is a variable transmission gear.

17. The combination as set forth in claim 14 wherein said clutch is an overriding clutch.
18. The combination as set forth in claim 14 wherein said clutch is a controlled slip clutch.

19. The combination as set forth in claim 13 wherein said first means and said second means are driven from a common drive motor, and said second means includes a clutch for disengaging said second means from said common drive.

20. The combination as set forth in claim 19 wherein said motor is a pole-reversible motor.

21. The combination as set forth in claim 13 wherein said auxiliary means and said second means are driven from a common drive, and said auxiliary means includes a controllable slip clutch for disengaging said auxiliary means from said second means.

22. The combination as set forth in claim 21 wherein said auxiliary means further includes a controllable clutch for braking said second means.

23. The combination as set forth in claim 13 wherein said second means includes a motor for driving said delivery mechanism, a control element for controlling the drive of said motor and a value setting device for regulating said control element.

24. The combination as set forth in claim 23 wherein said first means includes a motor for driving said spindle and an electric speed indicator operatively connected to said motor for responding to the speed of said motor and operatively connected to said value setting device for controlling said value setting device.

25. The combination as set forth in claim 16 wherein said gear is infinitely variable.

26. The combination as set forth in claim 13 wherein said second means is a two-speed pole-reversible motor and said auxiliary means is a change gear driven from said motor.

27. In combination with a draw twister having a spindle for winding yarn and a delivery mechanism for feeding the yarn, an apparatus comprising a spindle drive for driving said spindle, means for selectively driving said delivery mechanism between a production speed and a reduced speed from said production speed, said means including a drive motor operable at at least two speeds corresponding to said production speed and said reducing speed and a switch means connected to said drive motor for actuating said drive motor to operate selectively at one of said two speeds whereby the delivery mechanism is driven at a reduced speed after starting and before acceleration to production speed and after deceleration from production speed and before stopping.

28. The combination as set forth in claim 27 wherein said means further include a change gear connected to said drive motor for maintaining said reduced speed and said production speed at a constant ratio.

29. The combination as set forth in claim 27 wherein said means further includes an infinitely variable gear connected to said drive motor for varying said reduced speed relative to said production speed.

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