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(54) STRAND WINDING MACHINE

(71) We, JOHNS-MANVILLE CORPORATION, a corporation organized under the laws of the State of New York, United States of America, of 22 East 40th Street, New York, State of New York 10016, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a strand winding machine for winding a strand into a package. Heretofore strand winding machines have been provided with guides to guide a strand along the winding axis of a mandrel upon which the strand is to be wound in a pattern which deposits the windings in place to build a package. These guides or traverses have been arranged so that they are maintained relatively close to the mandrel and, as the winding package builds, are moved away from the mandrel. As shown in U.S. Patent No. 1,427,035 entitled "Traverse Motion for Winding Machines", the winding mandrel can be supported on a swinging arm. The swinging arm allows the mandrel to recede from the fixed axis of a drive roll as the winding package builds. Thus the mandrel recedes from a strand guide which is mounted with the drive roll and moves on a fixed path along the winding axis of the mandrel.

Where the winding mandrel is independently driven, thereby eliminating the drive roll, the strand guides have been provided with spacer guides. The spacer guides maintain a spaced relation between the winding mandrel and strand guide by again allowing the winding mandrel to recede from the strand guide as the package size grows. This concept is illustrated in U.S. Patent No. 3,249,312 for "Method and Apparatus for Winding Strand Material". In the mechanism disclosed in the latter patent, the spacer guide is a roller which bears upon and follows the outer periphery of the package.

An alternative way of maintaining a spaced relationship between a package periphery and a strand guide is to pivotally mount the strand guide. This permits the strand guide to recede away from the winding package

under the guidance of a sensor bearing on the package periphery and operating in a manner similar to the above spacer guide. The guide and sensor are moved a very slight distance away from the package in increments, each increment of movement taking place with a predetermined displacement of the sensor. The prior art discloses it is preferable to render the sensor operative only when it is adjacent an end region of the package. The sensor is caused to travel in contact with the face of the package when the package engages it at any point other than the end of the package.

In all the above apparatus of the prior art a guide means or sensor means, either continuously or periodically, engages the face of the package. These means are used to maintain a spaced relationship between the strand guide and the continually increasing periphery of the package as it is wound. If the spaced relationship is not maintained, the strand is forced further around the strand guide increasing tension within the strand. Where the strand is glass fiber, being wound directly upon formation from molten glass, it is very important to prevent increased tension because the strand is in a frangible condition when approaching the winding machine and can break. Increased tension within the strand also causes the layers on the package to become more tightly wound. In addition, the outer surface of the package becomes wider than the inner layers of the package resulting in successive layers which overlap and are virtually tied together. If the strand layers overlap and become tied together, the strands are not free to unwind from the package when used in subsequent production operations. While helping to eliminate the tension problem, these prior art guides or sensors do present problems. When the strands are coated, contact with the wound strand by the guide means or sensor means of the prior art tends to cause a buildup on the guide sensor of material wiped from the strand. Furthermore the guide or sensor means tend to abrade and displace the strand.

It is an object of the present invention to

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overcome the above tension problem as well as the additional problems involved with winding coated and frangible strands by providing a control assembly for the strand guide which does not contact the peripheral surface of the winding package.

According to the present invention we provide a strand winding machine for winding strand into a package on a strand receiving mandrel rotated about a winding axis, a strand guide for guiding a strand onto said mandrel, and an actuator for moving said strand guide toward and away from the winding axis of said mandrel, said actuator comprising a fluid operated drive member, linkage connecting said actuator to said strand guide, and a control member, free of the strand surface wound on said mandrel for controlling said actuator, said control member comprising a checking cylinder affixed to the actuator to control the rate of movement of the strand guide by controlling the speed of the actuator, and said control member including means for adjusting the checking cylinder to effect different speeds for the actuator.

The above objects and advantages of the present invention will become more apparent from the following detailed description of the invention and the accompanying drawings wherein:—

Figure 1 is an elevational view of a fragment of a bushing feeding glass fibers past an applicator to gathering wheels from which strands are wound on a winding machine incorporating a strand guide mechanism according to this invention;

Figure 2 is an end view of the equipment in Figure 1;

Figure 3 is a plan view of the actuator for the strand guide mechanism taken along line 3—3 of Figure 1;

Figure 4 is a section taken along line 4—4 of Figure 3 with the exception of the cylinder which is shown in full view; and

Figure 5 is an enlarged end view and partial section of the actuating mechanism of Figure 3 taken along line 5—5.

Referring to Figures 1 and 2, the bottom portion of a bushing 12 is illustrated from which a number of glass fibers 14 are drawn and gathered into two strands 16 at gathering wheels 18. An applicator 20 upstream of the gathering wheels 18 applies a coating such as a resin binder to the fibers 14. The strands 16 then pass over strand guide 22 and are wound by the winding hub 24 of the winding machine 26. The winding hub 24 carries two or more forming tubes or mandrels 28 with a strand 16 being wound on each mandrel. Figure 2 illustrates the initial position A of the strands at the start of the winding process and a subsequent position B, by dashed lines, which is indicative of the strands 16 after a number of layers of strands

16 have been placed on the mandrels 28. The equipment illustrated produces packages of wound strand 16 on the mandrels 28 for use in subsequent processes wherein the strand 16 is unwound from the mandrel for use again as a strand 16. While the equipment described is for producing wound packages of coated fiber glass strand 16, it will be appreciated that the apparatus incorporated within the equipment and described below is applicable to strands of other materials whether coated or uncoated.

Successive layers of strand 16 are wound on the mandrels 28 in a patterned form by the interrelated movements of the winding hub 24 and strand guide 22. The winding hub 24 is rotated by what can best be described as an inverted motor having an armature portion affixed to a movable frame 30 and a rotating motor housing. The winding hub 24 is placed over and affixed to the motor housing. Mandrels 28 are affixed to the face of the winding hub 24 and are rotated by the motor housing and hub 24. Thus the strands 16 attached to the mandrels 28 are wound onto the face thereof. The strands 16 are caused to traverse the face of the mandrels by movement of the movable frame 30, by a cylinder not shown, in the direction of the longitudinal axis of the winding hub 24. At the same time, rotation of traverse mechanisms 32 of the strand guide 22 imparts movement to the respective strands in a direction generally parallel to the longitudinal axis of the winding hub 24. Proper coordination of the movement of the mandrels 28 mounted on the movable frame 30 with the movement imparted to the strands 16 by the traverse mechanisms 32 causes the strand to be wound in a regular pattern. One of the pattern contours obtainable is illustrated in phantom in Figure 1 where the ends 34 of the packages are tapered.

The strand guide 22 is movable in spaced relation to the buildup of layers of strand 16 on the mandrels 28. The distance between the surface layer of strand 16 on the package and the strand guide 22 is maintained generally constant. In maintaining the distance between the surface layer of strand 16 and the strand guide 22 it can be seen from Figure 2 that, as the package of strand 16 builds up from position A to position B, the strand guide 22 and the traverse mechanisms 32 must be moved back away from the winding hub 24 in a direction perpendicular to the winding axis of the hub in order that the angle of introduction of the strands 16 to the package being wound remains the same and the paths of the strands 16 between the gathering wheels 18 and the packages is generally nearly a straight line as viewed in Figure 2 and oscillates between the limits of the traverse as viewed in Figure

1. The deflection of the strands 16 at the point that the strands 16 pass the strand guide 22 is only enough to retain the strands 16 in contact with the rotating traverse mechanisms 32. Since the packages are continually increasing in diameter as the strands 16 are wound, the strand guide 22 is also moved continuously.

The traverse mechanisms 32 are affixed to a traverse rod 36 of the strand guide 22 by collars 29. Whilst two traversing mechanisms are shown, the guide 22 may have one or more traverse mechanisms depending upon the number of strands to be wound and in some cases the traversing feature may not be required. The traverse rod 36 has a journal connection to pivotal bars 38 which support both the traverse mechanisms 32 and the electric motor 40 for rotating the traverse rod 36. Pivotal bars 38 are affixed to the rotatable shaft 42 which has journal connections to the knee structures 44. The knee structures 44 are rigidly connected to each side of the frame 46 of the winding machine 26. One end of the rotatable shaft 42 is clamped between one end of a linkage bar 48 and a mating clamp 50 which fits underneath the linkage bar 48, whereby the linkage bar 48 is rotatably fast with the rotatable shaft 42. The other end of the linkage bar 48 is pivotally connected to clevis 52. A clevis rod 54 interconnects clevis 52 with clevis 56. Threaded connections between the clevis rod and clevises 52 and 56 are opposite hand to enable the clevis rod 54 to function as a turnbuckle. The clevis rod 54, therefore, enables the linkage to be adjusted linearly. The linkage is completed by the lever 58 and connecting bar 60, see Figures 2 and 3. The lever 58 is pivotally connected to clevis 56 and connecting bar 60 and supported by a pivotal connection with knee structure 44. Horizontal linear motion by an actuator 62 is converted by the linkage to rotational motion on pivotal bars 38 of the strand guide 22. Other means of imparting motion to the strand guide can comprise a mounting on rollers or a slidable mount which moves horizontally on a base such as knee structure 44. In addition, the linkage could be replaced with other mechanisms for transferring motion from the actuator 62 to the pivotal bars 38, for example, by gear rack and pinions.

Figures 3, 4, and 5 illustrate the actuator 62 in greater detail. The linkage is connected to the actuator 62 by a pivotal connection between connecting bar 60 and link 64. Link 64 is bolted to an actuator bar 66 which is pivotally mounted for arcuate motion in the horizontal plane at its free end, along with hydraulic cylinder operator 68 by virtue of the trunnions 70. These trunnions 70 have journal connections with a support angle 72 and a base 74 which is a

structural angle with a journal plate affixed to one end thereof. The base 74 is fixedly connected to the frame 46 of the winding machine 26 and supports both the operator 68 and a cam 76. The cam 76 is swingable in a horizontal plane about a pin 73 inserted into base 74 and cam 76 at the longitudinal end of the cam 76 farthest from the operator 68. A longitudinal groove 78 in the cam 76 is open at the top and contains a cam follower 80 into which a journal pin 82 is seated. The journal pin 82 passes up through the slide 84 of the actuator bar and terminates within the crosshead 86. A slot 88 in the actuator bar 66 retains the slide 84. The crosshead 86 is bolted to the cylinder rod 90 of the operator 68 as well as the cylinder rod 92 of the checking cylinder 94. The checking cylinder 94 is supported at the rod end by a plate 96 affixed to the actuator bar 66 to which the checking cylinder front mount 98 is bolted. The cylinder back mount 100 is bolted to the actuator bar extension 102 whereby the checking cylinder 94 and operator 68 are rigidly interconnected structurally, and both are swingable in a horizontal plane about trunnions 70.

Figure 5 best illustrates cam stops 104 and 106 on both sides of the cam 76 at the end of the cam opposite the rotatable pin connection. One cam stop 104 consists of a segmental structural angle 108 bolted to the base 74 with a stop bolt 110 threaded through the angle 108 to abut against the side of the cam 76. A lock nut 112 is provided to firmly fix the position of the stop bolt 110. Similarly, the other cam stop 106 consists of a stop bolt 110, lock nut 112, and cam stop plate 114. The plate 114 is bolted to the base 74. The cam stops 104 and 106 are adjusted by backing off the lock nuts 112 to release the stop bolts 110 which can then be screwed in or out to firmly position the cam 76 which is swingable between the stop bolts 110.

The hydraulic cylinder operator 68 is powered by a conventional hydraulic power unit and an electrically operated four-way control valve, neither of which is illustrated. The supply of hydraulic fluid is furnished to the back port 116 of the operator 68 and returned by the front port 118.

The actuator functions in the following manner. As the cylinder rod 90 moves from its starting position C (shown in phantom in Figure 4) the journal pin 82 is guided by the cam follower 80 riding in groove 78 of the cam 76. The cam is placed on an angle with respect to the actuator bar 66. Thus, movement of the cylinder rod 90 causes the actuator bar 66 and cylinder operator 68 to rotate about the trunnions 70. With the angularity of the cam 76 with respect to the actuator bar 66 being small, a large movement of the cylinder rod 90 results in a

very small movement of the actuator bar 66 which is linked to the strand guide 22 to impart rotational motion thereto. Thus movement of the actuator bar through the linkage causes the pivotal bars 38 to be rotated away from the winding hub 24 as the cylinder rod advances from position C to position D of Figure 4.

The speed of the cylinder operator 68 is accurately controlled to correlate the movement of the strand guide 22 with the rate of package buildup of strand 16. The cam 76 angularity is set to correlate the degree of movement of strand guide 22 with the amount of strand 16 to be built-up on the package of strand 16. Thus, the strand guide 22 is continually moved away from the package of strand 16 at a rate equal to the rate of advance of the strand 16 toward the strand guide 22 as strand builds up on the package.

The cylinder operator 68 speed is controlled on the actuator 62 illustrated by a checking cylinder 94 affixed to the cylinder operator 68. A checking cylinder 94 of this nature is one manufactured commercially by the Bellows Co. under the trademark Hydro-Check. Briefly, the checking cylinder is oil filled having a checking piston rod 92, adjustable needle valve assembly 120 and a springloaded balance cylinder 122 as illustrated in Figures 3 and 5. The operator 68 forces the checking piston rod 92 outward upon forward movement of cylinder rod 90 because of the interconnection between the rods 90 and 92 within the crosshead 86. Movement of the checking rod 92 moves a piston within the checking cylinder forcing oil therein through the transfer tube 124, through the needle valve assembly 120 and into the rear of the checking cylinder 94. The rate of flow of oil through the valve assembly 120 is adjustable by turning the knob 126 which controls the size of the passage through a needle valve within the valve assembly 120. The rate of piston advance is very accurately controlled by the fixed flow past the valve assembly 120. The checking piston rod 92 is easily returned by flow through a one-way valve (not shown) in the checking piston. The balance cylinder 122 compensates for checking piston rod 92 displacement in the inward stroke, since the system is a closed one, returning the displaced amount of fluid to the checking cylinder on the outward stroke by a spring loaded piston.

The hydraulic cylinder operator 68 could be replaced by a pneumatic cylinder or a hydraulic motor.

A continuously movable strand guide 22 has been described which has a rate of movement away from a package of strand 16 which is directly correlated to the rate of package buildup toward the strand guide 22. However, the movement of the strand guide

22 which is independent of any contact with the surface of the package, can be continuous or intermittent.

By correlating the strand buildup on the package and the travel time on the cylinder operator 68, the space between the package of strand being wound and that portion of the strand guide which contacts the strand as it approaches the package can be maintained essentially constant. This keeps the degree of wrap of the strand about the guide essentially constant. Thus, the strand guide 22 permits an even tension to be maintained in the strand, better package build-up and larger package buildup. As a result there is a significant decrease in package deformation and in breakage occurring upon unwinding the strand from the package. Further, since there is no requirement for contact with the surface of the package of strand 16, clogging of contacts and sensors has been eliminated along with the wiping of the surface layer of strand 16 on the package where the strand is coated.

The strand guide 22 actuating mechanism is a simple mechanical device with a wide range of adjustment which is easy to regulate and accurate. The mechanism is also rugged to withstand dirty conditions as well as machinery vibration and the like.

WHAT WE CLAIM IS:—

1. A strand winding machine for winding strand into a package on a strand receiving mandrel rotated about a winding axis, a strand guide for guiding a strand onto said mandrel, and an actuator for moving said strand guide toward and away from the winding axis of said mandrel, said actuator comprising a fluid operated drive member, linkage connecting said actuator to said strand guide, and a control member, free of the strand surface wound on said mandrel for controlling said actuator, said control member comprising a checking cylinder affixed to the actuator to control the rate of movement of the strand guide by controlling the speed of the actuator, and said control member including means for adjusting the checking cylinder to effect different speeds for the actuator.

2. A strand winding machine according to Claim 1 wherein said actuator for moving said strand guide includes a cam and a cam follower which is connected to said fluid drive member, said cam being capable of adjustment in position to regulate the distance travelled by said strand guide.

3. A strand winding machine according to Claim 1 wherein said actuator includes a cam and a cam follower connected to said fluid drive member which is pivotally mounted and develops relative motion between said cam and said cam follower, a pivotally mounted actuator bar and a slide, said bar

very small movement of the actuator bar 66 which is linked to the strand guide 22 to impart rotational motion thereto. Thus movement of the actuator bar through the linkage causes the pivotal bars 38 to be rotated away from the winding hub 24 as the cylinder rod advances from position C to position D of Figure 4.

The speed of the cylinder operator 68 is accurately controlled to correlate the movement of the strand guide 22 with the rate of package buildup of strand 16. The cam 76 angularity is set to correlate the degree of movement of strand guide 22 with the amount of strand 16 to be built-up on the package of strand 16. Thus, the strand guide 22 is continually moved away from the package of strand 16 at a rate equal to the rate of advance of the strand 16 toward the strand guide 22 as strand builds up on the package.

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The strand guide 22 actuating mechanism is a simple mechanical device with a wide range of adjustment which is easy to regulate and accurate. The mechanism is also rugged to withstand dirty conditions as well as machinery vibration and the like.

WHAT WE CLAIM IS:—

1. A strand winding machine for winding strand into a package on a strand receiving mandrel rotated about a winding axis, a strand guide for guiding a strand onto said mandrel, and an actuator for moving said strand guide toward and away from the winding axis of said mandrel, said actuator comprising a fluid operated drive member, linkage connecting said actuator to said strand guide, and a control member, free of the strand surface wound on said mandrel for controlling said actuator, said control member comprising a checking cylinder affixed to the actuator to control the rate of movement of the strand guide by controlling the speed of the actuator, and said control member including means for adjusting the checking cylinder to effect different speeds for the actuator.

2. A strand winding machine according to Claim 1 wherein said actuator for moving said strand guide includes a cam and a cam follower which is connected to said fluid drive member, said cam being capable of adjustment in position to regulate the distance travelled by said strand guide.

3. A strand winding machine according to Claim 1 wherein said actuator includes a cam and a cam follower connected to said fluid drive member which is pivotally mounted and develops relative motion between said cam and said cam follower, a pivotally mounted actuator bar and a slide, said bar



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being connected to said fluid drive member at the pivotal end thereof, said slide being connected to said cam follower and said fluid drive means, and said slide being slidable within said bar to cause said cylinder and bar to swing when said cam is fixed at an angle to said bar upon actuating said fluid drive means, said linkage including linkage for converting linear motion to rotational motion to swing said strand guide, said means for adjusting the checking cylinder comprising a needle valve.

4. A strand winding machine according to Claim 3 wherein said cam is capable of adjustment to regulate the distance travelled by said guide strand.

5. A strand winding machine according to any one of Claims 1 to 4 wherein said strand guide includes a traverse mechanism

for guiding the strand over the face of said receiving mandrel.

6. A strand winding machine according to any one of Claims 1 to 5 wherein the fluid drive member is a hydraulic cylinder.

7. A strand winding machine according to any one of Claims 1 to 6 wherein the fluid drive member is a pneumatic cylinder.

8. A strand winding machine as claimed in Claim 1, substantially as hereinbefore described with reference to, and as shown, in, the accompanying drawings.

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