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(54) Improvements in and relating to winding apparatus.

(57) A rotatably driven mandrel (2) is mounted on a pivot arm (1). A smoothing roller (3) is provided on a further pivot arm (4), and is biassed into contact with the package to apply a force to the package periphery, and hence control the packing density of the wound thread. During winding, as the diameter and weight of the package (9) grows, the increase in diameter deflects the roller (3) downwardly. A sensor (12) detects this and, via a mechanical linkage (11), causes the motor (10) to raise the pivot arm (1) by an amount that maintains the position of the roller (3) substantially constant and maintains the force supplied by the roller (3) to the package periphery substantially constant. This allows the packing density to be kept substantially constant, independently of variations in the weight of the package (9).

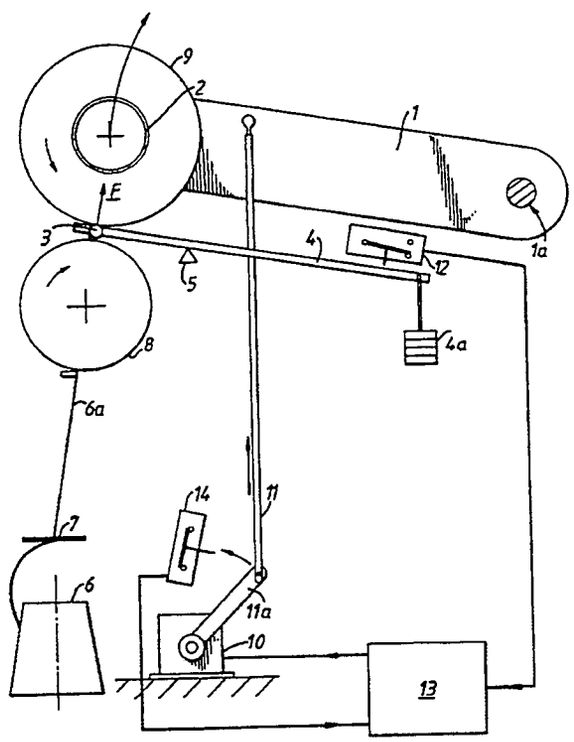

Fig.1.

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IMPROVEMENTS IN AND RELATING TO WINDING APPARATUS

This invention relates to apparatus for winding flexible material and particularly, but not exclusively, to apparatus for winding thread into packages.

Thread-winding apparatus generally comprises a pivoted carriage arm, which is provided at one end with a rotatably mounted motor driven mandrel, onto which the thread is wound into a package. To guide the thread as it is wound onto the mandrel and to control the packing density of the wound thread, the thread is usually fed between a smoothing roller in pressured contact with the periphery of the package as it is wound onto the package.

With systems where the roller is fixed and the mandrel is provided on an arm which pivots freely to maintain the mandrel in pressured contact with the roller using the effect of gravity, the variation in pressure exerted on the package by the roller will increase as the package grows in size and weight, adversely affecting the packing density of the thread.

A proposal for maintaining a constant pressure between a package, supported on a pivoted support arm, and a positionally fixed roller is disclosed in GB-A-2114169, which involves measuring a value (such as the current drawn by the mandrel drive motor) which varies with the pressure applied to the package by the roller, comparing the measured value with a reference value to provide an error signal and varying the pressure to reduce value of the the error signal. The value of the error signal is reduced by providing a system to partially support the weight of the arm and package. For example, a pneumatic ram, or mechanical ratchet arrangement, is provided to apply a variable upward pressure to the pivoted support arm, without positively controlling the angular position of the pivot arm. Such a system is comparatively complicated.

According to one aspect of the present invention there is provided apparatus for winding flexible material onto a mandrel, comprising mandrel support means for rotatably supporting a mandrel during winding of material onto the mandrel to form a package, and loading means arranged to contact the periphery of the package and between which and the package periphery material is arranged to pass as it is wound into the package, characterised in that the loading means is moveable and is arranged to be deflected by an increase in diameter of the package during winding, that means are provided for biassing the loading means into contact with the package during winding to apply a force to the package periphery, and that means for controlling the position of the mandrel support means are provided to move the mandrel support means during winding so as to maintain substantially constant the force applied by the loading means to the package periphery as the diameter of the package increases during winding.

The means for controlling the position of the mandrel support means may be arranged to be controlled in accordance with the deflection of the loading means by the package during winding.

The means for controlling the position of the mandrel support means may be arranged to move the mandrel support means during winding so as to maintain the position of the loading means substantially constant as the diameter of the package increases during winding.

The means for moving the mandrel support means may comprise drive means, operable to move the package in a direction away from the loading means, and control means arranged to operate the drive means in accordance with the increase in diameter of the package during winding. Sensor means may be provided to provide the control means with an indication of the package diameter.

These sensor means advantageously sense the deflection of the loading means caused by the increase in package diameter during winding. The sensor means may be arranged to provide an output indication to the control means, causing operation of the drive means, when a pre-determined increase in the diameter of the package is sensed. Where the loading means is mounted on a pivot arm, the sensor means may be arranged to provide an output indication when the pivot arm is pivoted through an angle corresponding with the pre-determined increase in package diameter.

When operated, the drive means may be arranged to move the mandrel support means by a pre-set amount. Alternatively, the drive means may be arranged to move the mandrel support means by an amount sufficient to remove the output indication from the sensor means.

Where the loading means is mounted on a pivot arm, the force applied to the package periphery by the loading means is advantageously adapted to remain substantially constant over the working range of pivotal movements of the loading means pivot arm.

Limit means may be provided for sensing the condition of maximum movement of the mandrel support means, which limit means provide an indication to prevent further winding.

Advantageously, when not moving, the mandrel support means, the means for controlling the position of the mandrel support means may be arranged to lock the mandrel support means in position during winding.

The drive means are preferably electrically, hydraulically, mechanically or pneumatically operated.

In addition to being simple and easy to maintain, another advantage of the apparatus of the present

invention is that its performance is not adversely affected by variations in the weight of the package. By maintaining constant a pre-selected force on the package during winding, the packing density of the wound material may be accurately controlled.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which :

Fig. 1 is a schematic drawing of an embodiment of winding apparatus according to the present invention ; and

Fig. 2 is circuit diagram of the control means circuitry of the apparatus of Fig. 1.

The apparatus shown in the drawings comprises a mandrel support means in the form of a mandrel support or carriage arm 1 pivotally mounted at one end. At the other end a mandrel 2, onto which material is wound, is rotatably mounted on the arm. The mandrel 2 is rotated in an anti-clockwise direction by drive means, for example an electric motor (not shown), so as to wind the material onto the mandrel to form a package 9.

Situated below the mandrel 2, and for contacting the periphery of the package of wound material, is a loading means in the form of a roller 3 which is rotatably mounted on one end of a pivot arm 4. Arm 4 is pivotable about an intermediate fulcrum 5 and carries at its other end weights 4a for biassing the roller in the direction of the mandrel. The weights provide a constant biassing force on the roller. The biassing force can be adjusted, for example, by varying the number of weights 4a or by varying their position along the arm 4. The force applied by the roller 3 to the periphery of material wound onto the mandrel, and which determines the packing density of material wound onto the mandrel, varies with the position of the roller about the axis of fulcrum 5 but is constant in any one position of the roller.

In the Fig. 1 embodiment thread 6a, from an input package 6, passes through a thread guide 7. Alternatively a tensioning device 7 could be provided. The thread 6a then passes through a clockwise-rotating slotted traverse drum 8, (or other suitable traversing mechanism) before passing between the roller 3 and the periphery of the package of thread 9 already wound onto the mandrel 2 to be wound into the package.

To control the packing density of material wound onto the mandrel, the position of the mandrel relative to the roller 3 is adjusted during a winding operation so as to maintain the position of the roller substantially constant and maintain substantially constant the biassing force applied to the package periphery. To this end drive means are provided for moving the carriage arm 1. In the illustrated embodiment, the drive means is in the form of a geared synchronous electric motor 10 connected to the carriage arm 1, via an articulated linkage 11. Other forms of drive means may, however, be employed, such as hydraulically, mechanically or pneumatically operated systems. The motor 10 is operable to rotate the smaller link 11a about the motor axis in an anti-clockwise direction, to raise the mandrel 2 by pivoting the pivot arm 1 about its pivot 1a. When not being operated to rotate the link 11a, movement of the pivot arm 1 about the pivot 1a is prevented during winding. In the illustrated embodiment, the pivot arm is prevented from moving by the motor 10, although separate locking means may be provided.

At the start of the winding operation, when there is no thread wound onto the mandrel 2, the smaller link 11a and carriage arm 1 are both closer to horizontal than is shown in the accompanying drawing. The pivot arm 4 is aligned with line A-A, with the roller 3 in contact with the mandrel 2 exerting a chosen force F which may, for example, be of the order of 10-100 Newtons. When winding commences, the diameter of the package 2,9 increases as the wound thread 9 builds up on the mandrel 2 deflecting the left-hand end of pivot arm 4 downwardly. When the pivot arm 4 is deflected by a pre-determined amount, an output indication is provided to control means 13 by sensor means 12, which may, for example, be an electrical limit switch. In response to this indication, the control means 13 causes the motor 10 to operate, rotating the smaller link 11a anti-clockwise through a small angle, so raising the package 2,9 and returning the pivot arm 4 to a position of approximate alignment with line A-A. Motor 10 may either be operated to raise the package 2,9 until sensor means 12 ceases to give an output indication, or by a pre-set increment.

The position of the sensor means may be adjustable to allow for the pre-determined increase in sensed diameter at which the sensor means 12 provides its output indication to be set according to the material to be wound.

This process of repeated adjustment of the position of the package 2,9 continues as the thread is wound onto the mandrel 2, until limit means 14, which may also be an electrical limit switch, is operated to provide an indication to the control means 13 to stop further winding. To allow for removal of mandrel 2, a manual override may be provided to allow for the raising and lowering of the carriage arm 1 manually. This also allows for the winding of packages 2,9 which are already part-wound. Although in the illustrated embodiment the override takes the form of push button switches 15, 16, it will be appreciated that other suitable switch means may be employed.

In the illustrated embodiment, the mandrel 2 may, for example, be of 105 mm diameter and the diameter of the final wound package 2,9 may be 305 mm diameter, with the result that in a complete winding operation, the centre of the mandrel 2 is raised through 100 mm. The sensor 12 may be set to provide an output indication to the control means 13 when the roller 3 is deflected from its position of alignment with

the line A-A by, for example, 1 mm. In this way, the position of the roller 3 can be maintained substantially constant relative to the drum of the traverse mechanism 8 during the winding operation, so that the roller 3 exerts a substantially constant force on the periphery of the package 2,9 during winding despite the increase in package diameter and weight.

To allow for the winding speed to be kept constant, the speed of the motor (not shown) which rotates the mandrel 2 may be reduced as the diameter of the package grows. Means for sensing the absolute diameter of the package may advantageously be provided in the form of a sensor (not shown) for measuring the position of the carriage arm 1.

Although in the illustrated embodiment of the present invention the loading means 3 biased towards and into contact with the mandrel is a rotatable roller, it need not be but may comprise some other suitable form of guide, such as a smooth bar or rod.

Furthermore, although in the illustrated embodiment the mandrel support means and loading means take the form of a pivotally mounted carriage arm 1 and pivot arm 4, respectively, one or both of said means may be arranged to be movable linearly, rather than angularly.

Claims

1. Apparatus for winding flexible material onto a mandrel, comprising mandrel support means (1) for rotatably supporting a mandrel (2) during winding of material (6) onto the mandrel to form a package (9), and loading means (3, 4) arranged to contact the periphery of the package and between which and the package periphery (9) material is arranged to pass as it is wound into the package, characterised in that the loading means (3, 4) is moveable and is arranged to be deflected by an increase in diameter of the package during winding, that means (4a) are provided for biassing the loading means (3, 4) into contact with the package during winding to apply a force to the package periphery, and that means (10, 11) for controlling the position of the mandrel support means are provided to move the mandrel support means (1) during winding so as to maintain substantially constant the force applied by the loading means to the package periphery as the diameter of the package (9) increases during winding.

2. Apparatus as claimed in Claim 1, wherein the means (10, 11) for controlling the position of the mandrel support means (1) are arranged to be controlled in accordance with the deflection of the loading means (3, 4) by the package (9) during winding.

3. Apparatus as claimed in Claim 1 or Claim 2, wherein the means (10, 11) for controlling the position of the mandrel support means (1) are arranged to move the mandrel support means during winding so as to maintain the position of the loading means (3, 4) substantially constant as the diameter of the package (9) increases.

4. Apparatus as claimed in any of the preceding claims, wherein the means (10, 11) for controlling the position of the mandrel support means (1) comprise drive means (10) operable to move the package (9) in a direction away from the loading means (3, 4) and control means (13) arranged to operate the drive means (10) in accordance with the increase in diameter of the package (9) during winding.

5. Apparatus as claimed in Claim 4, comprising sensor means (12) to provide the control means (13) with an indication of the package diameter.

6. Apparatus as claimed in claim 5, wherein the sensor means (12) senses the deflection of the loading means (3, 4) caused by the increase in package diameter during winding.

7. Apparatus as claimed in Claim 5 or Claim 6, wherein the sensor means (12) is arranged to provide an output indication to the control means (13), causing operation of the drive means (10), when a pre-determined increase in the diameter of the package (9) is sensed.

8. Apparatus as claimed in Claim 7, wherein the loading means (3) is mounted on a pivot arm (4) and the sensor means (12) is arranged to provide an output indication (4) when the arm is pivoted through an angle corresponding with the predetermined increase in package diameter.

9. Apparatus as claimed in any of Claims 4 to 8, wherein the drive means (10) is arranged to move the mandrel support means (1) by a pre-set amount when operated.

10. Apparatus as claimed in Claim 7 or Claim 8, wherein the drive means (10) is arranged to move the mandrel support means (1) by an amount sufficient to remove the output indication from the sensor means (12).

11. Apparatus as claimed in any of the preceding claims, wherein the loading means (3) is mounted on a pivot arm (4) and the force applied to the package periphery (9) by the loading means is adapted to remain substantially constant over the working range of pivotal movements of the load-

ing means pivot arm (4).

12. Apparatus as claimed in any of the preceding claims, wherein limit means (14) are provided for sensing the position of maximum movement of the mandrel support means, which limit means provide an indication to prevent further winding.

13. Apparatus as claimed in any of the preceding claims, wherein, when not moving the mandrel support means (1), the means (10, 11) for controlling the position of the mandrel support means are arranged to lock the mandrel support means in position during winding.

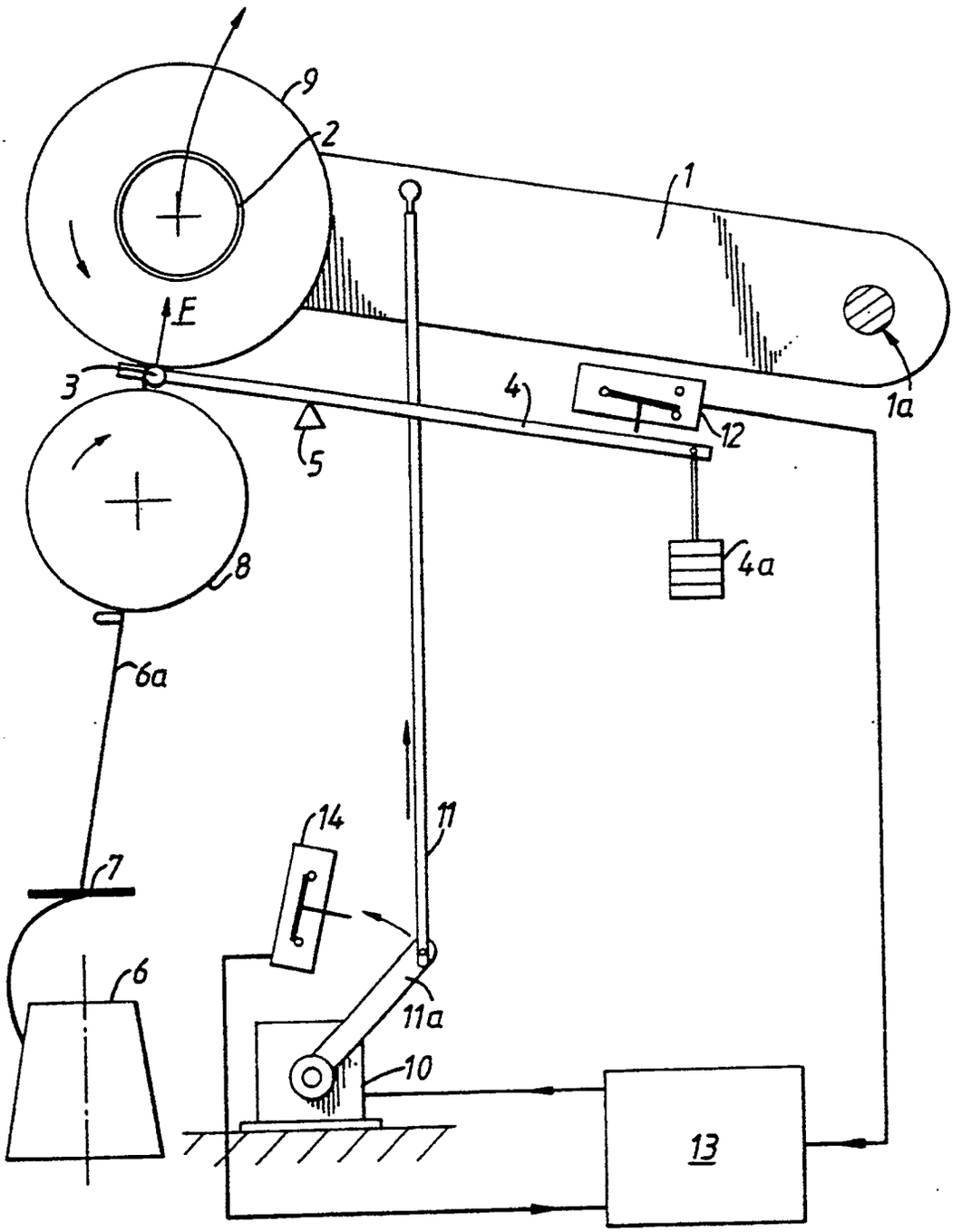

Fig.1.

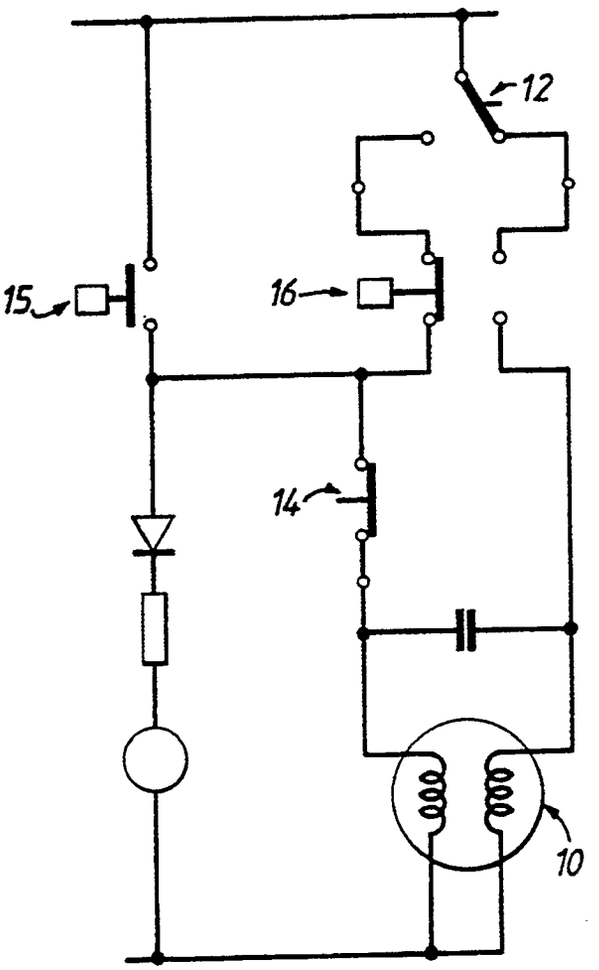

Fig.2.