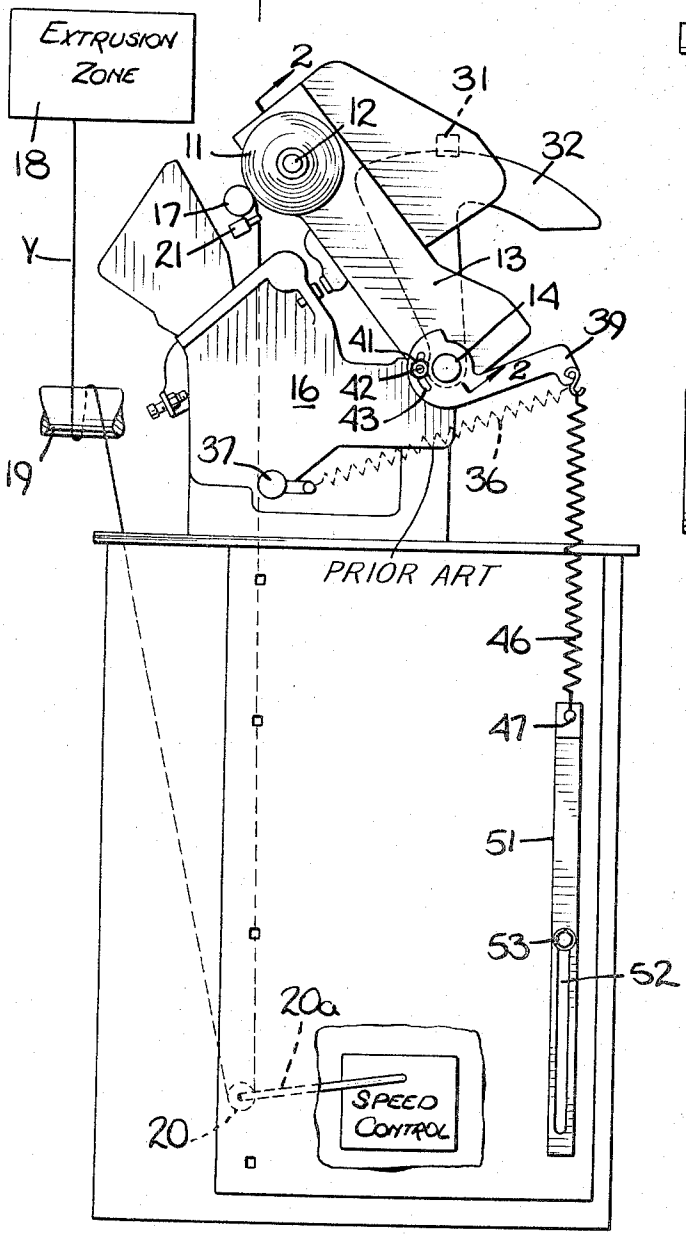
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WINDING DEVICE

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Fig. 1.



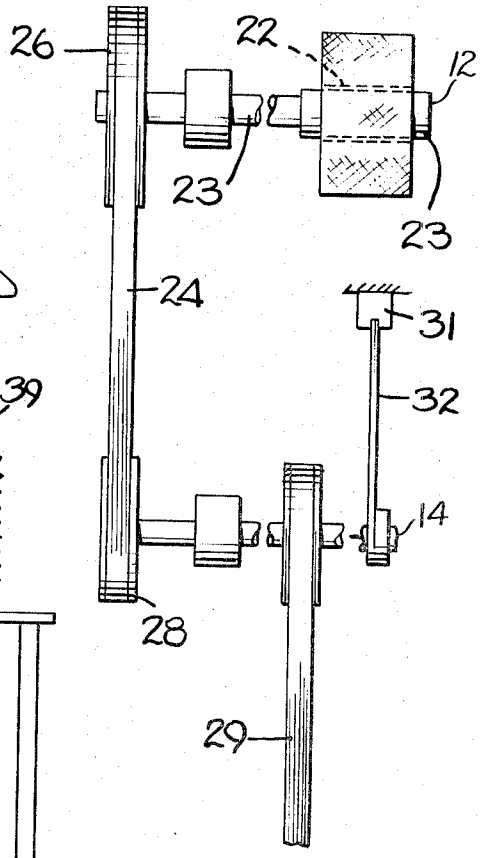


Fig. 2.

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Fig. 4.

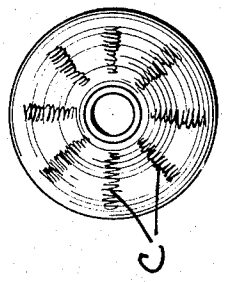


Fig. 5.

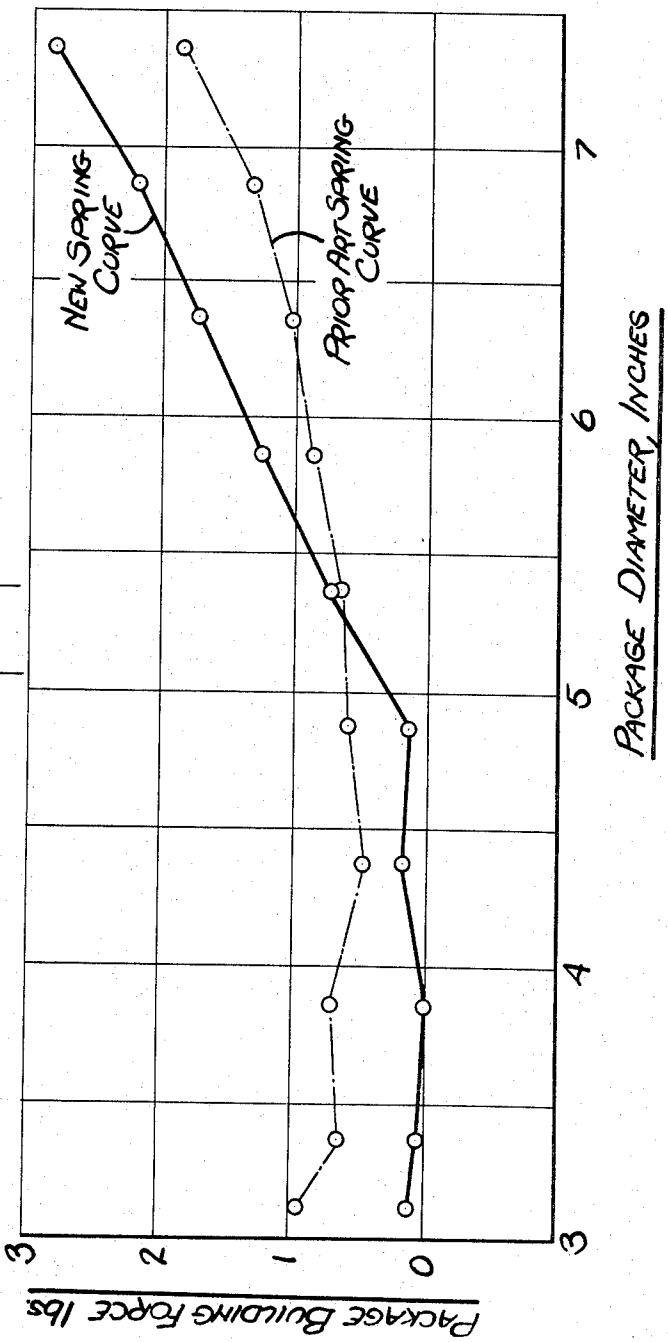
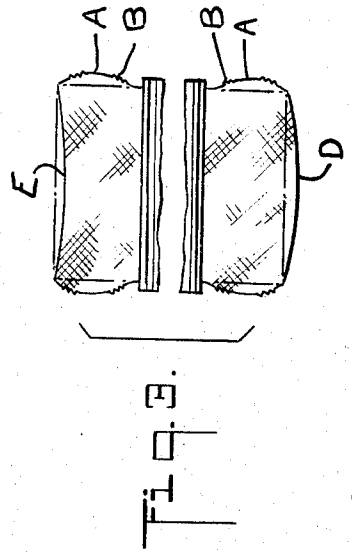


Fig. 3.



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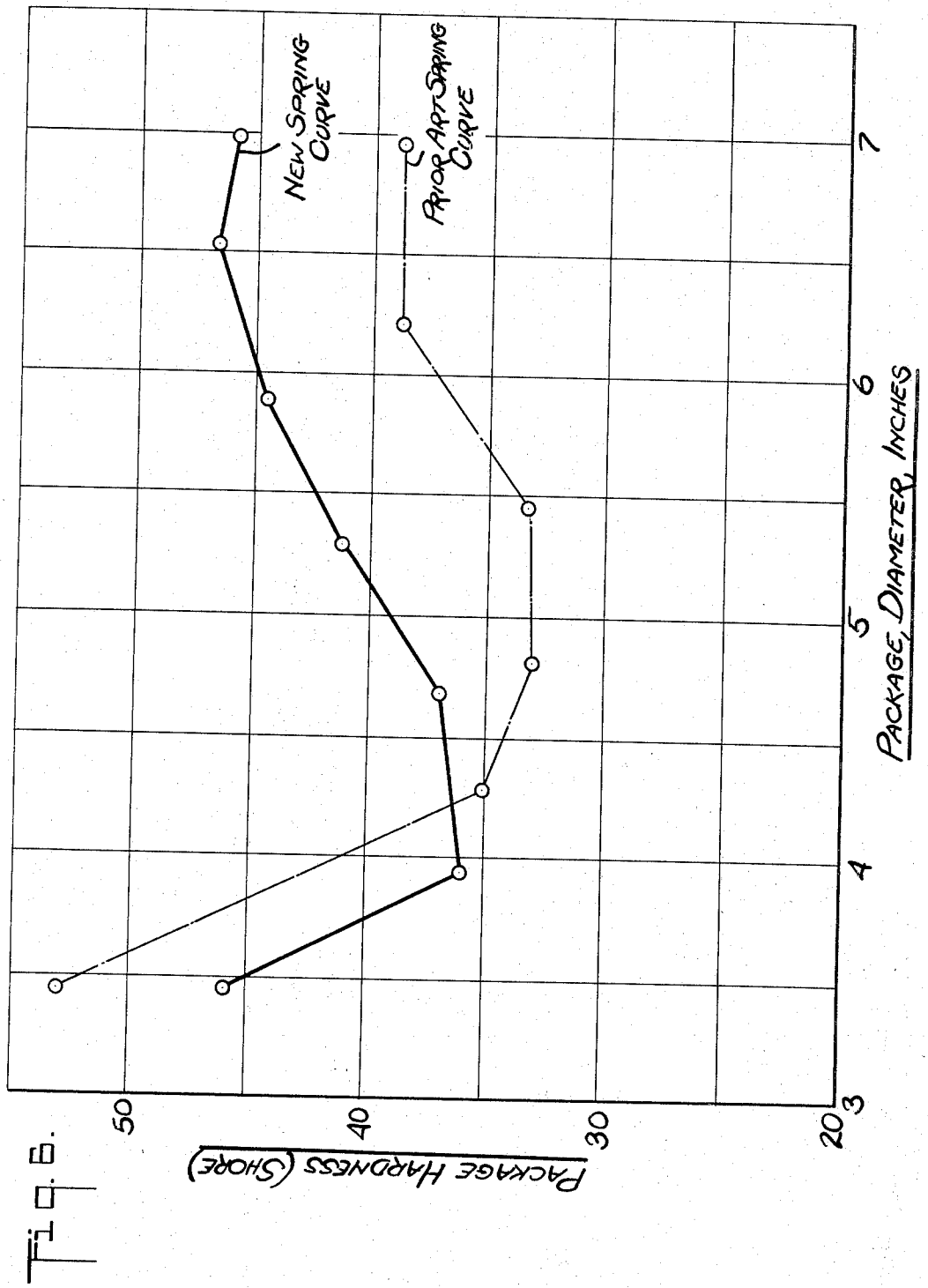


Fig. 6.

United States Patent Office 3,375,989 Patented Apr. 2, 1968

3,375,989

WINDING DEVICE

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Filed July 20, 1965, Ser. No. 473,370
2 Claims. (Cl. 242—18)

ABSTRACT OF THE DISCLOSURE

An apparatus and method for winding yarn onto a rotating package mounted on a pivoted, counterbalanced support wherein a spring is used to counterbalance the pressure exerted between the windings on a bobbin and an idler roll in contact therewith wherein the spring exerts a counterbalancing force along a line which moves through an arc of not more than about 5 degrees during the movement of the rotating package from the empty to fully wound position while increasing the pressure exerted on the idler roll as the yarn package increases in diameter, thereby decreasing the yarn tension and relaxing the spring counterbalancing force.

This invention relates to the winding of yarn, and relates more particularly to an improved apparatus for the winding of packages of continuous multifilament yarn.

It is an object of this invention to provide a new and useful apparatus and process for the production of high quality uniform packages of yarn.

Another object of this invention is to obtain improved, more uniform wound packages of yarn by a simple modification of existing winding equipment.

Other objects of this invention will be apparent from the following detailed description and claims.

One preferred form of apparatus for accomplishing the foregoing and other objects is illustrated in the accompanying drawings, in which:

FIGURE 1 is a side view of a conventional winding device, showing (in dotted lines) the conventional position of a counterbalancing spring, and (in solid lines) the position of the counterbalancing spring in accordance with this invention.

FIGURE 2 is a schematic and simplified cross-section of a portion of the winding device, taken along line 2—2 of FIG. 1.

FIGURES 3 and 4 are views of typical undesirable defects in wound yarn packages, FIG. 3 being a composite side view showing several defects, and FIG. 4 being an end view of a defective package.

FIGURE 5 is a graph showing the variation of calculated package building force with package diameter, comparing the results of the new and prior art arrangements.

FIGURE 6 is a graph showing the variation of hardness of the package comparing the results of the new and prior art arrangements.

While FIGS. 1 and 2 of the drawing illustrate one winding device (or winding position), it will be appreciated that in commercial operation there are a whole series of such identical devices, e.g., 50 to 100 such devices, arranged side-by-side on a single winding frame, for winding up a corresponding series of yarns. At each winding position, a yarn Y is wound onto a package **11** mounted on a driven spindle **12** rotatably supported near the upper end of a winder head **13**, which is pivoted at **14** to a fixed frame **16**. The yarn package **11** rests on a freely rotatable idler roll **17** (or "bail") which is frictionally driven by the rotation of the package. The yarn is supplied continuously from an extrusion zone **18** (such as a cabinet for the dry-spinning of cellulose acetate multifilament yarns) to a driven rotating metering roll **19**, and then passes down and around a dancer roll **20** situated at the end of

a pivoted compensator arm **20***a*. The yarn then passes upward to a reciprocating driven traverse guide **21** which, during the winding operation, moves back and forth just below the nip of the idler roll **17** and the package **11**, in a path parallel to that nip and spaced, for example, approximately ⅜ inch from the nip. As is well known, the movement of the traverse guide serves to distribute the yarn along the length of the package, in a predetermined pattern, while the contact between the package **11** and the idler roll **17** presses the yarn firmly onto the package and improves the accuracy of the distribution of the yarn along the length of the package **11**.

It will be understood that at the start of the winding the package **11** is simply an unwound core, such as a cardboard tube **22** mounted on a suitable mandrel **23** carried by the spindle **12**. As the winding proceeds, the package increases in size due to the winding of yarn thereon; for example, the initial external diameter of the unwound package (i.e., the core) may be about 3 inches while the fully wound diameter of the package may be about 8 inches, so that the package travels through an arc of, for example, about 40° during the winding operation. The diameter of the idler roll **17** is much smaller than that of the package, e.g., about ¾ inch. During the travel of the package, the center of gravity of all the mass (including the package) pivoted about pivot **14** will conventionally remain to the left (on the bail side) of the vertical line passing through the center of pivot **14**.

The spindle **12** is driven through a belt **24** extending from a pulley **26** at the end of the spindle to another pulley **28** mounted concentrically with the pivot. The pulley **28** is in turn driven through a timing belt **29** at a speed which decreases during the winding operation, so that the linear velocity of the continuously expanding periphery of the package **11** remains substantially constant, in a manner well known in the art.

Vibration of the package is damped by a friction device **31** (carried by the winding head **13**), applying a constant radial pressure to the surface of a sector **32** attached to the fixed frame **16**.

The compensator arm **20***a* is connected to devices controlling the speed of the spindle drive, in a manner well known in the art (as in U.S. patents 2,752,105 and 2,754,459). In this way transient variations in yarn tension during winding are reduced or eliminated; generally the control devices are preset to cause the winding tension to decrease gradually at a predetermined rate during the winding of the package.

In the winding machines of the prior art the weights of the winding head **13** and of the package carried thereby are partially counterbalanced by the force of a stretched helical spring **36** (shown in dotted lines) which extends from a fixed mount **37** on the fixed frame **16** to the end of an arm **39** secured to the winding head **13**. The arm **39** is mounted for movement about the pivot pin **14** and is adjustably secured to the winding head by engagement with a nut **41** threaded on a bolt **42**, which bolt projects laterally from the base portion of the winding head and is disposed in an arcuate slot **43** (concentric with the pin **14**) in the arm **39**.

In the regular use of the prior art winding machines, the wound packages obtained have not been as uniform as desired. When (for any given continuous multifilament yarn to be wound at a given speed) the appropriate uniform adjustments of the springs **36** are made (after a series of initial winding trials to determine the best adjustment) by adjusting the arms **39** at all the identical side-by-side winding devices of the winding frame, the packages produced at some of the winding devices are found to be poor in quality. The windings on the bad packages may be bulged, or they may be uneven with many broken filaments owing to vibrations. Some of the

defects are illustrated in FIGS. 3 and 4. The undesirable bulges are indicated at A; these bulges generally exhibit circular rings B, when the package is viewed from the end. Radial compression marks C may also be evident, and the "face" of the package may be convex (as shown at D) or concave, as shown at E.

In accordance with one aspect of this invention, the uniformity of the packages is greatly improved by changing the position of the fixed mount of the end of the spring so that the spring, **46**, is in the position shown in solid lines, with its fixed mount at **47**, so that the angular motion of the line of action of the spring, measured at its fixed mount **47**, during the movement of the package from empty to fully wound position is restricted to an arc of at most about 5°, preferably less than 3°, e.g., about 2°. The counterbalancing force of the spring, as transmitted to arm **39** is, therefore, a function of the change in spring length and is not appreciably affected by the angle of the applied force; the direction of this force remains roughly perpendicular to the line joining the centers of **14** and **39** during the winding of the package. It will also be evident that in the embodiment shown in the drawing, the length of the moment arm (drawn, from the center of **14**, precisely perpendicular to the line of action of the spring) remains approximately constant during the winding.

It is found when the springs are mounted in accordance with this invention, one may adjust them on the equipment in a different manner from that conventionally employed in the art. More importantly, the changed position of the spring makes it possible to obtain a properly wound package, with a single uniform setting, at all the side-by-side winding devices of the winding frame. In the use of the apparatus according to this invention a series of initial winding trials should also be made for each particular yarn at the chosen winding speed. For each trial the "breakway tension" is measured. This breakway tension is the force just sufficient to move the unwound core **22** away from idler roll **17** and is, of course, measured along a line passing through the axes of the spindle **12** and idler roll **17** (i.e., normal to the nip). Measurement of the breakaway tension may be effected by passing a string around the unwound core, attaching the spring to a spring balance and pulling on the spring balance, along the line indicated above, and recording the reading of the balance. The results of the winding trials, at various breakway tensions, are used to determine which tension is optimum, i.e., which tension corresponds to the best wound package; that is, the one which has the least bulge and which also shows minimum winding vibration (evidenced, for example, by broken filaments). All the arms **39** of the numerous side-by-side winding devices are then adjusted so that the breakaway tension at each winding device is equal to the optimum tension, so determined.

The effects of my new spring arrangement are evident in production trials. In one trial there was a decrease in rejects by some 20%.

It is interesting to note that calculations of the package building force (that is, the force at the nip between the idler roll **17** and the windings of the package) indicate that this force is more nearly constant during the winding process when the prior art type of spring arrangement is employed. Nevertheless the new spring arrangement produces better packages.

The package building force may be readily calculated from the known forces, being the vector summation of (in one direction) the weight of the package, the weight of the whole winding head and the substantially constant frictional forces at the friction blade and (in the other direction) the force of the spring. It will be appreciated that as winding proceeds the weight of the package will increase, the force exerted by the spring will decrease, and there will be changes in the directions of the forces exerted by the package weight, the spring tension and the winding head weight. The vector summation, taking into account all these changes for any given point in the winding operation, can be readily calculated. FIG. 5 shows the results of the calculations with the prior art arrangement and the new spring arrangement. FIG. 6 shows the characteristics of the packages produced with the two arrangements, in terms of package hardness at various distances from the center of the package; in measuring these package hardnesses, the initial measurements were on fully wound packages and the yarn was then stripped off the packages gradually and the hardnesses at the different diameters of the partially unwound packages were measured, using a Shore Durometer.

As will be seen in FIG. 5, a typical package building force with the new spring arrangement is practically zero for the first 1½ inch thickness of winding, then rises to a value of almost 3 pounds over the next 3 inches of windings. With the prior art arrangement, the package building force typically varied between about ½ pound and about 1¾ pounds over the same 4½ inches of winding. Despite the lower initial package building force, the final package was generally harder, and more uniformly hard, when the new arrangement was employed, as shown in FIG. 6.

The results shown in FIGS. 5 and 6 were obtained in the winding of cellulose acetate yarn composed of 90 continuous filaments and having a total denier of 320 on a core having an outside diameter of 3⅛ inches, to form a package 4¼ inches long and 7.4 inches in diameter and weighing 4.5 pounds. The package was wound at a constant wind ratio of 2.24 with the yarn tension gradually decreasing from 17 grams to 12 grams during the winding. The breakaway tension in this run, using the new spring arrangement, was 1¼ pounds and the initial spring tension was 13 pounds, which decreased substantially linearly to a value of 6½ pounds when the package diameter reached 7⅜ inches. The axis of the core was 7.4 inches from the center of the winding head pivot **14**. The idler roll was ¾ inch in diameter and the line joining the axes of the idler roll and of the core made an angle of 40° with the horizontal when the unwound core, mounted on the winding head, rested against the idler roll. In the calculations the friction force was assumed to be constant in view of the very low velocity of the angular movement of the winding head about its pivot, and the force at the nip, resulting from the vector summation of the friction force and the weight of the winding head was determined experimentally (with the spring detached from the arm **39**) measuring the static force along the line joining the axes of the idler roll and of the core.

The fixed mount **47** is advantageously made adjustable, as by locating it at the end of a bar **51** having a slot **52** through which extends a clamping bolt **53** screwed to the fixed base portion of the equipment. It will be appreciated that by loosening the bolt **53**, the bar **51** may be raised and then clamped in a new position with the mount **47** closer to the winding head. Or, if desired, the bar **51** may be clamped at an angle to the vertical.

It is to be understood that the foregoing detailed description is given merely by way of illustration, and that variations may be made therein without departing from the spirit of this invention.

The embodiment of the invention in which an exclusive property or privilege is claimed is defined as follows:

1. In a winding apparatus in which yarn is wound onto a rotating package mounted on a pivoted support and resting against a rotating roll so that the windings of yarn on said package are pressed against said roll wherein said roll is an idler roll and said package is axially driven and there are means for continuously supplying a continuous multifilament yarn to said package and yarn traversing means for laying the yarn onto said package in a cross-wound pattern and wherein said support pivots through an arc to accommodate the increased thickness

of the yarn windings as the winding of the package proceeds and in which there is a spring to counter balance the pressure between said windings and said roll owing to the weight of the support and the package, the improvement which comprises mounting said spring so that said spring exerts its force along a line which moves through an arc of at most about 5 degrees during the movement of the package from empty to fully wound position, said spring being set to a value substantially completely counter balancing the forces pressing said package against said roll for the initial portion of the winding operation, the construction arrangement being such that in the latter portion of the winding of the package, the spring force

is substantially relaxed to thereby insufficiently counter balance said forces.

2. Apparatus as set forth in claim **1** in which said arc is les than 3°.

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