United States Patent

Meredith

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[54] METHOD AND APPARATUS FOR FILAMENT WINDING

[72] Inventor: **Diven Meredith,** 87-135 Avenue 56, Thermal, Calif. 92274

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[52] **U.S. Cl.** .... **242/54 R,** 242/35.5 R, 242/47, 242/129.8, 242/156.1, 242/170

[51] **Int. Cl.** **B65h 75/00,** B65h 49/04

[58] **Field of Search** .... B65h/59/04; 242/35.5, 54, 47, 242/128, 147, 153, 154, 156.1, 129.5, 129.8, 130, 130.1, 131, 132, 141, 146, 151, 1, 170, 171; 28/21, 725 P, 76 R

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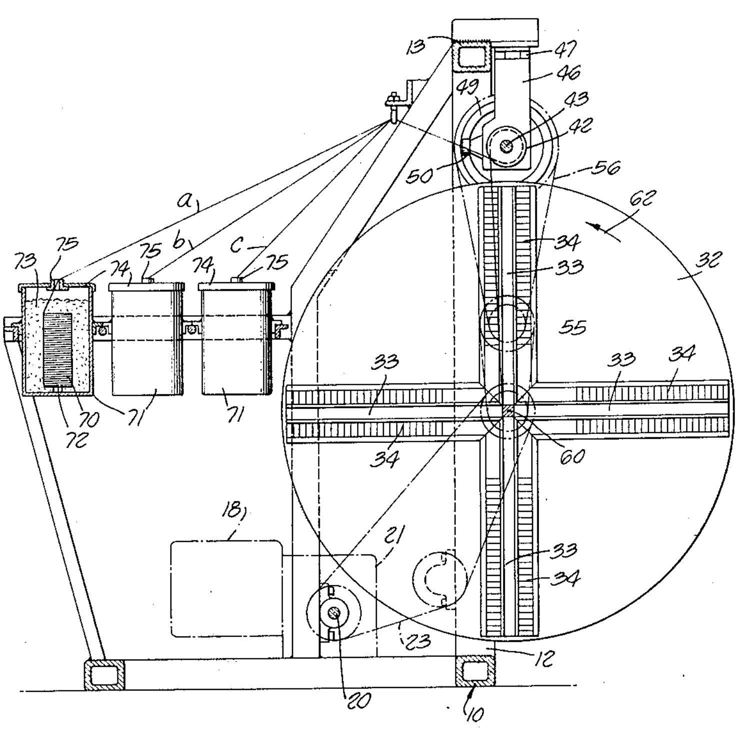
Primary Examiner—Stanley N. Gilreath
Attorney—Lyon and Lyon

[57] **ABSTRACT**

This invention concerns a method and apparatus for simultaneously winding a plurality of filaments to form a mass transfer unit. A series of filaments axially spaced along a central core member are wound upon it as it is turned about a longitudinal axis to initially secure the spaced filaments thereto. Separator blocks are then placed in position one at a time while turning the core member to clamp the filaments between the separator blocks and the core member. The core member and separator blocks continue turning while additional separator blocks are added one at a time to form a plurality of radial stacks of separator blocks so that the filaments are clamped between adjacent separator blocks in each stack. Simultaneously the filaments are fed axially so that they are wound helically on the separator blocks. One aspect of the method is to insure proper action in withdrawing each filament from its supply coil without backlash or tangling; each coil is secured in a generally upright stationary position within a container, which is then filled with discrete rounded particles to a depth to surround and submerge the supply coil, and the filament is then pulled upward off the upper end of the supply coil. Apparatus particularly adapted for carrying out this method includes a pair of axially spaced supports mounted to turn on a common axis with radial guide channels on each support for receiving and supporting one end of each of the separator blocks to form plurality of radial stacks.

5 Claims, 6 Drawing Figures



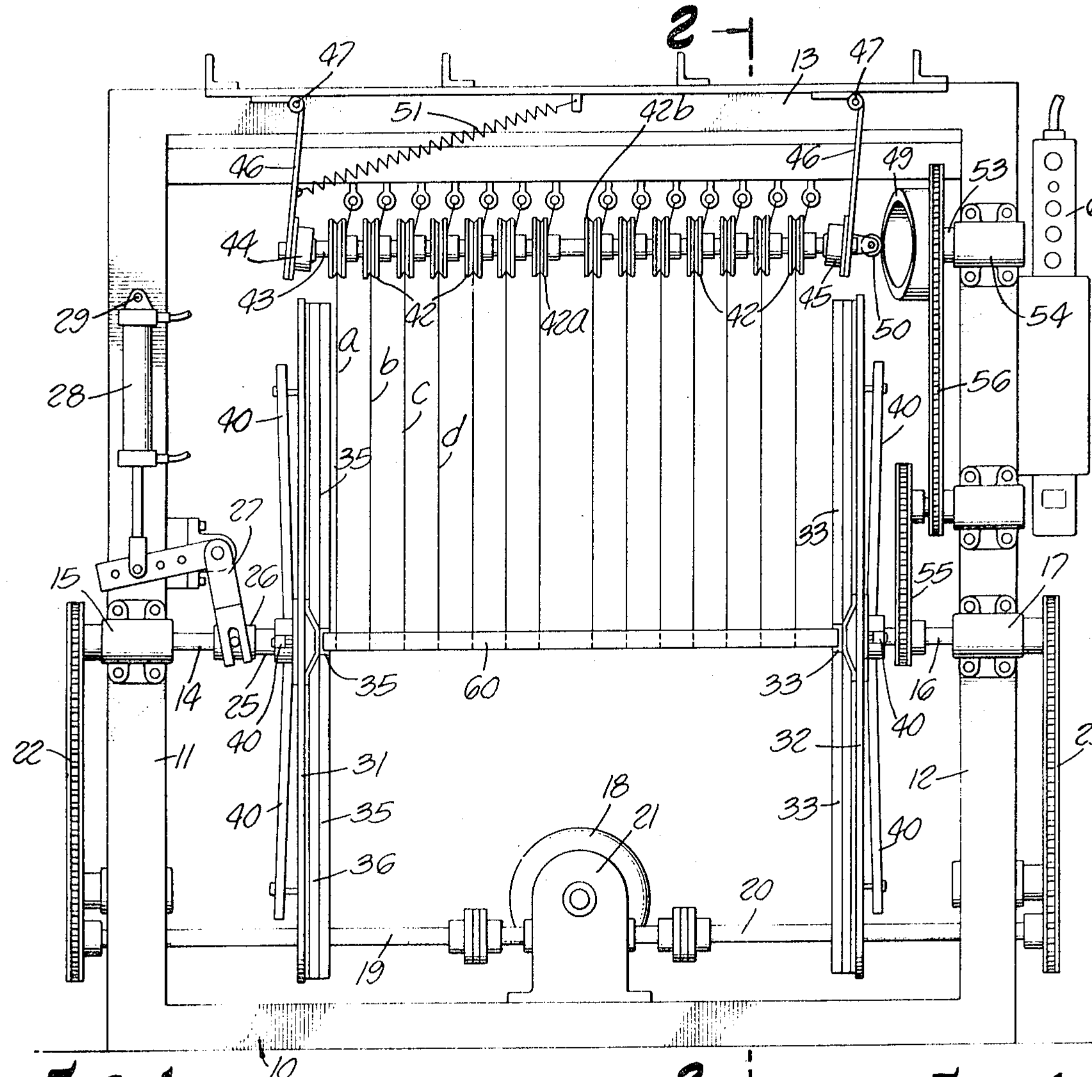


FIG. 1.

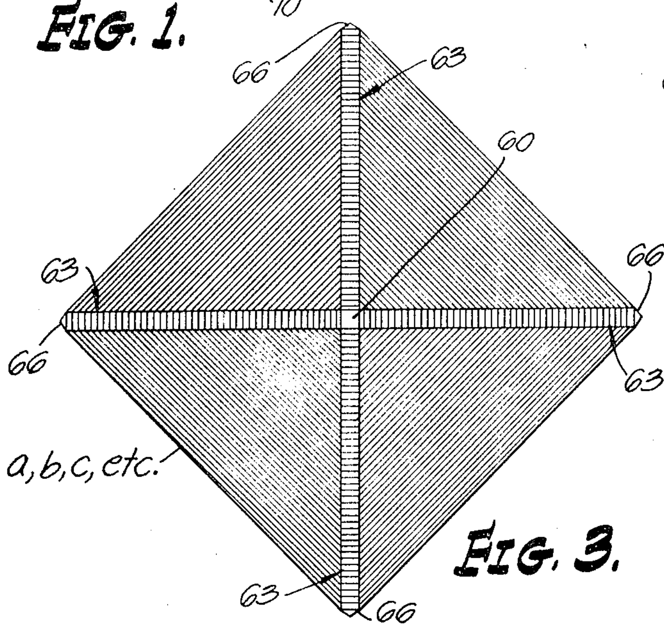
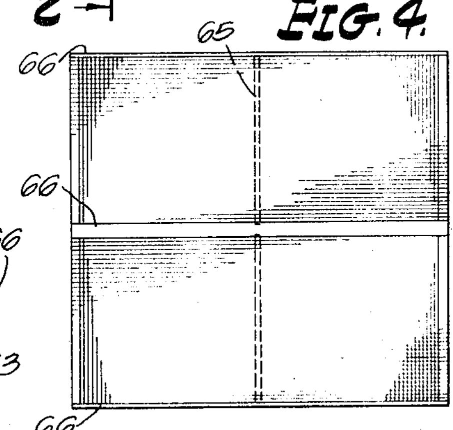


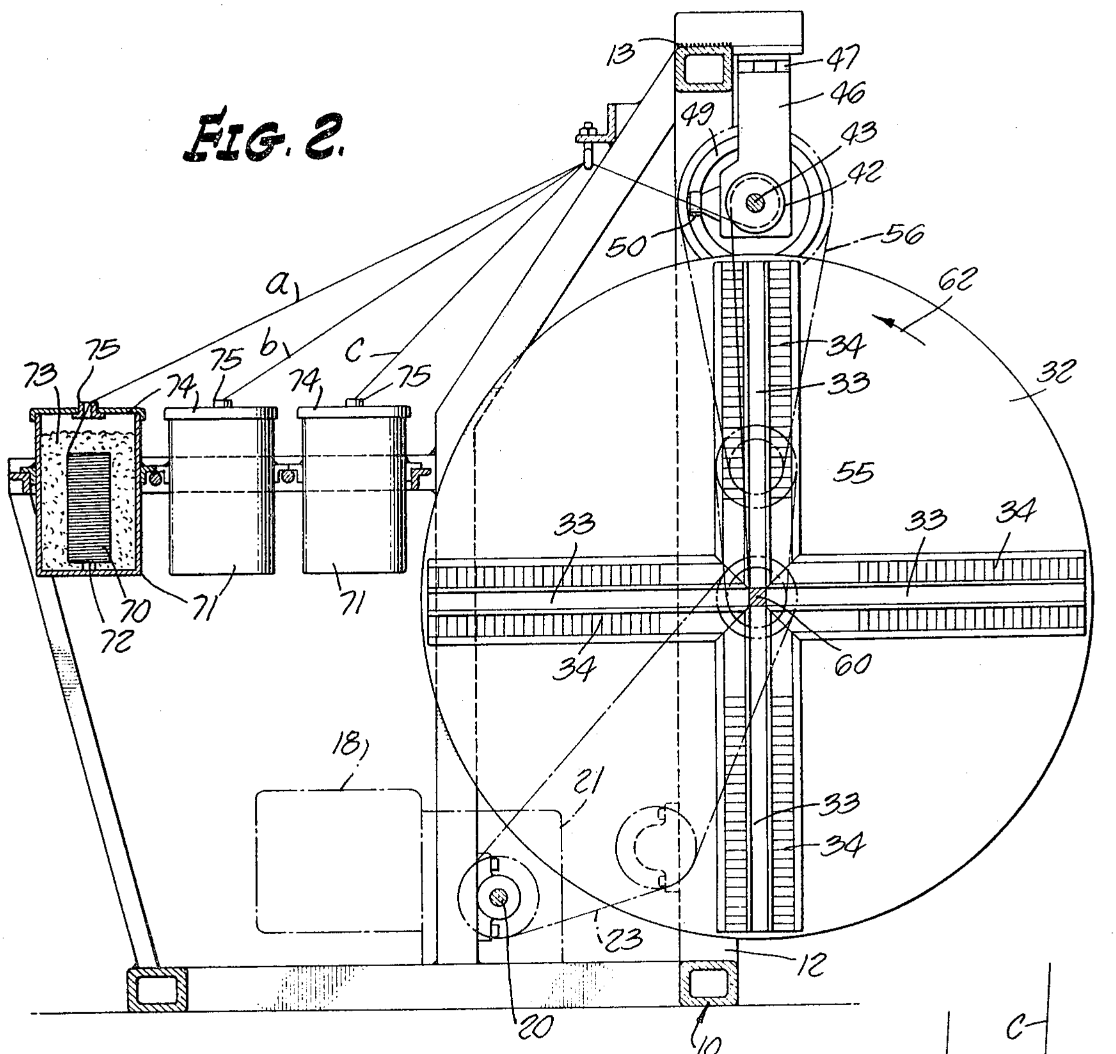
FIG. 3.

FIG. 4.



INVENTOR
DIVEN MEREDITH
BY Lyon & Lyon
ATTORNEYS

FIG. 2.



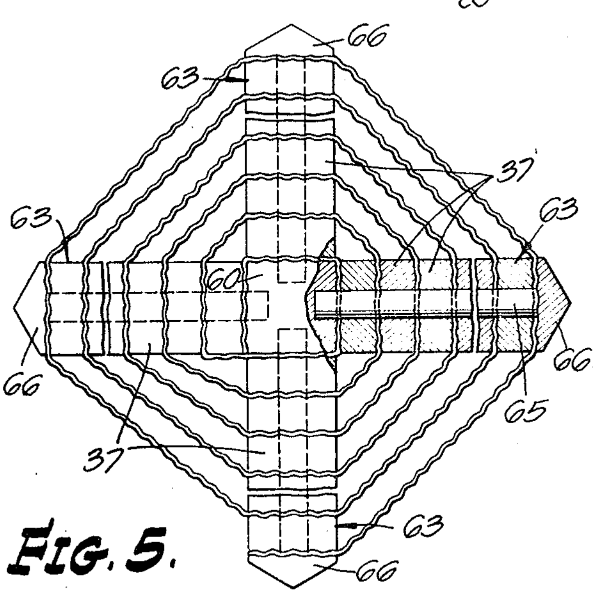


FIG. 5.

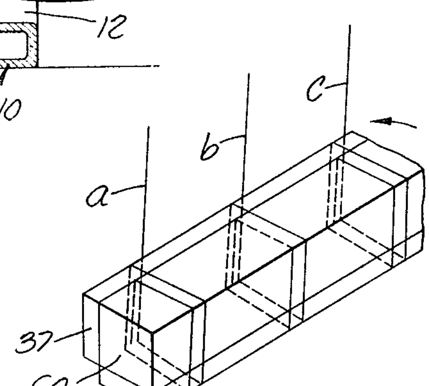


FIG. 6.

INVENTOR
DIVEN MEREDITH
BY Lyon & Lyon
ATTORNEYS

METHOD AND APPARATUS FOR FILAMENT WINDING

This invention relates to a method and apparatus for simultaneously winding a plurality of filaments to form a mass transfer unit such as shown in my prior U.S. Pat. No. 3,463,463, granted Aug. 26, 1969, entitled "Mass Transfer Device for Contacting a Liquid with a Gas." Such a unit may be described as comprising a series of substantially horizontal tensioned filaments disposed in spaced relation so that liquid may drip downward from one filament to the next. Mass transfer units of this type have met with considerable commercial success in pressure cooling installations for fruits, vegetables, etc. The mechanical construction of such a mass transfer unit may comprise a central core with several, typically four, stacks of separator blocks radiating from the central core, with the filaments clamped between adjacent separator blocks and extending free and unsupported between the stacks.

In accordance with this invention, the method of making such a mass transfer device comprises simultaneously winding a plurality of filaments. The filaments are axially spaced along one side of an axially extending core member and the core member is turned about its longitudinal axis to wind the filaments around the core member. Separator blocks are then added one at a time to clamp the filaments between the separator blocks and a side of the core member. The core member and separator blocks continue turning while intermittently adding additional separator blocks one at a time to form a plurality of radial stacks of separator blocks, so that the filaments are clamped between adjacent separator blocks in each stack. At the same time, the filaments are fed axially during the turning movement in order that the filaments may take a helical path.

Apparatus particularly adapted for carrying out this method includes a pair of axially spaced supports power driven to turn about a common axis. The supports have radial guide channels, for example four, for receiving and supporting one end of each of a plurality of separator blocks which are added during the winding operation to form a plurality of radial stacks. A group of axially spaced filament guide pulleys are disposed parallel to the axis and are caused to move axially back and forth as the winding operation progresses.

Because of the variable and uneven rate of unwinding the filament strands from their individual supply coils, backlash and tangling may be encountered with conventional coil unwinding apparatus. In order to overcome this difficulty, each filament supply coil is secured in a generally upright stationary position within a container, the container filled with discrete rounded particles to a depth to completely submerge the supply coil, and the filament strand is pulled upward off the upper end of the supply coil.

Other objects and advantages will appear hereinafter.

IN THE DRAWINGS

FIG. **1** is a front elevation of a preferred embodiment of an apparatus for simultaneously winding a plurality of filaments to form the mass transfer unit described above.

FIG. **2** is a side elevation taken substantially on the lines **2—2** as shown on FIG. **1**.

FIG. **3** is an end elevation of a mass transfer unit of the type produced by the method and apparatus of this invention.

FIG. **4** is a side elevation of the device shown in FIG. **3**.

FIG. **5** is an end view partly broken away, in diagrammatic form, showing details of the device shown in FIG. **3**.

FIG. **6** is a diagrammatic perspective view showing how the filaments are simultaneously wrapped around the core member and separator blocks.

Referring to the drawings, the stationary frame generally designated **10** includes a pair of upright posts **11** and **12** connected at their upper end by a horizontal header **13**. A first rotary stub shaft **14** is mounted in a bearing assembly **15** fixed on the post **11**, and a second rotary stub shaft **16** is mounted on a bearing assembly **17** carried on the post **12**. The stub shafts **14** and **16** are in axial alignment. Means are provided for rotating the stub shafts in unison and, as shown in the drawings, this means includes a variable speed electric motor **18** mounted on the frame **10** and connected to drive the shafts **19** and **20** through a reduction gear assembly **21**. Stub shaft **14** is driven through a chain and sprocket connection **22** from shaft **19**, and similarly stub shaft **16** is driven through a chain and sprocket connection **23** from shaft **20**.

A sleeve member **25** is slidably keyed to stub shaft **14**, and a shifter collar **26** mounted to rotate on the sleeve **25** is connected through a bellcrank assembly **27** for operation by a double acting power cylinder assembly **28**. This assembly **28** is pivotally mounted at **29** on the post **11** and acts to shift the sleeve **25** axially on the stub shaft **14**.

A large circular flange **31** is fixed to the sleeve **25** and is thus supported on the stub shaft **14**. A similar large circular flange **32** is fixed on and is carried by the stub shaft **16**. The flange **32** is provided on its inner surface with four radially extending guide channels **33**, each supported on a large number of transfer spring fingers **34** (see FIG. **2**). The guide channels **33** are equally spaced about the large flange **32**. Similarly, the large flange **32** is provided with four radiating equally spaced guide channels **35** mounted on spring fingers **36**. Each guide channel **35** is in direct confronting parallel relation with one of the guide channels **33**, so that separator blocks **37** may be manually installed in parallel guide channels, during the winding operation described below. Four stiffener bars **40** are mounted on the outside faces of each of the large diameter flanges **31** and **32** and serve to maintain radial alignment of the flanges.

A series of filament guide pulleys **42**, one for each filament strand *a*, *b*, *c*, *d*, etc., are fixed in axially spaced position on a pulley shaft **43**. This shaft is carried on self-aligning bearings **44** and **45** suspended on parallel straps **46** connected by pivots **47** to the header **13**. The pulley shaft **43** is parallel to the rotary axis of the stub shafts **14** and **16** and are caused to move axially back and forth by means of the rotary cam **49** and follower roller **50**. The spring **51** holds the follower roller **50** in engagement with the surface of the cam **49**. The cam **49** is fixed on shaft **53** mounted in bearing assembly **54** on post **12** and is driven by chain and sprocket connections **55** and **56** from the stub shaft **16**. Accordingly, rotation of the flanges **31** and **32** is accompanied by back and forth movement of the pulley shaft **43** and filament guide pulleys **42**. Two of the pulleys **42*a*** and **42*b*** are spaced wider apart than the others to provide a blank space not wrapped by filaments, for the purpose of installing a dowel rod, as described below.

In operation, a central core member **60** is positioned centrally between the flanges **31** and **32**. This core member **60** may comprise a wood post square in cross section. It is installed in axially extending central position by retracting the flange **31** by means of the power cylinder assembly **28** and bellcrank **27**. The flange **31** is then returned to its operating position and the core member **60** is clamped endwise between the flanges. Each of the guide channels **33** and **35** radiate from one of the flat faces of the core member **60**. The individual filaments *a*, *b*, *c*, *d*, etc., are preferably formed of polypropylene and are crimped in a zigzag fashion. This crimping produces offset prominences which contribute to an overall elastic effect to overcome any sag characteristics which might be encountered with straight noncrimped filaments. The filaments which pass over the guide pulleys **42** are manually drawn downward into the level of the core members **60**, or below. The filaments are attached to the core member by any convenient means; for example, they may be drawn together in a bundle and tacked loosely to the core member **60** by tying a knot. The core member **60** is then rotated by turning of the flanges **31** and **32** in unison. This is accomplished by manually operating one of the buttons on the control panel **61** to cause the electric motor **18** to drive the stub shafts **14** and **16** in unison. A few revolutions of the core member **60** cause the filaments to spread out in spaced relationship on the core member, in accordance with the spacing of the filament guide pulleys **42** on the pulley shaft **43**. At this point, the individual filaments *a*, *b*, *c*, *d*, etc., are in the position shown in FIG. **1** of the drawings.

While the central core member **60** is turning in the direction of the arrow **62**, one of the separator blocks **37** is placed in the guide channels **33** and **35** which are nearest the front of the machine, and the separator block **37** is moved toward the rotary axis until separator block contacts the core member **60**, clamping the filaments between the separator block and the core member **60**. This operation of inserting the separator block occurs while the guide channels **33** and **35** are moving toward vertical position. This operation may be performed by automatic feed equipment, not shown, or manually by the operator. As the separator block **37** turns with the core member **60**, the separator block **37** is contacted by each of the filaments *a*, *b*, *c*, *d*, etc., and is thus held in position against the core member **60**. It is prevented from dropping downward by gravity along the guide channels **33** and **35** as it moves under the central core member **60** as the rotation continues. Each time a pair of guide channels **33** and **35** approach vertical position above the core member **60**, the operator manually inserts another separator block **37**, and the filaments wrap around it and hold it against movement radially outward. The diagram of FIG. **6** shows the position of the core member **60** after the first two separator blocks **37** have been installed.

The turning motion of the flanges **31** and **32** and of the central core member **60** and separator blocks **37** continues, with the operator manually adding four separator blocks **37**, one at a time, for each revolution of the flanges. Four stacks **63** of separator blocks **37** are thus built up radially from the central core member **60** along the guide channels **33** and **35**. The filaments are clamped between adjacent separator blocks **37** and extend free and unsupported between the radiating stacks **63**. During the rotary motion of the flanges, the pulley shaft **43** is caused to reciprocate axially by the rotary cam **49** and follower **50**, and the extent of lateral movement is slightly less than the axial spacing of the guide pulleys **42** on the pulley shaft **43**. The rotary cam **49** turns at a slower rate than the stub shafts **14** and **16**, so that a number of revolutions of the flanges are required before the pulley shaft **43** has moved forward and back through its complete cycle of motion.

When the mass transfer packing unit (as shown in FIG. **3**) has been built up to the desired size, in accordance with the above-described method, the rotation is stopped and the operator uses a jig, not shown, to drill four radial holes through the center of each stack **63** of wooden separator blocks **37**. The holes are drilled deep enough to enter the central core member **60**. A dowel pin **65** is then installed in each of the holes to prevent any lateral shifting of the separator blocks **37**. End caps **66** are then installed and secured at the outer end of each of the stacks **63**, and the filament strands are cut, to complete the assembly. The assembly may then be withdrawn from the machine by operating the power cylinder assembly **28** to cause the bellcrank **27** to retract the flange **31**.

Although four stacks **63** of separator blocks have been shown and described in connection with the process and apparatus, it will be understood that a greater or lesser number of stacks may be used.

Since the required feed rate of filament strands varies widely during uniform rotation of the device being constructed, considerable difficulty may be encountered in preventing backlash and tangling of the filaments as they are being withdrawn from their respective helically wound supply coils. It has been found that this objectionable backlash and tangling may be entirely eliminated by placing each supply coil **70** in an upright position within the container **71**, and fixing the lower end **72** of the supply coil so that it remains upright within the container and does not turn. The container is then filled to a level to surround and submerge the entire supply coil **70** with discrete solid rounded particles **73**. For crimped polypropylene filaments of approximately 0.010 inch nominal per cross section, it has been found that the rounded kernels of the cornlike agricultural product maize, often used as cattle feed, operate satisfactorily. The "hydraulic" head of the kernels provide an inward-directed force preventing looseness and backlash of the filament as it is being withdrawn from the supply coil. Lightweight ballbearings would work equally well. Polished rice grains have been found unsatisfactory because they are oblong rather than rounded and tend to pack together. Sand grains are too angular and also pack together to give unsatisfactory results. The depth of the discrete solid rounded particles, as well as the density thereof, controls the degree of tension required in the filament to cause unwrapping movement from the supply coil.

Each of the containers **71** is provided with a removable cover **74** having a central aperture **75** directly above the centerline of the supply coil **70** and through which the filament from the coil passes. The filament tension is maintained at the desired level and objectionable backlash and tangling are eliminated, even though the rate of feed of filaments from the supply coil is irregular.

Having fully described my invention it is to be understood that I am not to be limited to the details herein set forth but that my invention is of the full scope of the appended claims.

I claim:

1. The method of withdrawing a filament from a helically wound supply coil comprising: mounting the supply coil in a generally upright position below the level of a blanket of discrete smooth rounded particles surrounding the supply coil, to produce inward forces on the coil throughout its length preventing looseness of the coiled filament, and pulling the filament off one end of the supply coil.

2. The method set forth in claim **1** in which the particles comprise a natural agricultural seed product.

3. The method set forth in claim **1** in which the particles comprise milo maize.

4. The method of withdrawing a filament from a helically wound supply coil comprising: mounting the supply coil in a generally upright stationary position within a container, filling the container with discrete smooth rounded particles to a depth to completely surround the supply coil, to produce inward forces on the coil throughout its length preventing looseness of the coiled filament, and pulling the filament upward off the upper end of the supply coil.

5. The method of withdrawing a filament from a helically wound supply coil comprising: mounting the supply coil in a stationary position below the level of a blanket of discrete smooth rounded particles surrounding and submerging the supply coil, to produce inward forces on the coil throughout its length preventing looseness of the filament on the coil and pulling the filament through the blanket off one end of the supply coil.

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