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1. We are the nominated persons.
2. The nominated person is the assignee of the actual inventor.
3. The nominated person is the assignee of the applicant of the basic application listed in the declaration under Article 8 of the PCT.
4. The basic application is the application first made in a Convention country in respect of the invention.

Dated: 21 September 1993

By **PHILLIPS ORMONDE & FITZPATRICK**  
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By:

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To: The Commissioner of Patents

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- (57) Claim

1. A combination including: a container, an article within the container, and a plurality of randomly oriented separate spiral coils of relatively thin flexible strip within the container and disposed about the article, each of said coils being wound in a relatively loose coil shape having overlapping, unsecured convolutions, each successive convolution at least partially overlapping all preceding convolutions.

6. Dunnage for cushioning packaged articles, said dunnage in the form of separate spiral coils each including a flexible strip having unsecured convolutions closely adjacent one to the next, each successive convolution at least partially overlapping all preceding convolutions, and having central areas adjacent opposite ends of the coil that are surrounded by the convolutions and are large relative to the aggregate thickness of a ring formed by the convolutions.

10. Apparatus for concurrently forming a plurality of separate spiral coils of thin flexible paper, having multiple convolutions, including:

a stationary narrow rigid convex surface;  
means for continuously feeding a length of thin flexible paper wider than the width of individual coils to be formed continuously along a path and across said

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surface, and for continuously bending the length of paper against, and moving it through engagement across, said surface with sufficient force and pressure to continuously stretch one side of the length of paper relative to an opposite side and to cause the length of paper to curl in a single direction sufficiently to form a spiral coil of plural overlapping convolutions;

means for cutting the length of paper in the direction of feed to form adjacent strips; and

means for periodically cutting said length of paper across its width to separate coiled portions of the strips.

16. A method for concurrently forming a plurality of separate spiral coils of paper having plural convolutions, including the steps of:

providing a length of paper wider than the width of individual coils to be formed;

continuously sliding the length of paper across a single narrow, rigid, convex surface with an endless flexible movable surface:

bending and tensioning the length of paper across said convex surface with sufficient force to cause the length of paper to coil in a single direction into multiple overlapping convolutions when unrestrained;

continuously cutting the length of paper along the direction of feed to form adjacent strips; and

periodically cutting the length of paper across its width to separate coiled portions of the strips.

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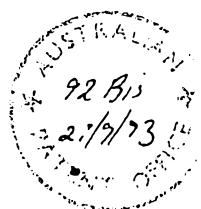
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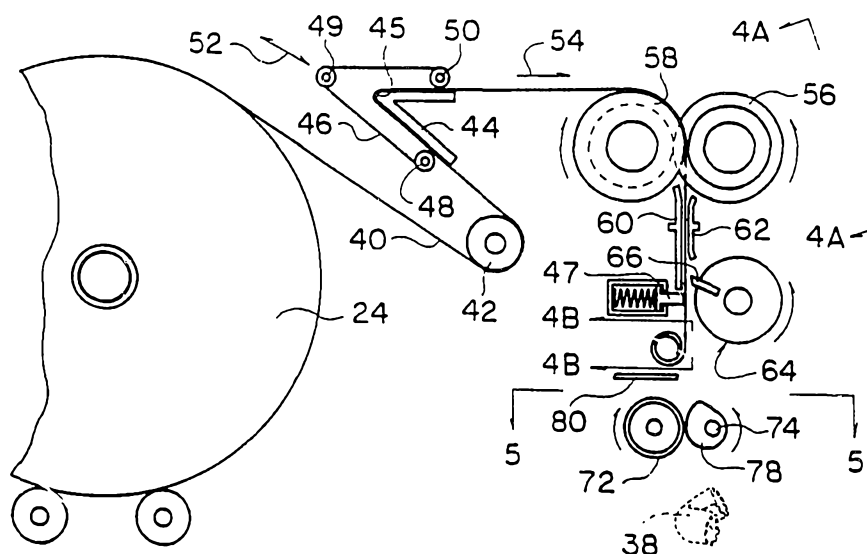
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(54) Title: IMPROVED DUNNAGE, METHOD AND APPARATUS FOR MAKING, AND PACKAGE USING SAME



## (57) Abstract

Improved dunnage made from spiral coils (22, 36, 38) of paper that are recyclable and biodegradable, or from other thin, flexible, resilient strips. The coils are cylindrical or cylindrical with a transverse fold (37, 39), and are randomly oriented in a container (26) to provide cushioning for packaged articles. The coils (22, 36, 38) are formed at the time of use by modifying the material (24) used to cause it to coil and forming strips (34) from the material (24). This eliminates the need for storage of bulky dunnage. Paper (24) used to form the coils (22, 36, 38) is stretched to cause it to coil. Apparatus (20) concurrently forms plural coils from a web.

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IMPROVED DUNNAGE,  
METHOD AND APPARATUS FOR MAKING, AND  
PACKAGE USING SAME

Related Application

This application is a continuation-in-part of copending U.S. patent application Serial No. 07/681,087 filed April 5, 1991.

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Technical Field

This invention relates to spiral coils, improved dunnage made from the coils, packages for articles that protect the articles by the use of the coils randomly oriented, and methods and apparatus for making the coils.

10

Background Art

It is common to protect articles being shipped in containers by filling extra space in the container with so called dunnage to isolate the articles from the container walls and inhibit movement of the articles within the container. Retailers, and especially those who specialize in catalog sales, typically use boxes that are not specifically designed in size or shape for particular articles and therefore they include substantial amounts of packing or dunnage in the boxes along with the article or articles shipped to reduce the risk of breakage.

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Cushioning dunnage, such as excelsior, shredded newsprint, and the like has been in long use. More sophisticated materials and forms have also been proposed, such as the helical coil-like or tubular-like dunnage made from paper web shown in U.S. patent No. 3,650,877, or helically convoluted synthetic strands as shown in U.S. patent No. 3,347,036. Recent popular materials are plastic bubble sheets, particles or shapes of materials such as polystyrene, and other open-or closed-cell foamed

materials. All packaging is coming under attack because of disposal problems, especially due to the lack of adequate landfill facilities and the non-biodegradable properties of the popular plastic packing materials. The quantity of plastic dunnage used in packaging is so great, and the ability to recycle it is so poor, that the disposal problem is becoming unmanageable. While some industrial uses of polystyrene particles, to take one current example of a widely used dunnage material, permit collection and re-use, the great majority of such material is used for packing retail products that are widely distributed directly to consumers, who individually never receive enough to justify collection and recycling; yet in total, the amount of polystyrene packing used is making its disposal a major problem. The same is true of bubble pack. A further problem with such materials is the space they require for storage prior to use. The nature of the plastic dunnage is such that it takes as much space while stored as it does in use. Retailers and especially mail-order houses, find it necessary to provide large rooms or warehouses merely to hold the dunnage needed for shipping their products. This adds substantially to the packaging costs. Some of the non-plastic dunnage used, such as shredded newsprint, lacks structural strength and is easily compressed, and is disliked by retailers and customers because of the dirt and mess associated with its use, as well as the space it occupies unless the retailer does its own shredding, which still involves a less desirable packing operation than dispensing small plastic particles into a package.

Disclosure of Invention

The present invention is capable of overcoming the storage problem, the disposal problem and the difficulties in packing with shredded material. It is able to  
5 provide low cost, small size, dunnage that can be formed and directly dispensed into packages by the retailer. In its preferred form, the dunnage itself is recycled material, can again be recycled, and is biodegradable. It is extremely compact before being formed and after use it can be compressed in volume to a small fraction of its volume as used.

10 The dunnage may be small, resilient, spiral coils of



Disclosure of Invention

The present invention overcomes the storage problem, the disposal problem and the difficulties in packing with shredded material. It provides low cost, small size, dunnage that can be formed and directly dispensed into packages by the retailer. In its preferred form, the dunnage itself is recycled material, can again be recycled, and is biodegradable. It is extremely compact before being formed and after use it can be compressed in volume to a small fraction of its volume as used.

The dunnage is small, resilient, spiral coils of thin, flexible, resilient strips, most advantageously paper strips, randomly oriented in a container to fill unused space, retard relative movement of an article within the container, and typically also at least in part to isolate the article from the container walls and thereby cushion fragile articles against shock.

Convolutions of the strips forming the coils are preferably closely adjacent one to the next and provide rigidity in the axial direction, and they surround an open central area that facilitates transverse distortion, but with resilience due to the inherent properties of the paper. Optionally, a transverse fold can be formed in the coil, either perpendicular to the coil axis or at an angle to the axis, to reduce axial rigidity and to vary the manner in which the randomly oriented coils interrelate. A variety of the shapes can be used together in a single package, which variety as well as the proportions of the different constructions used varies the cushioning characteristics of the dunnage.

The preferred manner of forming the coils is to modify a length of paper in a manner to cause it to coil, then separate it into strips and sever the coils; thereafter, if desired, creasing the coils transversely. Most





advantageously, one side of the paper is stretched to cause it to coil.

Apparatus is provided for modifying the paper by stretching one side of the paper by bending it across a rigid edge, applying force and moving the paper across the edge. The modified paper is cut into strips that then curl to form the coils. Advantageously, the paper is initially in the form of a rolled web and is continuously fed and stretched across a narrow rigid edge, slit in its direction of travel by rotary cutters and cut transversely to desired length by a shear, so as to fall directly into a shipping carton on a platform or conveyor below the shear, thereby avoiding any need for storing the formed dunnage.

This invention has the advantages of being ecologically sound because the paper used is preferably fully or partially recycled and is recycleable after use and is biodegradeable, lower in cost than bubble wrap, styrene "peanuts" or the like, and paper wadding, and is without static cling. Hard wound rolls of kraft paper store in a fraction (estimated to be between about 1/80th and 1/200th, depending upon the density of the coils) of the space that would be required for styrene dunnage that would fill the same capacity as the spiral coils made from the roll. By controlling the degree to which the paper coils, as by varying the tension on the web and/or the force applied against the edge across which the web is drawn, which regulates the diameter of the coils, and by varying the length of the strips that form each coil, the softness or firmness of the coils and the bulk density can be changed to suit the needs of the articles being packaged. The number of cutting cycles performed can be easily coordinated with step-by-step advance of a conveyor moving cartons beneath the coil-forming machine to control the amount of dunnage dispensed into each carton,

allowing a mix of carton sizes to be handled through pre-programmed control of the conveyor feed.

According to one broad aspect of the present invention, there is provided a combination including: a container, an article within the container, and a plurality of  
5 randomly oriented separate spiral coils of relatively thin flexible strip within the container and disposed about the article, each of said coils being wound in a relatively loose coil shape having overlapping, unsecured convolutions, each successive convolution at least partially overlapping all preceding convolutions.

Preferably, the convolutions of each coil have a common axis and the coils  
10 are relatively small with respect to the container and article and substantially isolate the article from direct contact with the container.

Preferably, at least some of the coils have a transverse fold or crease creating a bend in the axis of each of those coils and an axial variation in the shape of those coils.

According to another broad aspect of this invention, there is provided dunnage  
15 for cushioning packaged articles, said dunnage in the form of separate spiral coils each including a flexible strip having unsecured convolutions closely adjacent one to the next, each successive convolution at least partially overlapping all preceding convolutions, and having central areas adjacent opposite ends of the coil that are  
20 surrounded by the convolutions and are large relative to the aggregate thickness of a ring formed by the convolutions.

Preferably, at least some of the coils have a transverse fold creating a bend between opposite ends and a variation in the size of the central areas between the ends.

According to a further broad aspect, this invention provides an apparatus for  
25 concurrently forming a plurality of separate spiral coils of thin flexible paper, having multiple convolutions, including:

a stationary narrow rigid convex surface;

means for continuously feeding a length of thin flexible paper wider than the  
30 width of individual coils to be formed continuously along a path and across said surface, and for continuously bending the length of paper against, and moving it



through engagement across, said surface with sufficient force and pressure to continuously stretch one side of the length of paper relative to an opposite side and to cause the length of paper to curl in a single direction sufficiently to form a spiral coil of plural overlapping convolutions;

5 means for cutting the length of paper in the direction of feed to form adjacent strips; and

means for periodically cutting said length of paper across its width to separate coiled portions of the strips.

10 Preferably, the apparatus further includes means, including opposed members spaced transversely of the path, for engaging and transversely creasing coils formed from the strips.

According to yet another broad aspect, the invention provides a method for concurrently forming a plurality of separate spiral coils of paper having plural convolutions, including the steps of:

15 providing a length of paper wider than the width of individual coils to be formed;

continuously sliding the length of paper across a single narrow, rigid, convex surface with an endless flexible movable surface;

20 bending and tensioning the length of paper across said convex surface with sufficient force to cause the length of paper to coil in a single direction into multiple overlapping convolutions when unrestrained;

continuously cutting the length of paper along the direction of feed to form adjacent strips; and

25 periodically cutting the length of paper across its width to separate coiled portions of the strips.

Preferably, the method further includes the step of:

creasing coils formed from the strips transversely between ends of the coils.



The invention also relates to apparatus for concurrently forming a plurality of coils of thin, flexible, resilient material, the apparatus having means for feeding along a path a length of the material wider than individual coils to be formed, means for modifying the length of material along the path to cause the modified length to coil when unrestrained, means for temporarily restraining the modified length from coiling, and means for separating the modified length into strips that form separate coils.

#### Brief Description of Drawings

A preferred embodiment of the invention is shown in the accompanying drawings, in which:

Figure 1 is a perspective view of apparatus for forming and dispensing spiral coils for use as dunnage, in accordance with the present invention;

Figure 2 is a partial top view of a partially filled, open package, diagrammatically indicating the manner in which spiral coils are randomly contained to protect a fragile article in a container;

Figure 3 is a diagrammatic view of apparatus for forming the coils in accordance with the invention;

Figure 4A is a partial perspective view of a web drive and slitting mechanism taken along the line 4A-4A of Figure 3, with parts omitted, showing a part of the slitting apparatus and diagrammatically indicating the slitting of a length of paper;

Figure 4B is a partial perspective view, taken along the line 4B-4B of Figure 3, of the coils severed from the strips of paper formed by the slitting apparatus;

Figure 5 is a top view taken along the line 5-5 in Figure 3, showing a creasing mechanism and diagrammatically illustrating the folding of coils;



Figures 6A and 6B diagrammatically show the manner in which a coil of paper is received and then creased by the mechanism of Figure 5, with Figure 6B being taken along the line 6B-6B of Figure 5;

5        Figures 7A and 7B are front and perspective views, respectively, of a cylindrical coil constructed in accordance with the present invention;

10        Figures 8A and 8B are front and perspective views, respectively, of a cylindrical coil having a transverse fold or crease that is perpendicular to the axis of the coil and constructed in accordance with the present invention;

15        Figures 9A and 9B are front and perspective views, respectively, of a cylindrical coil having a transverse fold or crease that is oriented at an angle not perpendicular to the axis of the coil and constructed in accordance with the present invention;

20        Figure 10 is a diagrammatic side elevational view of a second embodiment of apparatus for forming the coils in accordance with the invention;

Figure 10A is an enlarged portion of Figure 10; and

Figure 11 is a front elevational view of the apparatus of Figure 10 taken from the right side of Figure 10.

#### 25        Best Mode for Carrying Out the Invention

30        With reference to the drawings, a machine 20 is shown in Figure 1 for forming spiral coils 22 from a roll of paper 24 and for depositing the coils directly into an open box 26 on a support 28 beneath the machine. The support 28 in the embodiment shown accommodates the sliding of the box to proper position. Typically, where random sized boxes are being used and the articles being packaged are fragile, an operator will dispense a layer of dunnage in the form of the coils, place an article or  
35        articles in the box, and then fill the remaining volume

with additional dunnage, thereby isolating the packaged article from the walls of the box, as diagrammatically illustrated in Figure 2. The forming and dispensing of the coils is advantageously controlled by a foot switch 30. For applications where continuous packaging of similar items in boxes of uniform size is desired, two machines 20 can be used in tandem and the support 28 can be in the form of a conveyor, moving the boxes to a first machine that dispenses a layer of coils, then to a station between the two machines where an article or articles are placed in the box, and then to the second machine where the box is filled with coils. In that type of operation, the machines can be set to automatically form and dispense a predetermined quantity of coils each time a container is detected at the machine station. Because the coils are formed as they are used, no storage of bulky dunnage is required.

The coils 22 are formed of a strip 34 of paper (Figure 4 and Figure 7B) convolutely coiled into a spiral. Preferably, convolutions C1 of the strip are closely adjacent one to the next and a central area A1 surrounded by the convolutions is large in the transverse direction relative to the thickness of a ring R formed by the convolutions C1. The thickness of the ring is sufficient to provide substantial axial strength or rigidity to the coil, while the inherent flexibility of the paper, along with the thickness of the ring and the relatively large central area A1 provides transverse resilience and "give," so that together those properties along with the random orientation of the coils in a container provide good isolation and cushioning of packaged articles. However, the convolutions can be more uniformly spaced throughout the area within the outer circumference of the coil. A preferred spiral coil 22 is made of a strip of 30 to 100 pound (13.6 to 44.5 kilogram) basis weight kraft paper (virgin, recy-



5 cled, or a combination), between 3/4 inch and 2 1/2 inches (1.9 and 6.35 cm.) wide and between about 3 and 10 (7.62 and 25.4 cm.) inches long. The outside diameter of the coil is between about 3/8 and 5/8 inch (.95 and 1.59 cm.). Coils of these dimensions are useful for protecting articles having a large variation in size and weight. Of course, greater stiffness and larger coils can be achieved if necessary by using heavier paper, longer and wider strips and controlling the outside diameter by varying the extent to which the paper is modified to cause it to coil, or conversely, softer and smaller coils can be achieved in the opposite manner.

10 In accordance with the invention, the characteristics of the coils are modified in two additional embodiments 36 and 38, shown in Figures 8A, 8B and 9A, 9B, respectively. These coils are approximately twice as long as the coil 22, but otherwise are identically formed before modification. Each is then folded or creased centrally of the ends, transversely of the coil axis as indicated by the dotted lines 37, 39, resulting in a bent shape as shown in Figures 8B and 9B. The fold 37 is perpendicular to the coil axis and results in the two portions 36a and 36b being angularly related in a common plane to which the fold is perpendicular. The fold 39 is at other than a 90 degree angle to the axis of the coil, between 30 and 60 degrees and preferably 45 degrees, resulting in the two portions 38a and 38b being angularly related in a common plane to which the fold 39 is not perpendicular. In the preferred embodiments, the angle at the fold is between about 90 and 140 degrees. As a result of the fold, the area within the ring of convolutions varies axially of the coil, being substantially eliminated at the fold and at a maximum and substantially circular in shape at the ends. These modified shapes do not have the direct column strength along their length

that the cylindrical shape shown in Figures 7A and 7B has and interact with one another or with the other embodiments differently when randomly oriented in a container than do the cylindrically shaped coils. For example, the two angularly related portions 36a, 36b or 38a, 38b when compressed toward each other not only have give and resilience through distortion of the cross sectional shape, but also through changes in the angle between the two angularly related portions. In addition, with the angular fold 39, it is unlikely that either of the portions 38a, 38b will experience or effectively resist direct column loads, but will have greater transverse resistance to compressive loads at the central area where the fold is located. Thus, they may function with more uniformity; i.e., their resistance to load may not vary as greatly in different directions as the cylindrical shapes. The different shapes can be blended in varying proportions within a container to obtain different cushioning characteristics.

Apparatus for forming coils 22, 36 and 38 is shown in Figures 3-6. As shown, a roll 24 of kraft paper or other suitable paper, such as recycled paper, is rotatably supported so a continuous web 40 of the paper can be drawn from the roll and formed into coils. The web has a width sufficient to form several coils simultaneously, as shown in Figures 4A and 4B. While the web shown in Figure 4A illustrates seven strips side-by-side, that is by way of a preferred example only and the number may vary depending upon the production desired. In Figure 4B, the strips are shown just after coiled portions have been cut from the strips, and from that location will fall through a discharge opening of the machine or will first be folded and then discharged. The coils in Figure 4B are located in the relationship they would have to the strips they are cut from in Figure 4A, but the cutting mechanism that



would be located between what is shown in the two figures is omitted. The web is tensioned by an idler roll 42 and is bent over a V-shaped plate 44 that extends the width of the web. The apex of the V over which the web travels forms a narrow, but not cutting-sharp, rigid edge 45.

The web is tensioned across the edge by an endless belt 46 that is as wide as the plate 44 and is entrained about three guide rolls 48, 49 and 50. The belt is in part in contact with the opposite side of the web from the web surface that slides across the plate and to that extent follows the contour of the web and V-shaped plate. This is assured by the placement of the rolls as shown in Figure 3, owing to the close proximity of rolls 48, 50 to the surfaces of the plate. Tension on the belt is adjusted by the roll 49, which is movable in the direction of the arrow 52. By virtue of the belt tension against the web and across the edge 45, the belt is moved with the web by friction and applies force to the web against the edge 45.

The web 40 is moved in the direction of the arrow 54 by two driven rolls 56, 58 that slit the web into strips 34 extending in the direction of web travel. As shown in Figure 4A, the rolls have alternating larger and smaller diameter portions (shown at 56L and 56S on roll 56), each equal in length to the width of the strips to be cut. The larger diameter portions of each roll nest with the smaller diameter portions of the other with a small clearance and shear the web at the junctures to form strips as the web is pulled through the nip of the rolls, which are spaced closely together to frictionally engage the strips.

Guides 60, 62, directly below the rolls 56, 58, on opposite sides of the strips and closely spaced apart, allow the strips to move downward while preventing the strips from coiling. At the lower terminus of the

guides, a cutting mechanism 64 severs the strips at a desired length. Those portions below the guides and cutting mechanism are allowed to coil, forming a spiral coil, preferably with closely adjacent convolutions and an open central area that is large relative to the thickness of the ring formed by the convolutions.

The cutting mechanism 64 utilizes a straight or slightly angled blade 66 that is on one side of and extends the width of the strips and is supported for rotation that will bring it into cutting contact with the strips. A non-rotatable blade 67 extends the width of the strips on the opposite side of the strips from the blade 66. The rotatable blade 66 acts against the blade 67 to shear the strips across the entire width of side-by-side strips. The blade 67 is supported for limited movement in the plane of the blade and is yieldably held in its operating position so that the two blades can properly cooperate to sever the coils from the strips as the rotatable blade is brought into contact with the strips. The blade 46 is rotated through one complete revolution each time the strips advance a desired distance past the cutting station, e.g., six to ten inches. Rotation is accomplished by a one-revolution drive, such as a reciprocable rack and a driven pinion with a pawl and ratchet wheel connection to the shaft for one-direction rotation, or a single revolution clutch, the operation of which is timed from the rotation of the rolls 56, 58 that advance the web.

Where it is desired to fold or crease the coils to form the embodiments of Figures 8A, 8B or 9A, 9B, a folding mechanism 70 is located beneath the cutting mechanism 47, aligned to receive severed coils, fold them, and discharge them from the machine. As shown in Figures 3-6B, a side-by-side roll 72 and shaft 74 in a common horizontal plane extend the width of the strips 34, parallel

with the coils and located to receive the coils between them. The roll 72 is of metal, coated with, or covered by a sleeve of, resilient material 75, such as plastic or rubber, and preferably has peripheral grooves 76. The roll 72 is larger in diameter than the coils 36 or 38, shown in Figures 8A and 9A. The shaft 74 has spaced cam-like discs 78 eccentrically disposed, each with a major radius  $r_1$  that extends just to or only slightly into opposed grooves 76, but out of contact with the surface of the roll 72. Each disc has a minor radius  $r_2$  that is located approximately 180 degrees from the major radius and that terminates substantially short of the surface of the roll 72, but close enough that the coils will not pass between the discs and the roll. The roll and shaft are counter-rotating as indicated by the directional arrows in Figure 3 and rotation is continuous during operation of the machine. When a coil drops from the cutting mechanism it falls to a position shown in Figure 6A, where it is supported by a disc and back-up roll and is pressed against the back-up roll as the disc and back-up roll counter rotate to bring the progressively larger radius portions of the disc into closer proximity to the roll 72, carrying the coil with them, folding or creasing the coil against the back-up roll and bending the end portions away from the roll, in part aided by the grooves 76. The roll and disc frictionally carry the creased or folded coil through the nip and discharge it below, as illustrated in Figure 6B. In some cases, the coil may not land or stay parallel to the roll and shaft, but rather tip to one side or the other. In that case, the discs will form the fold at an angle to the coil axis as illustrated at 39 in Figures 9A and 9B instead of perpendicular to the axis as illustrated at 37 in Figures 8A and 8B.

Where it is desired to assure that the coils are tilted when received in the nip of the roll 72 and the discs 78, a thin rod 80 (Figure 3) or the like is positioned in the path of each falling coil, beneath the cutting mechanism 64 and above the folding mechanism 70, adjacent one end of each coil so as to delay the downward movement of one end long enough to tip the axis of the coil from the horizontal, to approximately a 45 degree angle. The discs, especially at the edge surface portion leading into the major radius section, may be serrated or have a coating of high coefficient of friction to assure that the coils are pulled into the nip of the discs and back-up roll.

In operation, the driven rolls 56, 58 pull the web 40 from the roll 24 across the edge 45, slit the web into strips 34, and advance the strips to the cutting mechanism 64. The web is tensioned across the edge 45 by the idler roll 42, the pulling force of the drive rolls 56, 58, and the belt 46, which retards web movement owing to the fact that the belt is driven through frictional engagement with the web. In addition, the belt applies a force to the web in the direction of the edge to bend it sharply over the edge. As a result of the pulling and bending of the web across the edge, the opposite surface of the web from the one in direct contact with the edge is stretched relative to the surface in contact. This modifies the web in a manner that causes it to coil when the web tension is released and the web is not constrained, as when it exits the guides 60, 62 and the directly adjacent cutting mechanism 64. The individual coils that form beneath the cutting mechanism are concurrently cut from the supporting strips at intervals that are coordinated with the strip travel so that the coils are formed with a desired strip length to provide the desired strength and resilience to the coils. The coils

are then discharged in cylindrical form or are folded in the manner described immediately above.

5 A second preferred apparatus 100 embodying the invention is shown in Figures 10 to 11 of the drawings. In this embodiment, a roll of kraft paper 24' or other suitable material, such as recycled paper, is rotatably supported by the apparatus so a continuous web 40' can be drawn from the roll and formed into coils. The web has a width sufficient to form several coils simultaneously, as  
10 in the first embodiment described. The web is festooned and tensioned by idler rolls 101 as it leaves the roll and travels through a nip between a driven roll 102 and a narrow edge 103 of a fixed rigid blade 104. The driven roll and the blade extend the width of the web 40'. The  
15 roll has a resilient surface, e.g., polyurethane of light durometer, such as 30 to 50 durometer, and a greater coefficient of friction than the edge 103 of the blade. The roll is supported at the top of a frame 106 that is pivoted about a shaft 108 between the top and bottom of  
20 the frame. The lower end of the frame is connected to one end 110 of an over-center toggle mechanism 112. The toggle mechanism is connected at an opposite end 113 to a support nut 114 adjustable along a threaded adjusting rod 116 operated from outside the machine housing by an adjustment knob 117. An elbow link 118 at the end 113 has  
25 operating arms 120, 121 selectively operated by a linear actuator, such as a solenoid 122 having a laterally extending finger 124 at the end of a reciprocable rod 125. The solenoid is constructed to extend and retract the rod each time the solenoid is energized and to rotate the rod  
30 180 degrees (one cycle), so that actuations of the solenoid alternately open and close the toggle because the solenoid automatically acts alternately on the operating arms 120, 121. Each time the machine is operated to  
35 rotate the driven roll 102 through the motor driven spro-

cket 127, chain 128 and sprocket 129 on roll 102, the solenoid is energized for one cycle, the finger 124 contacts the arm 120 and the toggle is closed, pivoting the frame 106 to bring the roll 102 (now rotating) and web 40' against the edge 103 of the fixed blade 104. Each time the operation of the driven roll is stopped, the solenoid is energized for one cycle, the finger 124 contacts the arm 121 and the toggle is opened, moving the roll away from the blade. This not only automatically facilitates the infeed of the web from a new roll of paper through the nip of the drive roll 102 and blade 103, but also avoids having to start each operation of the machine with the roll under the load induced by the pressure between the roll and blade, allowing the use of a smaller drive motor. Because the end 113 of the toggle remains in its adjusted position unless purposefully changed by operation of the knob 117, the roll 102 is always returned to its former position each time coils are formed, applying the same force to the paper gripped between the roll and blade and thereby producing coils of the same size and density as before.

The roll 102 deforms inwardly when it presses the web 40' against the narrow edge 103 of the blade 104. The narrow blade edge is preferably smooth so as not to cut the web, and is rounded to facilitate travel of the web across the edge. The web is driven across the edge by the friction between the web and the roll surface. The surface of the web against the blade is believed to be compressed, while the surface of the web against the roll is believed to be stretched and substantially permanently expanded as it is bent over the edge of the blade by the deformation of the roll and is frictionally moved by the indented roll surface. The amount of force applied to the web and the extent to which the blade and web indent the roll can be varied by the knob 117. A

greater force causes a greater modification of the web structure and causes the web to curl to a greater extent. Thus the diameter and hence the density of the resulting coils can be readily controlled. This makes for a convenient way to control the cushioning characteristics of the dunnage to match the needs of the articles being packaged.

A web deflector 130 mounted on the frame 106 rides against or in close proximity to the roll 102 just beyond the location of the blade 104, and along with a guide 132 that is in spaced opposed relation to the deflector, directs the now modified web exiting from the nip of the roll 102 and blade 104, to a shear 134. The shear includes a shear block 135 and a shear blade 136. The block has a cutting edge 137 over which the web moves from the guide 132. The shear blade is reciprocated across the face of the shear block to sever the web. To this end, the shear blade is secured by pins 138, 139 at each opposite end to a cam follower housing 140, 141, each of which surrounds a single lobe cam (one cam 142 being shown in Figure 10) on a cam shaft 144 driven by a sprocket 146 (Figure 11). Rotation of the cams moves the housings, which carry the shear blade past the cutting edge of the shear block. The shape of the cams provides a relatively long dwell time during which the shear blade is stationary and out of the path of the web, allowing a desired length of web to move beyond the shear; and a relatively short stroke time, during which the shear blade is moved across the web path and then back out of the path. Space is provided behind the guide 132 for the web to buckle while the shear momentarily blocks movement of the web, which is fed from the roll 102 at a continuous and constant rate. The rate (cycles per second) at which the shear blade is reciprocated can be changed by changing the size of the sprocket 146. A movable idler

5 sprocket 148 shown in phantom in Figure 10 illustrates the condition of a drive chain 147 for the sprocket 146 when three different sizes of sprockets are used, each of which drives the cam shaft 144 at a different speed, changing the rate at which the shear is reciprocated, thereby providing a different length to the material severed from the web, to provide coils of different weight and strength. The drive chain 147 is driven by a sprocket 143 (Figure 11) on one end of a shaft 149, driven at its opposite end by the chain 128 and a sprocket 145.

10 A web slitting mechanism 150 is located on the downstream side of the shear 134, considered in the direction of web travel. This mechanism is constructed somewhat similarly to that of the first embodiment. The web is slit by adjacent discs 152, 153 spaced along parallel driven shafts 156, 158, with each shaft having alternating larger and smaller diameter portions 156L, 156S and 158L, 158S between the discs, with the larger diameter portions nesting with the smaller, and the discs being spaced to the desired width of the strips to be formed from the web. However, the nested portions are spaced peripherally to provide a gap for the web strips formed by the discs 152, 153 and do not drive the web or strips. Rather, only the cutting discs apply a driving force to the web downstream from the roll 102.

20 The slitting roll shafts are driven by a sprocket 160 on the shaft 156, which is driven by the chain 128 that drives the roll 102. The sprocket 160 is smaller than the sprocket 129 of roll 102, thereby rotating the shaft 156 at a greater speed. The shaft 158 is coupled by gears 157, 159 to the shaft 156 for rotation in the opposite direction at the same speed. Because the slitting discs rather than the nested shaft portions are in driving engagement with the web, the driving force is



slight, thereby only slightly tensioning the web downstream from the roll 102, but enough to advance the web portion being slit away from the web, once the shear 134 has severed it.

5           Portions of the web immediately coil adjacent the slitting mechanism as the web is slit into longitudinal strips by the discs 152, 153, as illustrated in 36' in Figure 10. Once the severed web portion passes completely through the slitting discs, the coils drop into the  
10           nip of a folding or crimping mechanism 170 below the slitting mechanism. In this embodiment, the folding mechanism utilizes spaced crimping wheels 172 on an idler shaft 174, and a parallel driven crimping roll 176 in direct surface contact with the wheels, forming a nip in  
15           which the coils are received for transverse creasing or folding. The wheels are rigid and have a thin periphery. The opposing roll has a yieldable surface, e.g., polyurethane having a durometer of approximately 30 to 50, and has a sufficient coefficient of friction to cause the  
20           coils 36' to move between the roll and a respective wheel, which is aligned with the middle of the coil as it drops from the slitting mechanism. The combination of the yieldable nature of the crimping roll and the relationship of the peripheries of the crimping roll and  
25           crimping wheels accommodates the folded or crimped portion of the coils 36' as the coils are frictionally forced between the two. The roll and wheels then discharge the folded coils from the apparatus. The crimping roll 176 is supported on the shaft 149 and driven by the  
30           sprocket 145 and the chain 128 that drives the roll 102. The crimping wheels 172, being in direct contact with the crimping roll 176, are driven by it. The supporting shaft 174 is omitted from Figure 11 for clarity of the slitting mechanism behind it.

An important advantage of the embodiment of Figures 10 and 11 is that the web 40' is primarily fed by the roll 102 at the point of modification and is subjected only to a slight tension after it has been modified to cause it to coil. Further, this slight tension is applied only at line contact at spaced locations where the web is being slit. Thus, application of forces subsequent to the modification of the web that would tend to counteract the tendency of the web or strips to coil have been minimized.

While the invention has been described with particularity, it will be appreciated that many variations and alterations may be made or features added, without departing from the spirit and scope of the invention set forth in the claims. For example, while paper is the preferred material because of the low cost and biodegradable properties and its ability to be recycled, as well as its inherent resilient qualities, other thin, flexible, resilient materials can be formed into coils and will function in a similar manner, and provide dunnage that will protect articles in containers and can be produced at the time and place the articles are packaged so as to eliminate bulky storage. It is believed that thin, flexible, resilient plastic sheets or webs, metal foils with proper temper, or laminates of plastic, metal foils and/or paper can be used. Where paper is used, it can be coated with materials that will promote coiling. Such coatings may be heat or moisture activated to shrink or expand and when applied to one side of a web and activated will cause coiling. While the invention has been disclosed applied to a web, it will be understood that it is equally applicable to discrete sheets, which may be of a length requiring severing across the direction of travel, or may be preselected of the desired length, elimi-

nating the need for transverse severing and requiring longitudinal slitting.

It has been found that the characteristics of paper web can be modified by forming flutes or ribbing along the length of the strips, as by embossing the paper during the travel from the roll 24 to the cutting mechanism 64. The increased bulk or effective thickness of the web results in an increased thickness of the ring R formed by the convolutions of the coil and a greater stiffness to the coil.

The paper dunnage can be dyed or printed with designs to provide distinctive packaging. Holiday colors such as green and red for christmas packing can be used as an attractive alternative to the mundane white or grey of plastic or brown of kraft paper. Existing dunnage fails to offer these options with the convenience and ease possible with the present invention.

Other uses than dunnage are also contemplated for the coils. For example, the coils can be used as animal bedding in kennels. For that application, the paper can be coated or impregnated with disinfectant, bug repellent, odor inhibitor, and/or a desirable fragrance, such as that of cedar or pine.

**The claims defining the invention are as follows:**

1. A combination including: a container, an article within the container, and a plurality of randomly oriented separate spiral coils of relatively thin flexible strip within  
5 the container and disposed about the article, each of said coils being wound in a relatively loose coil shape having overlapping, unsecured convolutions, each successive convolution at least partially overlapping all preceding convolutions.
2. A combination as claimed in claim 1 wherein the convolutions of each coil  
10 have a common axis and the coils are relatively small with respect to the container and article and substantially isolate the article from direct contact with the container.
3. A combination as claimed in claim 1 or claim 2 wherein each of said coils is a  
13.6 to 45.5 kilogram basis weight kraft paper strip between about 1.9 and 6.35  
15 centimetres wide and between about 7.62 and 25.4 centimetres in uncoiled length, substantially rigid in the axial direction of the coil and substantially resilient in directions transverse to the axial direction, the convolutions of each of said coils being closely adjacent one to the next forming a ring and a central area surrounded by the convolutions being large in the transverse direction relative to the thickness of  
20 the ring formed by the convolutions.
4. A combination as claimed in any one of claims 1 to 3 wherein at least some of the coils have a transverse fold or crease creating a bend in the axis of each of those coils and an axial variation in the shape of those coils.  
25
5. A combination as claimed in claim 4 wherein the direction of the fold is substantially perpendicular to the direction of the axis.
6. Dunnage for cushioning packaged articles, said dunnage in the form of  
30 separate spiral coils each including a flexible strip having unsecured convolutions closely adjacent one to the next, each successive convolution at least partially



overlapping all preceding convolutions, and having central areas adjacent opposite ends of the coil that are surrounded by the convolutions and are large relative to the aggregate thickness of a ring formed by the convolutions.

5 7. Dunnage as claimed in claim 6 wherein and at least some of the coils have a transverse fold creating a bend between opposite ends and a variation in the size of the central areas between the ends.

8. Dunnage as claimed in claim 6 or claim 7 wherein the strip is paper.

10

9. Dunnage as claimed in claim 8 wherein the paper has a coating on one side that promotes curling of the paper.

10. Apparatus for concurrently forming a plurality of separate spiral coils of thin  
15 flexible paper, having multiple convolutions, including:

a stationary narrow rigid convex surface;

means for continuously feeding a length of thin flexible paper wider than the  
20 width of individual coils to be formed continuously along a path and across said surface, and for continuously bending the length of paper against, and moving it through engagement across, said surface with sufficient force and pressure to continuously stretch one side of the length of paper relative to an opposite side and to cause the length of paper to curl in a single direction sufficiently to form a spiral  
25 coil of plural overlapping convolutions;

means for cutting the length of paper in the direction of feed to form adjacent strips; and

30 means for periodically cutting said length of paper across its width to separate coiled portions of the strips.



11. Apparatus as claimed in claim 10 wherein said means for feeding and bending the paper includes a roll having a periphery of constant diameter except where deformed by said narrow surface, said roll having a peripheral surface with a coefficient of friction greater than that of said narrow surface; and including a drive  
5 for rotating said roll to feed said material between the surface of said roll and said narrow surface and a support for locating said narrow surface and roll in mutual opposition for engaging said length of material therebetween.

12. Apparatus as claimed in claim 10 or claim 11 wherein said narrow rigid convex  
10 surface is provided at a narrow edge member.

13. Apparatus as claimed in any one of claims 10 to 12 wherein it further includes: means, including opposed members spaced transversely of the path, for engaging and transversely creasing coils formed from the strips.  
15

14. Apparatus as claimed in claim 13 wherein said means to crease coils includes opposed rotary surfaces to engage coils intermediate their ends.

15. Apparatus as claimed in claim 14 wherein said rotary surfaces include spaced  
20 narrow discs, and including means to drive at least one of said opposed rotary surfaces.

16. A method for concurrently forming a plurality of separate spiral coils of paper having plural convolutions, including the steps of:  
25

providing a length of paper wider than the width of individual coils to be formed;

continuously sliding the length of paper across a single narrow, rigid, convex  
30 surface with an endless flexible movable surface;



bending and tensioning the length of paper across said convex surface with sufficient force to cause the length of paper to coil in a single direction into multiple overlapping convolutions when unrestrained;

5 continuously cutting the length of paper along the direction of feed to form adjacent strips; and

periodically cutting the length of paper across its width to separate coiled portions of the strips.

10

17. A method as claimed in claim 16 further including the step of:

creasing coils formed from the strips transversely between ends of the coils.

15 18. A method as claimed in claim 16 or claim 17 wherein the steps of sliding, bending and tensioning the length of paper are accomplished by squeezing the length of paper between said convex surface and a roll having a resilient peripheral surface of greater coefficient of friction than said convex surface and rotating said roll.

20

19. A combination substantially as herein described with reference to any one of the embodiments illustrated in the accompanying drawings.

25

20. Dunnage substantially as herein described with reference to any one of the embodiments illustrated in the accompanying drawings.

21. Apparatus substantially as herein described with reference to any one of the embodiments illustrated in the accompanying drawings.

30

22. A method substantially as herein described with reference to any one of the embodiments illustrated in the accompanying drawings.

5

Dated: 16 June, 1995.

PHILLIPS ORMONDE & FITZPATRICK

Attorneys for:

10 PATRIOT PACKAGING CORPORATION

*David B Fitzpatrick*

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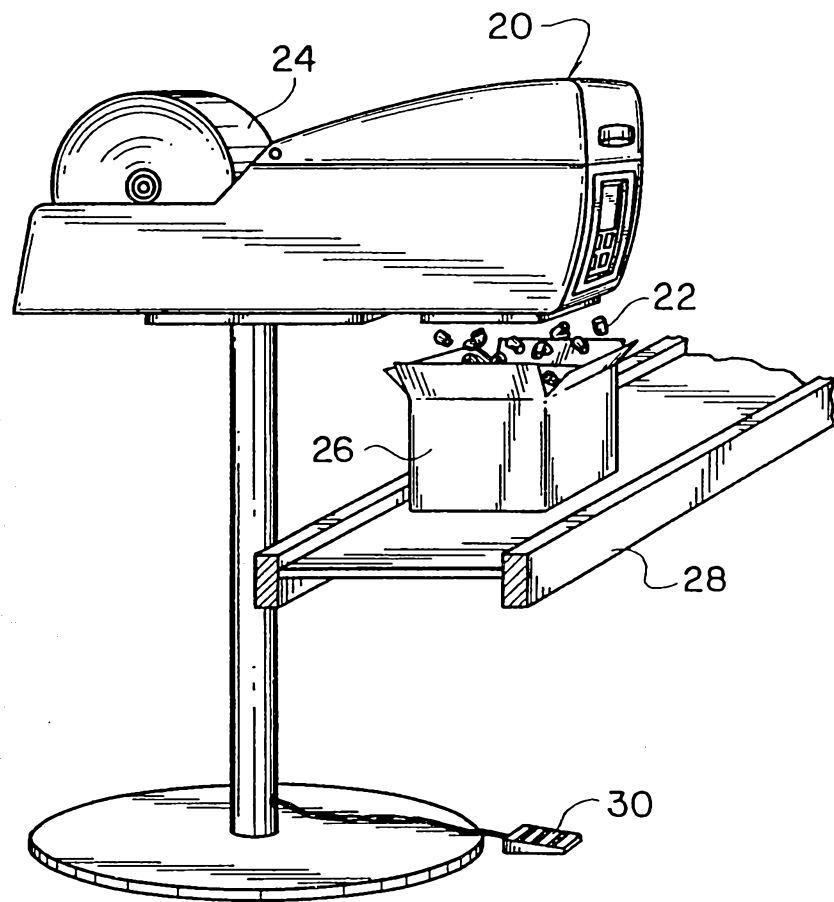


FIG. 1

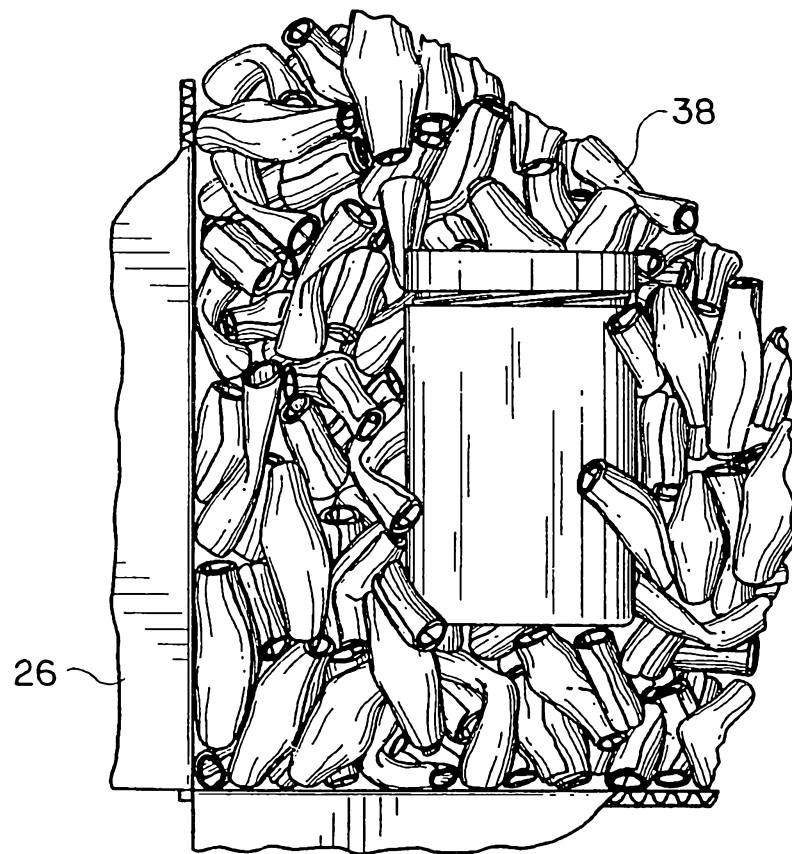
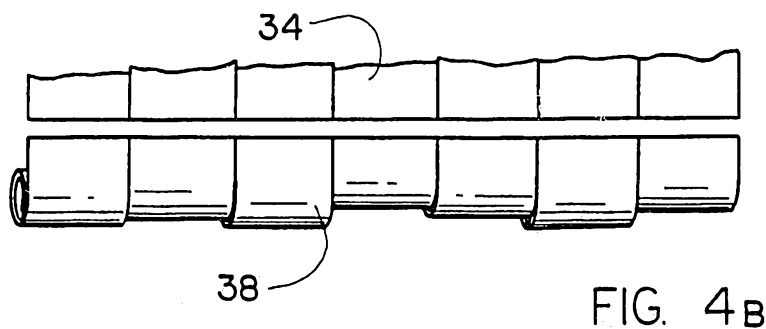
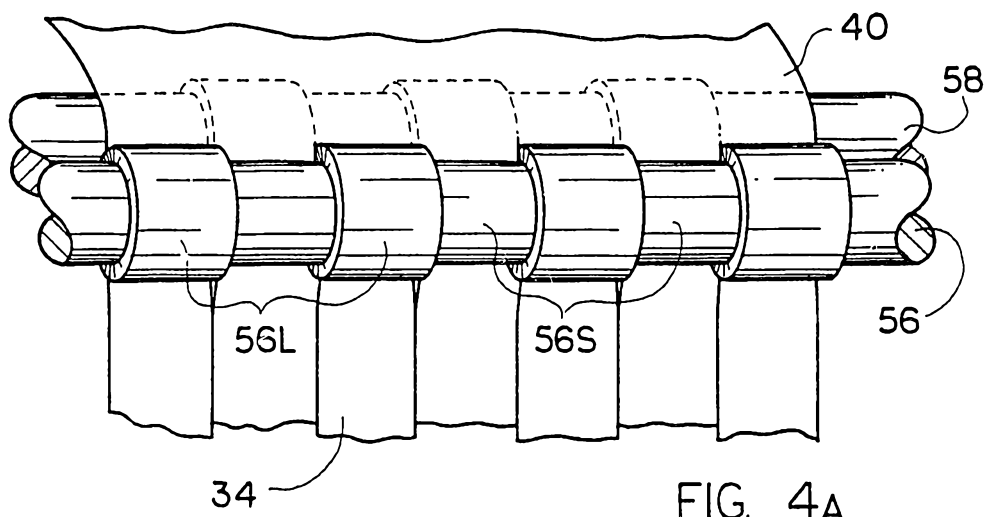
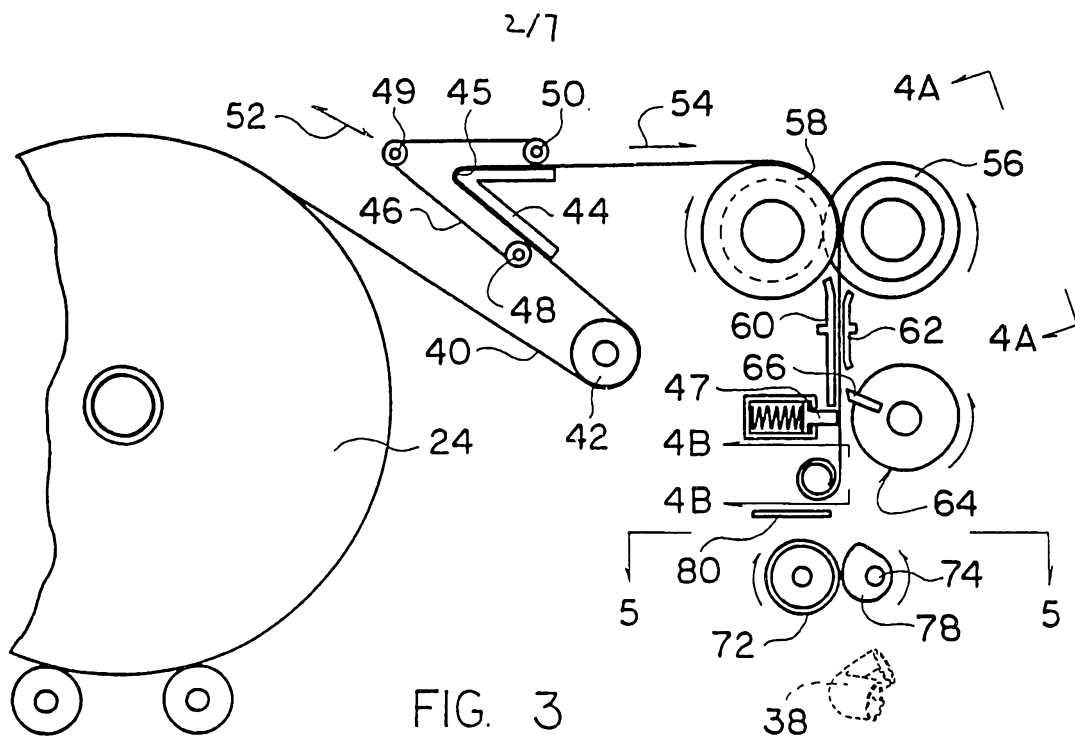


FIG. 2



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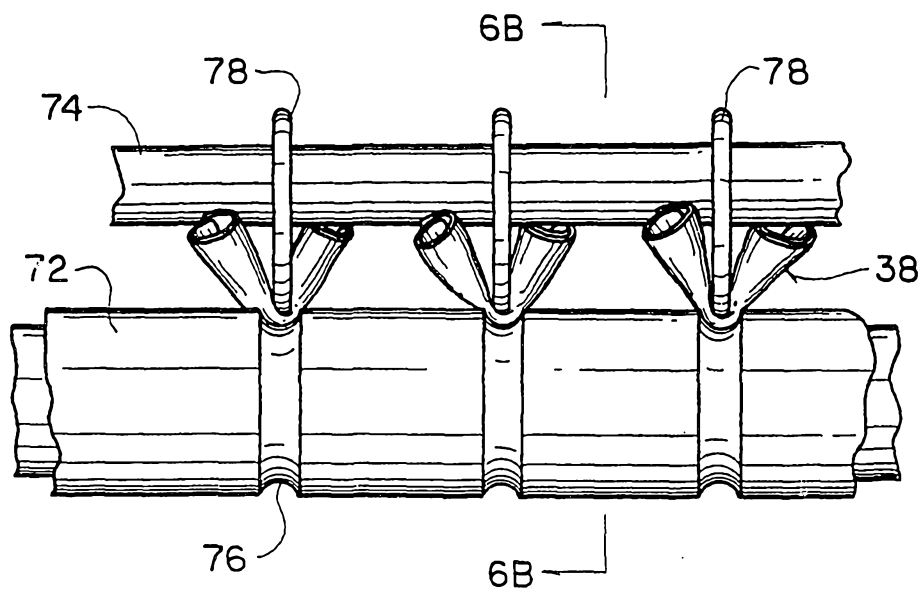


FIG. 5

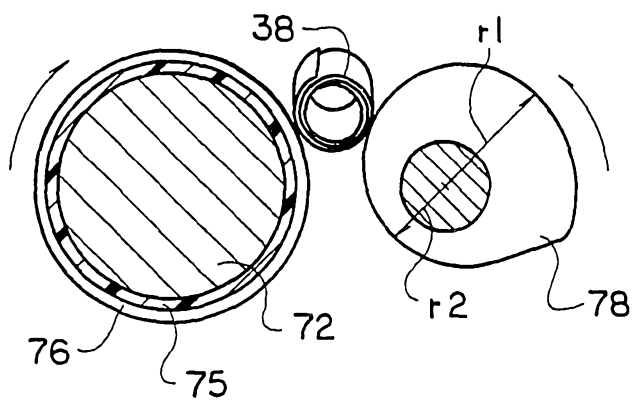


FIG. 6A

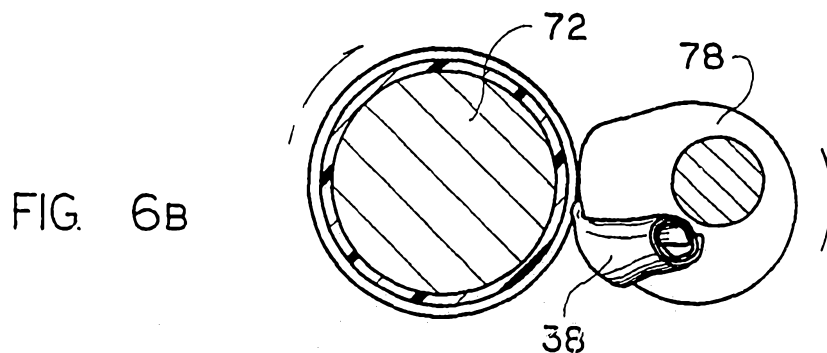


FIG. 6B

FIG. 7A

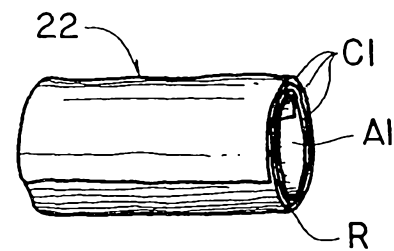
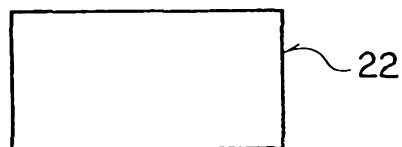


FIG. 7B

FIG. 8A

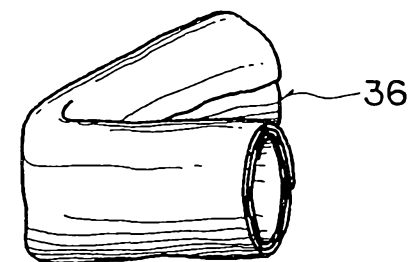
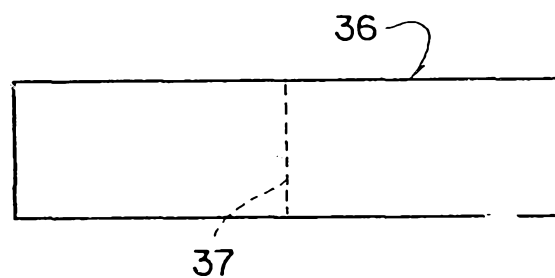


FIG. 8B

FIG. 9A

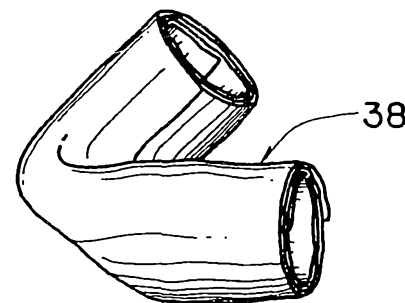
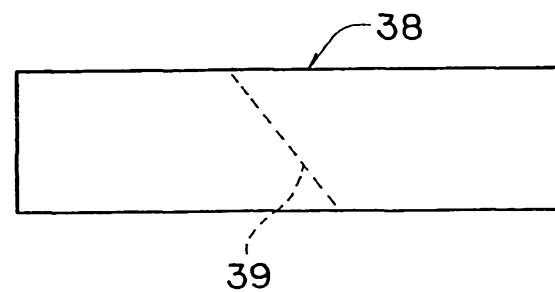
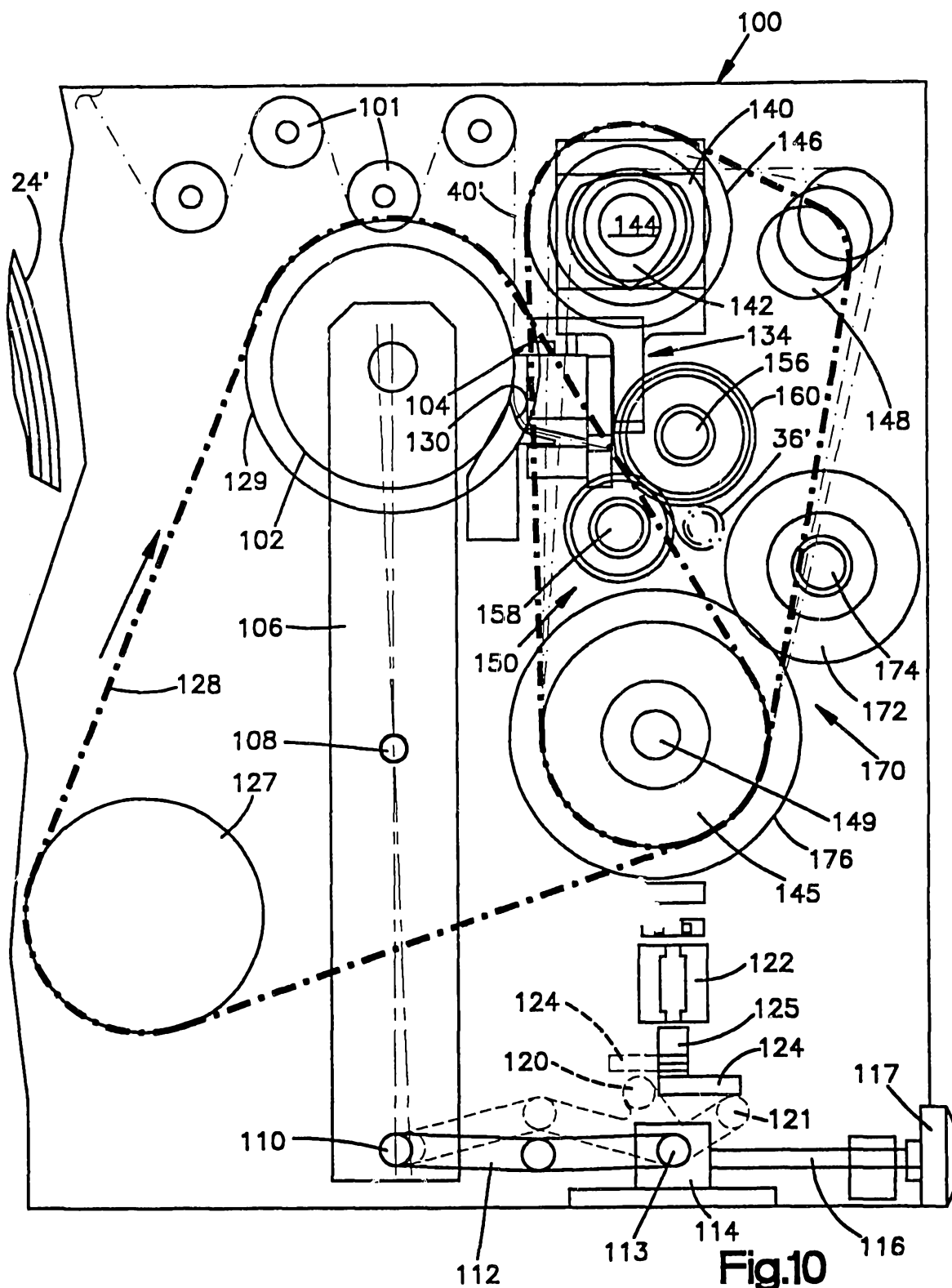


FIG. 9B



# SUBSTITUTE SHEET

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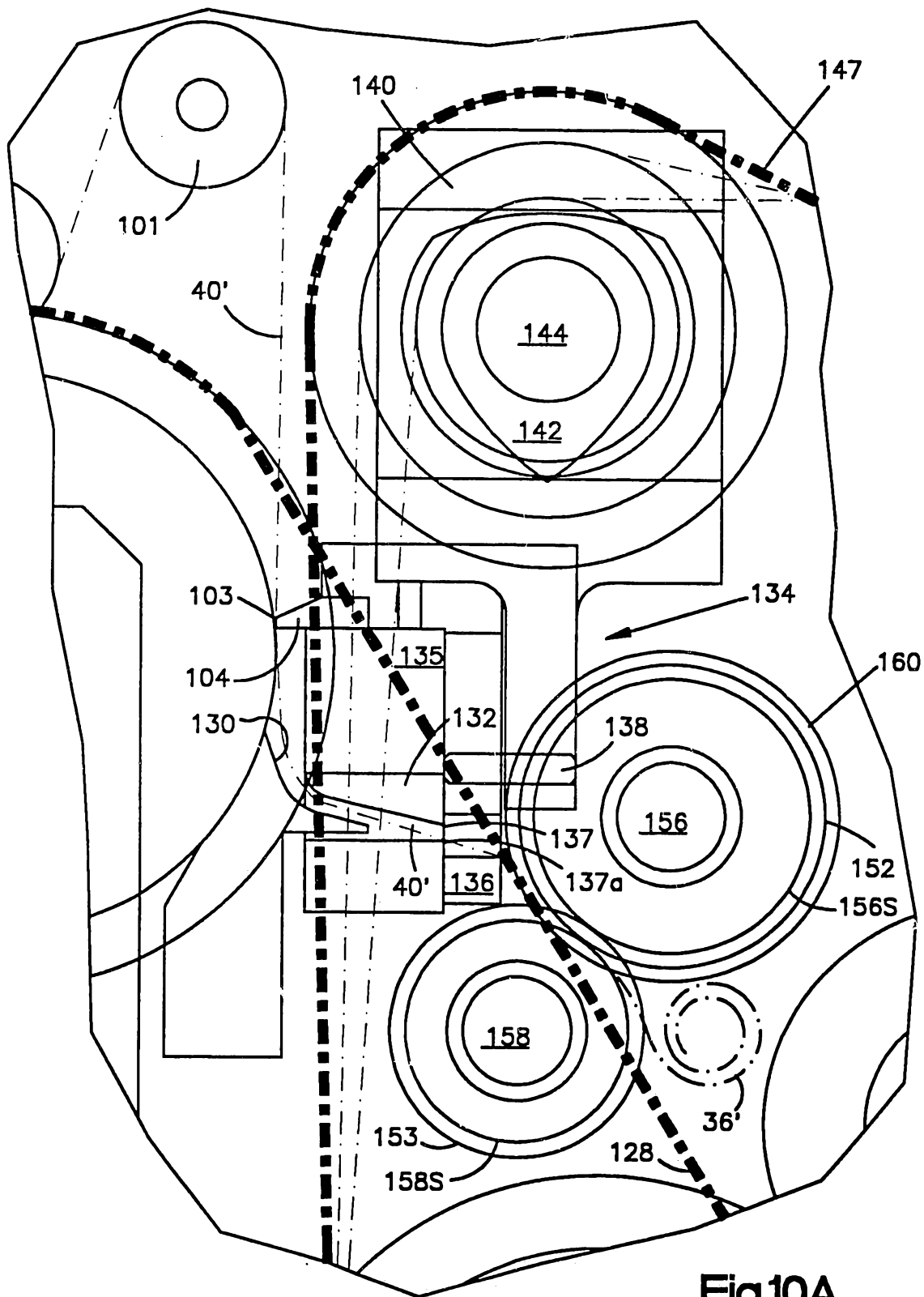


Fig.10A

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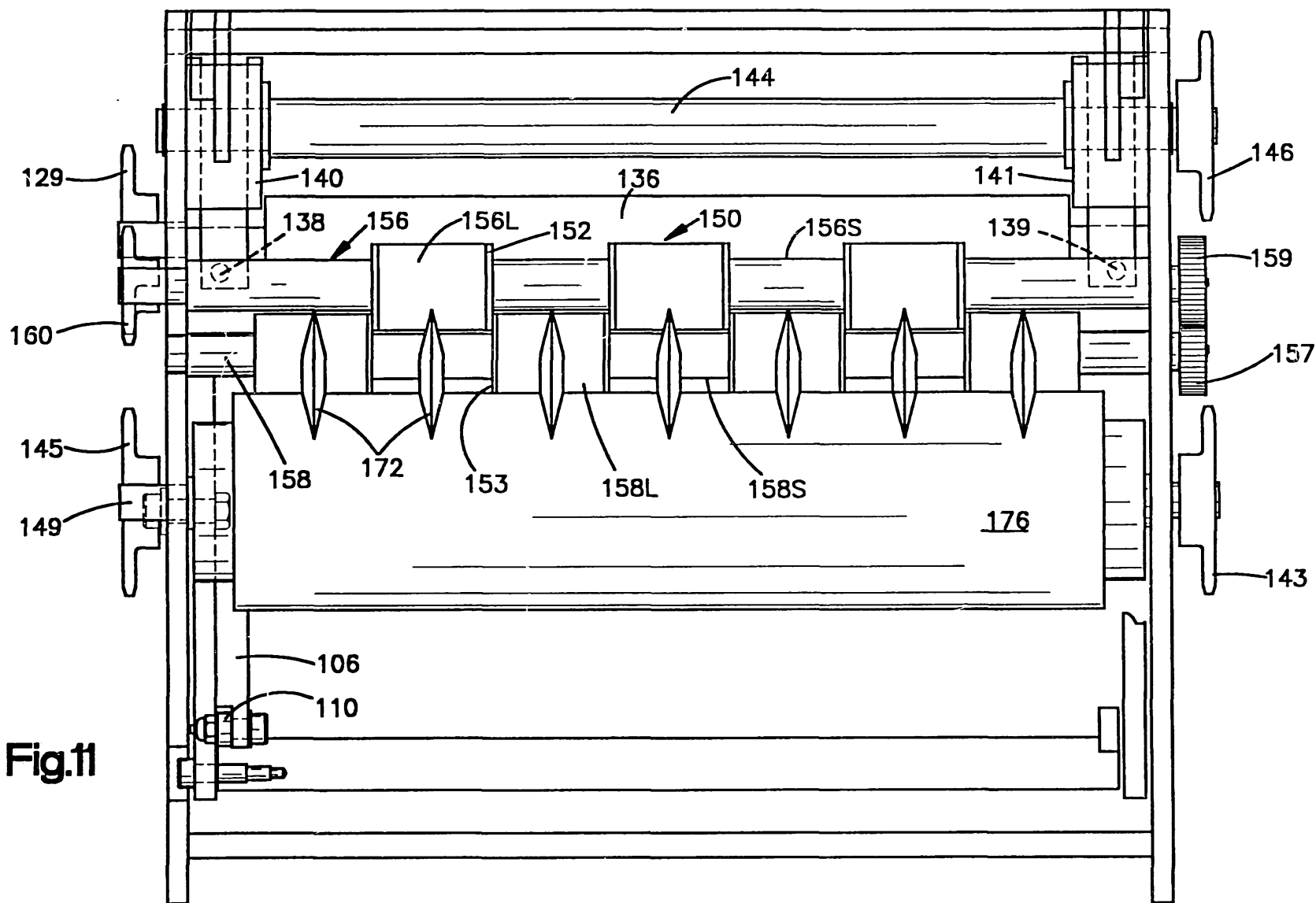


Fig.11

SUBSTITUTE SHEET

# INTERNATIONAL SEARCH REPORT

International Application No. PCT/US92/02864

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC IPC(5): B65B 23/00, 55/20, 61/20, 63/04; D02G 3/00; B31B 1/36; B31F 1/00 US CL: 53/139.5, 428, 435, 472; 428/369; 493/459		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
US	53/111R, 115, 118, 139.5, 238, 239, 428, 430, 435, 472, 474, 520; 428/369, 402; 493/352, 363, 365, 459, 462, 465, 967	
Documentation Searched other than Minimum Documentation to the extent that such documents are included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>9</sup>		
Category <sup>1</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
Y	US, A, 2,924,154 (RUSSELL) 09 FEBRUARY 1960, SEE ENTIRE DOCUMENT.	4,11
Y	US, A, 3,347,136 (KURE) 17 OCTOBER 1967, SEE ENTIRE DOCUMENT.	1-14
Y	US, A, 4,800,708 (SPERRY) 31 JANUARY 1989, SEE ENTIRE DOCUMENT.	6
Y	CA, A, 747,107 (KONDSTANDT) 29 NOVEMBER 1966, SEE ENTIRE DOCUMENT.	1-14
A	US, A, 390,442 (BRIGHAM) 02 OCTOBER 1888, SEE ENTIRE DOCUMENT.	
A	US, A, 2,297,368 (RIPPL) 29 SEPTEMBER 1942, SEE FIGURE 1.	
A	US, A, 3,047,136 (GRAHAM) 31 JULY 1962, SEE FIGURE 1.	
A	US, A, 3,650,877 (JOHNSON) 21 MARCH 1972, SEE FIGURE 5.	
<p>* Special categories of cited documents: <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application out cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search		Date of Mailing of this International Search Report
25 JUNE 1992		14 JUL 1992
International Searching Authority		Signature of Authorized Officer
ISA/US		LINDA B. JOHNSON



**FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET**

- |   |   |
|---|---|
| A | US, A, 4,247,289 (MCCABE) 27 JANUARY 1981,<br>SEE ENTIRE DOCUMENT.  |
| A | US, A, 5,088,972 (PARKER) 18 FEBRUARY 1992,<br>SEE ENTIRE DOCUMENT. |

**V ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE <sup>1</sup>**

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

- 1 ☐ Claim numbers \_\_\_\_\_ because they relate to subject matter <sup>1,2</sup> not required to be searched by this Authority, namely:
  
- 2 ☐ Claim numbers \_\_\_\_\_, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out <sup>1,2</sup>, specifically:
  
- 3 ☐ Claim numbers \_\_\_\_\_, because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

**VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING <sup>2</sup>**

This International Searching Authority found multiple inventions in this international application as follows:

- I. CLAIMS 1-14 DRAWN TO AN APPARATUS AND METHOD OF FORMING COILS.
- II. CLAIMS 15-21 DRAWN TO A COIL PER SE AND A PLURALITY USED AS DUNNAGE IN A CONTAINER.

- 1 ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
- 2 ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
- 3 ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers: 1-14

**TELEPHONE PRACTICE**

- 4 ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

**Remark on Protest**

- ☐ The additional search fees were accompanied by applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.