

CORE-WOUND PAPER PRODUCT AND METHOD OF MAKING IT

TECHNICAL FIELD

The invention relates to roll-type paper products such as paper towels and toilet tissue which comprise lengths of a paper web which are wound onto
5 disposable paper or cardboard cores and which lengths of paper are conventionally subdivided into convenient sheets by transverse lines of perforations or slits. Such paper is generally high bulk by virtue of, for example, low density paper making methods, and/or by embossing. In addition to the relatively high bulk of the paper, the void space within a roll
10 with a conventional hollow core takes up a substantial volume. Accordingly, the present invention provides compact, core-wound paper products and methods of making such products having substantially reduced shipping and storage volumes.

BACKGROUND ART

15 In order to reduce the volume of wound articles it is desirable to compact such articles or an array of such articles, in order to make effective use of available space during transport of the articles.

The background art discloses a number of different solutions for compacting core-wound paper rolls and the like. A package of compressed resilient
20 articles and a method of unpacking is disclosed in US 4 595 093. The figures depict the compressed articles as being of cylindrical shape and having circular tubular cores. The exemplary embodiment is stated to have been compressed to reduce the volume of the array of articles (e.g. rolls of toilet tissue) reduced by about twelve percent. Also, a process of packaging batts
25 of fibres is disclosed in US 3 537 226. This discloses forming a wound batt or roll on a rigid core, removing the core, encasing the roll in an air impervious bag, evacuating air and securing the contracted structure with a wrapper to maintain substantially the contracted state. As shown in the figures, there is a void in the center of the completed package which has an oval cross section.
30 Finally, a compact core-wound paper product and a method of making it is

disclosed in US 5 027 582. The document discloses a package including one or more individual articles which have been compressed to reduce the volume of each article and the assembled package of articles. As shown in the figures, the compressed article has a completely flattened core.

- 5 A problem arises when a compacted wound article as described above is unwrapped for use. Frequently the use of the article involves the insertion of a holder through the core of the article, as in the case of a roll of kitchen paper or toilet tissue. The user must first open up the deformed core by the application of force at suitable locations. The end result is generally an oval
10 core or a core with sharp folds along its interior surface. When a sheet of paper is to be removed, this usually results in an out-of-balance, wobbling rotation of the paper roll. This problem is, if not eliminated then at least significantly reduced by the product and method according to the invention.

DISCLOSURE OF INVENTION

- 15 The above problem has been solved by a method for packaging single and multiple rolls according to the independent claims 1 and 5, respectively, as well as an article packaged according to said methods according to claim 13, and their respective dependent claims.

The invention relates to a method of packaging a web product comprising at
20 least one compression loaded, core-wound roll, which web is made from tissue paper, non-woven fibre or a similar material.

- A tissue paper is defined as a soft absorbent paper having a low basis weight. One generally selects a basis weight of 8 to 30 g/m², especially 10 to 25 g/m² per ply. The total basis weight of multiple-ply tissue products is
25 preferably equal to a maximum of 65 g/m², more preferably to a maximum of 50 g/m². Its density is typically below 0.6 g/cm³, preferably below 0.30 g/cm³, where paper having a density between 0.08 and 0.25 g/cm³ is considered to be soft. The fibres contained in the tissue paper are mainly cellulosic fibres, such as pulp fibres from chemical pulp (e.g. Kraft sulfite and
30 sulfate pulps), mechanical pulp (e.g. ground wood), thermo mechanical pulp,

chemo-mechanical pulp and/or chemo-thermo mechanical pulp (CTMP). Pulps derived from both deciduous (hardwood) and coniferous (softwood) can be used. The fibres may also be or include recycled fibres, which may contain any or all of the above categories. The fibres can be treated with additives - such as fillers, softeners, such as quaternary ammonium compounds and binders, such as conventional dry-strength agents or wet-strength agents used to facilitate the original paper making or to adjust the properties thereof. The tissue paper may also contain other types of fibres, e.g. regenerated cellulosic fibres or synthetic fibres enhancing, for instance, strength, absorption, smoothness or softness of the paper. Tissue paper may be converted to the final tissue product in many ways, for example, by embossing or laminating it into a multi-ply product, rolled or folded.

The term non-woven may be applied to a wide range of products which, in terms of their properties, are located between those of paper and cardboard on the one hand, and textiles on the other hand. As regards non-woven a large number of extremely varied production processes are used, such as the air-laid and spun-laced techniques as well as wet-laid techniques. The non-woven includes mats, non-woven fabrics and finished products made thereof. Non-wovens may also be called textile-like composite materials, which represent flexible porous fabrics that are not produced by the classic methods of weaving warp and weft or by looping. In fact, non-wovens are produced by intertwining, cohesive or adhesive bonding of fibres, or a combination thereof. The non-woven material can be formed of natural fibres, such as cellulose or cotton fibres, but can also consist of synthetic fibres, such as Polyethylene (PE), polypropylene (PP), polyurethane (PU), polyester, nylon or regenerated cellulose, or a mix of different fibres. The fibres may, for example, be present in the form of endless fibres of pre-fabricated fibres of a finite length, as synthetic fibres produced in situ, or in the form of staple fibres. The nonwoven materials used in connection with the invention may thus consist of mixtures of synthetic and cellulose fibrous material, e.g. natural vegetable fibres

In the subsequent text, the terms "paper roll" or "paper product" will be used for products including wound webs of the above materials.

The core is preferably, but not necessarily, made from a relatively thin cardboard material, or a similar deformable material. The method involves
5 the use of a compression loading means for constraining such roll, each said roll of paper comprising a length of paper wound on a cylindrical, compression collapsible core, and said paper being somewhat resilient in a substantially radial direction, said compressive loading being applied to said roll to effect a deformation of said core of each roll into a predetermined
10 polygonal cross-section, and said constraining means comprises means for constraining each such deformed core and wound paper roll. The method according to the invention comprises the steps of:

- applying a sufficient and equal directional compressive loading on said roll from four orthogonal directions, to substantially reduce the volume of
15 and to perform a controlled deformation of said paper product;
- securing said means for constraining each said roll to substantially preclude substantial expansion of said core upon removal of said compressive loading.

It is assumed that the roll including a wound web is compressible, and that
20 the step of applying a directional compressive loading is effected by applying a compressive loading that deforms the core and wound paper in said roll an equal amount from four sides, without flattening said core.

The core may be compressed to a desired polygonal shape having a cross-section such as square, hexagonal or octagonal.

25 The roll may be constrained using a constraining means comprising a constraining enclosure. The constraining enclosure may in turn comprise a sheet of material from the group consisting of thermoplastic film, such as a shrink film, paper, or a similar suitable material.

According to a first alternative embodiment, securing of the roll may take
30 place while said roll is compressively loaded. In the case the constraining

means may be wrapped around the compressed roll, whereby said compressive loading is relieved.

According to a second alternative embodiment, securing of the roll may take place immediately after said compressive loading is relieved. In the case the
5 constraining means may be wrapped around the compressed roll as soon as the compressive loading is removed, but before the roll has had time to expand.

In both cases the constraining means is wrapped around opposing cut edges of said roll.

- 10 According to an alternative embodiment, the invention relates to a method of packaging a paper product comprising a plurality of compression loaded, core-wound rolls of paper and a compression constraining means for constraining each of said rolls, each said roll of paper comprising a length of paper wound on a cylindrical, compression collapsible core, and said rolls of
15 paper being somewhat resilient in a substantially radial direction, which rolls are disposed in a predetermined array having at least one layer of adjacent and mutually parallel cores, said compressive loading being applied to said rolls to effect a deformation of the core of each roll into a predetermined polygonal cross-section, as described above, and said constraining means
20 comprises means for constraining each such deformed core and associated wound paper roll in the array. The alternative method comprises the steps of:
- applying a sufficient directional compressive loading on said array from four orthogonal directions, to substantially reduce the volume of and to perform a controlled deformation of said array of paper products;
 - 25 - securing said means for constraining each said roll to substantially preclude substantial expansion of said cores upon removal of said compressive loading; and

It is assumed that the wound web is compressible, and that the step of applying a directional compressive loading is effected by applying a

compressive loading that deforms each of the cores and wound paper in said array an equal amount from four sides, without flattening said cores.

The compressive loading may be applied by placing one single or multiple parallel products on a flat support surface between a pair of opposing
5 punching plates, having their main surfaces parallel to the longitudinal axis or axes of said products. Subsequently an adjustable support plate is placed over the product or products, parallel to the support surface. Actuators acting on their respective punching plates are then activated to apply a compressive force onto the product or products.

10 According to a first alternative embodiment, securing of the rolls may take place while said roll is compressively loaded. In the case the constraining means may be wrapped around the compressed roll, whereby said compressive loading is relieved. In this case, the compression constraining means may comprise a number of adjacent units separated by gaps
15 arranged substantially parallel to the longitudinal axes of the rolls. The gaps allow constraining means to be wrapped around the rolls while maintaining the compressive load on the products. A constraining means, comprising a constraining band or similar, is introduced through each such gap around the circumference of adjacent rolls and wrapped about said rolls. The number of
20 gaps is dependent on the number of rolls in the array and the degree of compression in relation to the roll density of the rolls. Subsequently the compressive load is relieved.

According to a second alternative embodiment, securing of the array of rolls may take place immediately after said compressive loading is relieved. In the
25 case the constraining means may be wrapped around the compressed array of rolls as soon as the compressive loading is removed, but before the rolls have had time to expand.

In both cases the constraining means is wrapped around outer opposing cut edges of said rolls.

The core of each roll may be deformed to a desired shape during or in advance of the compressing step for the product or products. Alternatively, a support core may be inserted in each core prior to compression of the product or products, which support core or cores will impart a desired cross-sectional shape to each core during final compression of the product or products.

When compressing a relatively small number of rolls, such as single rolls, a flat four-, six- or eight-pack or similar packages having up to about four parallel rolls in any direction, a simple compression without supporting cores is preferable. As the number of parallel rolls increase the deformation of the cores will be increasingly difficult to control, in particular for loose wound rolls with a relatively low roll density. In the latter case the use of supporting cores, or pre-shaped cores, may be preferable.

In order to achieve a controlled compression of the core, it may also be provided with longitudinal fold lines on either or both sides of the material making up the core. At least one fold line may be used for each fold to be produced in the core of said roll. The fold lines are preferably indented or scored into the inner and/or outer periphery of the core during the manufacturing process, prior to the operation where paper is wound onto the core. For example, four equidistant, single fold lines may be indented along the outer periphery of a core to assist a controlled deformation into a substantially square core. According to a further example, each equidistant fold line may comprise multiple adjacent, cooperating fold lines. A fold line of the latter type may comprise a single fold line along the inner periphery of the core, complemented by one additional, adjacent fold line on either side of said single fold line and on the outer periphery of the core. The number of fold lines and their mutual arrangement is determined by the thickness and type of material used in the core, as well as the desired degree of compression. The number of equidistant fold lines provided around the inner and/or outer periphery of the roll determines the final cross-sectional shape of the roll, e.g. square, hexagonal, octagonal or a similar polygonal shape.

The array may be constrained using a constraining means comprising a constraining enclosure. The constraining enclosure may in turn comprise a sheet of material from the group consisting of thermoplastic film and paper.

5 The array may be constrained in several alternative ways, such as using a constraining means comprising a constraining band about said array, an array enclosure and a band about said array, an array enclosure and a band about each of said rolls, or an array enclosure, a band about said array, and a band about each of said rolls.

10 The invention also relates to a web product comprising at least one compression loaded, core-wound roll, which web is made from paper, non-woven fibre or a similar material. In the subsequent text, the term "paper roll" will be used for such products. The material used in the core has been discussed above. A compression constraining means is provided for constraining such a roll, each said roll of paper comprising a length of paper
15 wound on a cylindrical, compression collapsible core, and said paper being somewhat resilient in a substantially radial direction, when subjected to a compressive loading to effect a deformation of at least the core of each roll. Each said roll is deformed into a substantially polygonal cross-section, and is provided with constraining means for constraining and retaining the
20 substantially square shape of each such deformed core and wound paper roll.

As described above, the core may be compressed to a desired polygonal shape having a cross-section such as square, hexagonal or octagonal.

25 In accordance with all the above embodiments of the present invention, a wound web product is provided which comprises a directionally compression loaded, core-wound paper roll and compression constraining means in which the paper roll comprises a core and a length of paper wound thereon, and in which product the core is given a polygonal cross-section and the product has a somewhat square shape.

According to a preferred embodiment, the core may be given a substantially square cross-section. In this case the product is susceptible to being shaped by a user before use, so that the product resumes a generally round cross section and so that the core assumes a less deformed, tubular shape before
5 being mounted on a holder. The amount of manipulation required before use is also dependent on the relative size of the core and the outer diameter of a cylindrical holder for the core.

According to an alternative embodiment, the core may be given a substantially hexagonal or octagonal cross-section. In this case the product
10 may only require a marginal manipulation by the user, as the core is already substantially tubular and ready to be mounted on a holder.

The above examples may be related to a deformed product with a core that is to be mounted on a standard sized holder for products such as kitchen rolls or toilet rolls. Prior to deformation, cores of this type may have an
15 internal diameter in the range 20-60 mm and are typically selected in the range 35-45 mm. In order to avoid the typical rattling sound caused by a deformed core rotating around a cylindrical holder, the size of the core may be adapted to the standard type or size of holder for the product in question. According to one embodiment, the smallest cross-sectional radial dimension
20 of a deformed, polygonal core should be substantially equal to the radius of the cylindrical holder. This cross-sectional radial dimension is defined as the distance between the geometric centre of the polygon and a tangential point on an adjacent inner surface of the polygon. When mounting the roll or removing the core, it should be able to slide on or off without difficulty relative
25 to the holder.

According to an alternative embodiment, the smallest cross-sectional radial dimension of a deformed, polygonal core is made with a loose fit, that is, substantially equal to or slightly larger than the outer diameter of the cylindrical holder. For example, the smallest cross-sectional dimension of a
30 deformed, polygonal core may be selected to be up to about 10% larger than the radius of the cylindrical holder. In this case the difference in size depends

on factors such as the diameter and weight of the roll, whereby the difference is selected as to avoid or at least minimize any rattling between roll and holder.

According to a further alternative embodiment, the deformed, polygonal core is made with a slight press fit or a force fit, that is, substantially equal to or smaller than the outer diameter of the cylindrical holder. For example, the smallest cross-sectional radial dimension of a deformed, polygonal, preferably square core may be selected to be from 1% up to about 20% less than the radius of a cylindrical holder with which it is to cooperate. In this case the difference in size depends on factors such as the roll density of the wound web and the stiffness of the core material, which factors must be considered when manufacturing each type of roll. Hence, a relatively high roll density will only allow a relatively small deformation of the core, while a relatively low roll density will allow a larger deformation of the core. It is desirable that when mounting a wound roll or removing an empty core, the user should not be required to use excessive force. However, when mounted, the substantially flat sections making up the deformed core of the roll have been pushed outwards by the holder. A core expanded in this way will exert a spring force on the holder, whereby any rattling between roll and holder is eliminated.

The final dimension of the compressed core is limited by the diameter of the original core. For instance, if the core is deformed into a substantially square shape, then the sum of the four sides making up the square is substantially equal to the circumference of the core. From the relationship $4 \times X = \pi \times d$, it is clear that the minimum value of X is:

$$X = \frac{\pi}{4} \times d$$
, where X is the length of one side of the square and d is the diameter of the core.

If the core is to be compressed further, then a deformation of each side X may occur. This may cause folding or wrinkling of the core, but will not damage the wound material as such. Hence, the properties and the resulting

volume of the compressed core may be influenced by selecting a suitable of diameter for the original core and a suitable degree of compression.

The constraining means may be a constraining band about the roll, or a constraining enclosure such as a wrapper of thermoplastic film, such as a
5 suitable shrink film, or paper; or a combination of a band and an enclosure. Indeed, constraining means could even be a number of sewn stitches, or through-the-roll ties such as used on buttoned furniture cushions and mattresses. In another aspect of the invention, plural such rolls are disposed and constrained in a predetermined array. An example of such plural rolls is
10 a linear array of four rolls having their deformed cores in parallel relation. In such embodiments, the constraining means may comprise an array band, and/or an array enclosure, and may further comprise bands about the individual rolls of the array. For transport purposes, one or more arrays may be placed in a tray of cardboard or similar, which tray has a bottom surface
15 and an edge around its circumference. This edge will hold the array or arrays in place and assist in constraining the compressed rolls. Additional bands or wrappers may be used for containing the array or arrays of rolls on the tray. In a method aspect of the invention, a core-wound paper product such as a roll of toilet tissue or a roll of paper towels is subjected to a directional
20 compressive loading of sufficient magnitude to cause the core to be deformed into a substantially square or rectangular shape. The constraining means are then secured while the roll is still in compression, and then the compressive loading is relieved.

BRIEF DESCRIPTION OF DRAWINGS

In the following text, the invention will be described in detail with reference to the attached drawings. These drawings are used for illustration only and do not in any way limit the scope of the invention. In the drawings:

- 5 Figure 1 shows schematically an arrangement for performing a preferred packaging method according to the invention.
- Figure 2 shows the arrangement of Figure 1 after compressive loading has been applied.
- Figure 3 shows schematically an alternative arrangement for performing a
10 packaging method according to the invention.
- Figure 4 shows the arrangement of Figure 3 after compressive loading has been applied.
- Figure 5 shows a cross-section through the core C of a wound product according to the invention.
- 15 Figure 6 shows a cross-section through the core C of a wound product and a mandrel for supporting said core.
- Figure 7 shows a wound article according to the invention.

MODES FOR CARRYING OUT THE INVENTION

- Figure 1 illustrates schematically an arrangement for performing a preferred
20 packaging method according to the invention. The method shown involves packaging of a plurality of, in this case three, compression loaded, core-wound rolls of paper 1, 2, 3, each said roll of paper comprising a length of paper wound on a cylindrical, compression collapsible core, and said rolls being somewhat resilient in a substantially radial direction. The multiple
25 parallel rolls 1, 2, 3 are placed on a flat support surface 4 between a pair of opposing punching plates 5, 6 having their main surfaces parallel to the longitudinal axis or axes of said products. In addition, an adjustable support plate 7 is placed over the product or products, parallel to the support surface. After being placed in a predetermined array, said compressive loading being

applied to said rolls to effect a deformation of the wound material and core of each roll into a substantially polygonal cross-section. The loading is applied by a hydraulic cylinder 8, 9 connected to each punching plate 5, 6 and a pair of cylinders 10, 11 connected to the support plate 7.

- 5 The relative height and width of the respective punching plates and support plates are selected depending on the length and initial diameter of the roll and its core in combination with the desired final dimension of the roll or array of rolls. Although the example shows a single layer of three rolls, the method is also applicable to single rolls as well as multiple layers of rolls. Also, other
10 types of actuators may be used for applying the compressive loading, such as mechanical, pneumatic or ball screw actuators.

Once the array of rolls has been placed in the arrangement, a directional compressive loading is applied onto said array of rolls from four orthogonal directions, as shown in Figure 2. The force F_1 , F_2 applied by the punching
15 plates 5, 6 and the support plate 7, respectively, is sufficient to substantially reduce the volume of and deform said paper products without substantially flattening the cores C_1 , C_2 , C_3 .

While the rolls are compressively loaded, they are secured by a means for constraining each said roll to substantially preclude substantial expansion of
20 said cores upon removal of said compressive loading. The constraining means (not shown) can comprise one or more bands or strips of a paper or a thermoplastic material, or a plastic wrapper that may be shrink wrapped if desired. The process for securing the rolls is not a part of the invention and can be performed using any suitable known method and material.

25 It is assumed that the wound web is compressible, and that the step of applying a directional compressive loading is effected by applying a compressive loading that deforms each of the cores and wound paper in said array an equal amount from four sides, without flattening said cores. The above procedure can be performed on a single roll or on multiple rolls
30 comprising at least one layer of adjacent and mutually parallel cores. When

transferring a compressive loading on each roll in an array of rolls, the magnitude of the compressive force is determined by the movement of the pressure plates used for compressing said rolls. The movement of the pressure plates is in turn dependent on the desired degree of compression of
5 said rolls.

The rolls can be positioned with their longitudinal axes parallel to the horizontal support surface, as shown in Figure 1, or at right angles to said support surface. In the latter case, a further planar support plate would be arranged opposite the support plate 7 shown in Figure 1.

10 Figure 3 shows an alternative arrangement for performing the packaging method, wherein a support core may be inserted in each core prior to compression of the product or products. Using the reference numerals of Figure 1, Figure 3 shows three parallel rolls 1, 2, 3 placed on a flat support surface 4 between a pair of opposing punching plates 5, 6 having their main
15 surfaces parallel to the longitudinal axis or axes of said products. In addition, an adjustable support plate 7 is placed over the product or products, parallel to the support surface. After being placed in a predetermined array a support core 12, 13, 14 is inserted into each core C_1 , C_2 , C_3 . The support cores 12, 13, 14 are arranged to be floating, that is, moveable relative to each other
20 and to the punching and support plates 5, 6, 7 and the support surface 4. As shown in Figure 4, a compressive loading is then applied to said rolls to effect a deformation of the wound material and core of each roll into a substantially square cross-section. The loading is applied by a hydraulic cylinder 8, 9 connected to each punching plate 5, 6 and a pair of cylinders
25 10, 11 connected to the support plate 7. The support cores 12, 13, 14 will impart a desired cross-sectional shape to each core C_1 , C_2 , C_3 during final compression of the products. The support cores in Figure 3 and 4 are schematic representations. Examples of suitable support cores are shown in Figures 5 and 6.

30 Figure 5 shows a cross-section through the core C of a wound product according to the invention. A core having the outer diameter D will under

compressive loading be deformed to a substantially square cross-section CS with equal sides having the dimension X. If the deformation occurs without a supporting core, equal and opposing forces on the outer sides of the roll will cause a deformation as indicated in Figure 5. However, if a corresponding deformation is to be achieved using a solid supporting core 15 it will be necessary to bevel each corner 16 (indicated as hatched surfaces) of an initially square supporting core having the dimensions indicated by CS in order to allow it to be inserted into the core C before compression.

Figure 6 shows a cross-section through the core C of a wound product into which has been inserted an expandable supporting core or mandrel 17. This mandrel 17 has an initial square cross-section with the side x that allows insertion into the core C with a diameter D. The mandrel 17 comprises four sections 18 which can each be displaced in a direction E perpendicular to their respective outer surface. The displacement is caused by a suitable central displacement means (not shown), causing the mandrel 17 and its sections 18 to expand and assume a shape corresponding to the desired deformed shape of the core. The mandrel will both support the core and aid its deformation when a compressive loading is applied to the outer surface of the roll. The expansion of the mandrel takes place during the compressive loading of the roll, causing the roll to be deformed to a substantially square cross-section CS with equal sides having the dimension X.

The support core shown in Figure 6 comprises a mandrel with a square cross-section being divided into four displaceable sections by diagonal lines. Alternatively, the expandable mandrel may also comprise four displaceable sections with identical square cross-sections making up a square mandrel.

In order to achieve a controlled compression of the core, it is provided with longitudinal fold lines on either or both sides of the material making up the core. At least one fold line is used for each fold to be produced in the core of said roll. The fold lines are indented or scored into the inner and/or outer periphery of the core during the manufacturing process, prior to the operation where paper is wound onto the core. For example, a minimum of four

equidistant, single fold lines are indented along the outer periphery of a core to assist a controlled deformation into a substantially square core. According to a further example, each equidistant fold line comprises multiple adjacent, cooperating fold lines. A fold line of the latter type comprises a single fold line
5 along the inner periphery of the core, complemented by one additional, adjacent fold line on either side of said single fold line and on the outer periphery of the core. The number of fold lines and their mutual arrangement is determined by the thickness and type of material used in the core, as well as the desired degree of compression. The number of equidistant fold lines
10 provided around the inner and/or outer periphery of the roll determines the final cross-sectional shape of the roll, e.g. square, hexagonal, octagonal or a similar polygonal shape.

The above embodiments require the cores and their fold lines to be aligned relative to the press plates prior to deformation of the rolls. In order to avoid
15 this additional step, the cores can be provided with multiple, equidistant fold lines. The spacing between adjacent fold lines is chosen to ensure that a fold line will be located at, or at least sufficiently near, the position of a desired fold during compression, irrespective of the initial position of the core.

Alternatively, the core of each roll may be deformed to a desired shape
20 during or in advance of the compressing step for the product or products.

Figure 7 shows a wound article, or roll 19 with a deformed core C having a substantially square cross section. This example shows a loose wound roll with a relatively low roll density, e.g. $0,1-0,25 \text{ g/cm}^3$, where the shape of the core has little or no effect on the outer layers of the roll. The figure shows the
25 roll after an enclosing constraining band or wrapper, as described in connection with Figures 2 and 4 above, has been removed. The wound web around the core will then return to a shape more or less identical to its original cylindrical shape. The roll may also be provided with a core having any suitable polygonal cross-sectional shape, such as a hexagonal shape.

A controlled deformation of each of the cores will also allow the compressed and packaged roll products to be packaged more effectively for transport. When deforming the core into a substantially square cross-section, the maximum compression gives a square with a side X that is expressed as

5 $X = \frac{\pi}{4} \times D$, where D is the diameter of the roll.

In this case the maximum size reduction of the core is approximately 20%, which can be added to the compression of the paper on the roll. Further compression is possible, but will cause buckling of the sides between each longitudinal corner of the core.

- 10 For example, a row of parallel relatively loose-wound rolls each have their core and wound paper webs compressed to 80% of their original diameter. This size reduction will allow space for an additional roll for every five rolls, as compared to the space taken up by original uncompressed rolls.

The degree of compression is dependent on the size and thickness of the
15 core, the roll density of the wound material and the desired size of the compressed roll.

The invention is not limited to the embodiments described above, but may be varied freely within the scope of the appended claims.

CLAIMS

1. A method of packaging a paper product comprising at least one compression loaded, core-wound roll of paper and a compression
5 constraining means for constraining such roll, each said roll of paper comprising a length of paper wound on a cylindrical, compression collapsible core, and said paper being somewhat resilient in a substantially radial direction, said compressive loading being applied to said roll to effect a deformation of said core of each roll into a predetermined polygonal cross-
10 section, and said constraining means comprises means for constraining each such deformed core and wound paper roll, said method comprising the steps of:
- applying a sufficient and equal directional compressive loading on said roll from four orthogonal directions, to substantially reduce the volume of
15 and to perform a controlled deformation of said paper product;
 - securing said means for constraining each said roll to substantially preclude substantial expansion of said cores.
2. A method according to claim 1, c h a r a c t e r i z e d b y securing said roll using a constraining means comprising a constraining enclosure.
- 20 3. A method according to claim 2, c h a r a c t e r i z e d b y securing said constraining means while said roll is compressively loaded and relieving said compressive loading.
4. A method according to claim 2, c h a r a c t e r i z e d b y securing said constraining means immediately subsequent to relieving the compressive
25 loading of said roll.
5. A method according to claim 2, c h a r a c t e r i z e d b y constraining said roll using a constraining enclosure comprising a sheet of material from the group consisting of thermoplastic film and paper.

6. A method according to claim 1, characterized by said step of applying a directional compressive loading is effected by applying a compressive loading that deforms said core and wound paper product an equal amount from four sides, where said core is deformed into a polygonal cross-sectional shape.

7. A method according to claim 6, characterized by the directional compressive loading deforming said core into a polygonal shape along longitudinal fold lines in the core.

8. A method of packaging a paper product comprising a plurality of compression loaded, core-wound rolls of paper and a compression constraining means for constraining each of said rolls, each said roll of paper comprising a length of paper wound on a cylindrical, compression collapsible core, and said rolls of paper being somewhat resilient in a substantially radial direction, which rolls are disposed in a predetermined array having at least one layer of mutually parallel cores, said compressive loading being applied to said rolls to effect a deformation of said core of each roll into a predetermined polygonal cross-section, and said constraining means comprises means for constraining each such deformed core and wound paper roll in the array, said method comprising the steps of:

- applying a sufficient and directional compressive loading on said array from four orthogonal directions, to substantially reduce the volume of and to perform a controlled deformation of said array of paper products;
- securing said means for constraining each said roll to substantially preclude substantial expansion of said cores.

9. A method according to claim 8, characterized by constraining said array using a constraining means comprising a constraining enclosure.

10. A method according to claim 9, characterized by securing said constraining means while said array is compressively loaded and relieving said compressive loading.

11. A method according to claim 9, characterized by securing said constraining means immediately subsequent to relieving the compressive loading of said array.

12. A method according to claim 9, characterized by constraining
5 said array using a constraining enclosure comprising a sheet of material from the group consisting of thermoplastic film or paper.

13. A method according to claim 8, characterized by constraining said array using a constraining means comprising a constraining band about said array.

10 14. A method according to claim 8, characterized by constraining said array using a constraining means comprising a constraining enclosure and a band about said array.

15 15. The method of claim 8 wherein said constraining means comprises an array enclosure, a band about said array, and a band about each of said rolls.

16. A method according to claim 8, wherein said paper rolls are compressible, characterized by said step of applying a directional compressive loading is effected by applying a compressive loading that deforms each said core and wound paper an equal amount from four sides,
20 where each said core is deformed into a polygonal cross-sectional shape.

17. A method according to claim 13, characterized by the directional compressive loading deforming each said core into a polygonal shape along longitudinal fold lines in the cores.

18. A paper product comprising at least one compression loaded, core-
25 wound roll of paper and a compression constraining means for constraining such a roll, each said roll of paper comprising a length of paper wound on a cylindrical, compression collapsible core, and said paper being somewhat resilient in a substantially radial direction, when subjected to a compressive loading to effect a deformation of at least the core of each roll,
30 characterized in that said roll is deformed into a predetermined

polygonal cross-section, and is provided with constraining means for constraining and retaining the polygonal shape of each such deformed core and wound paper roll.

19. A paper product according to claim 18, characterized in that at
5 least the core has a substantially square cross-section.

20. A paper product according to claim 18 or 16, characterized in that the core is permanently deformed into said cross-section.

21. A paper product according to claim 18, characterized in that the paper product comprises a cardboard core.

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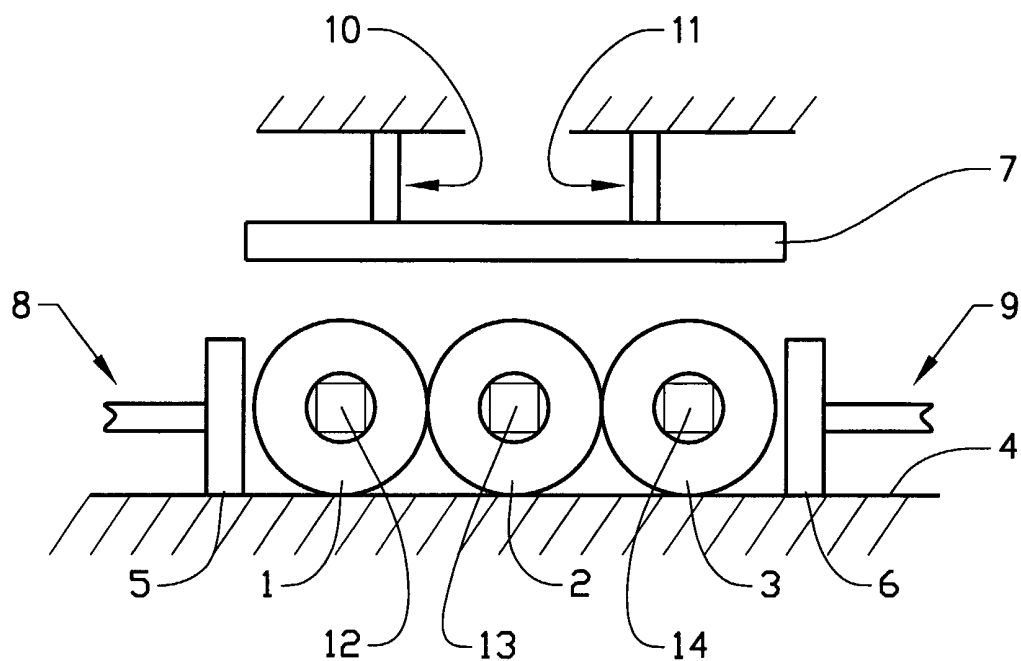


FIG. 3

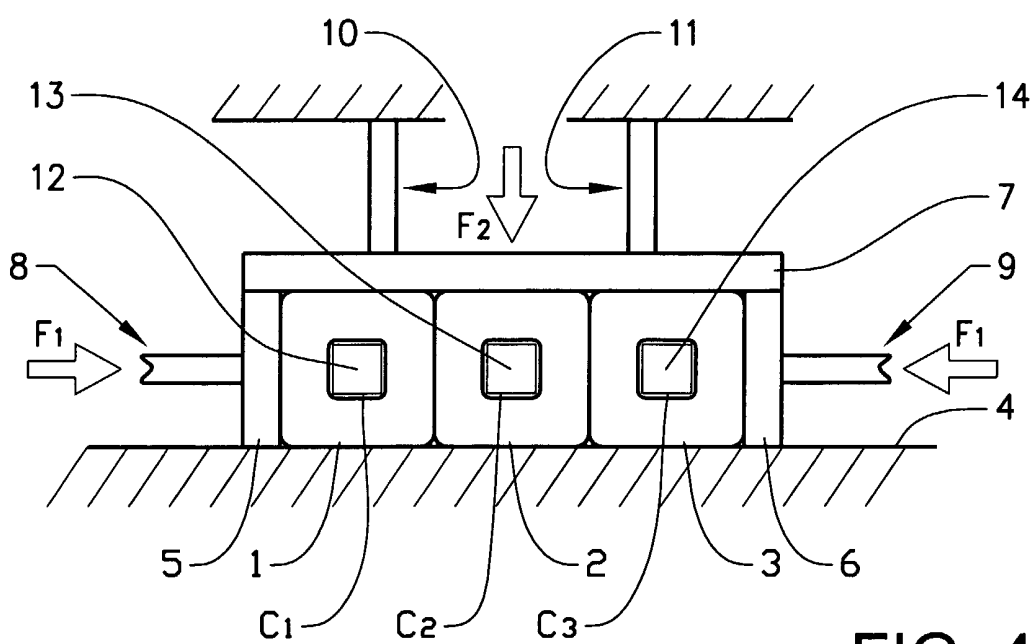
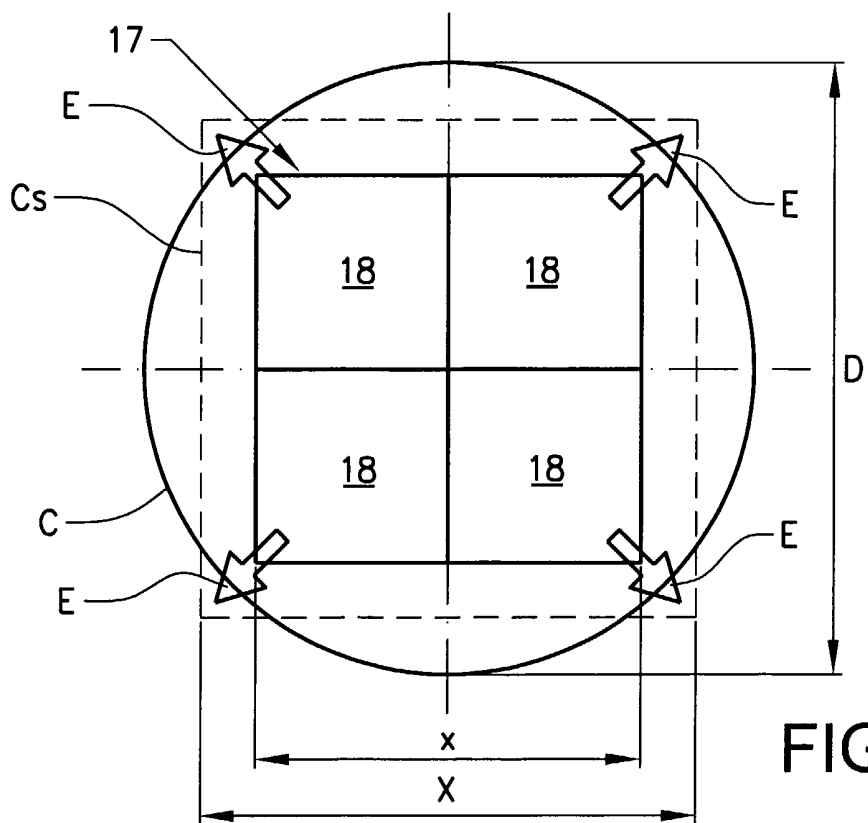
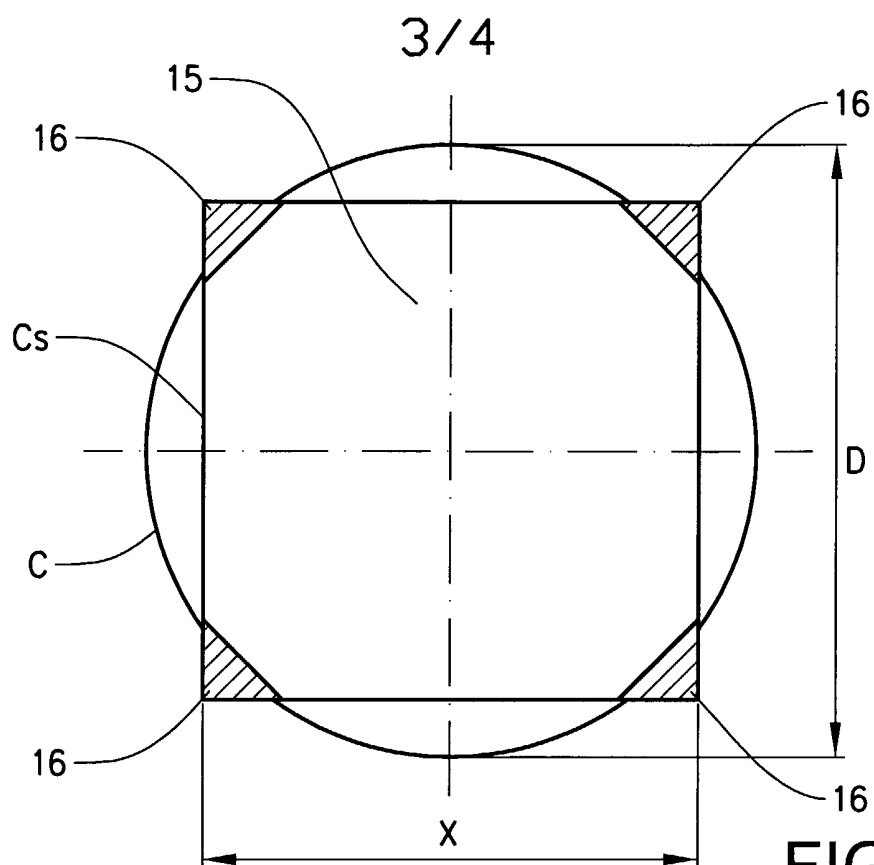


FIG. 4



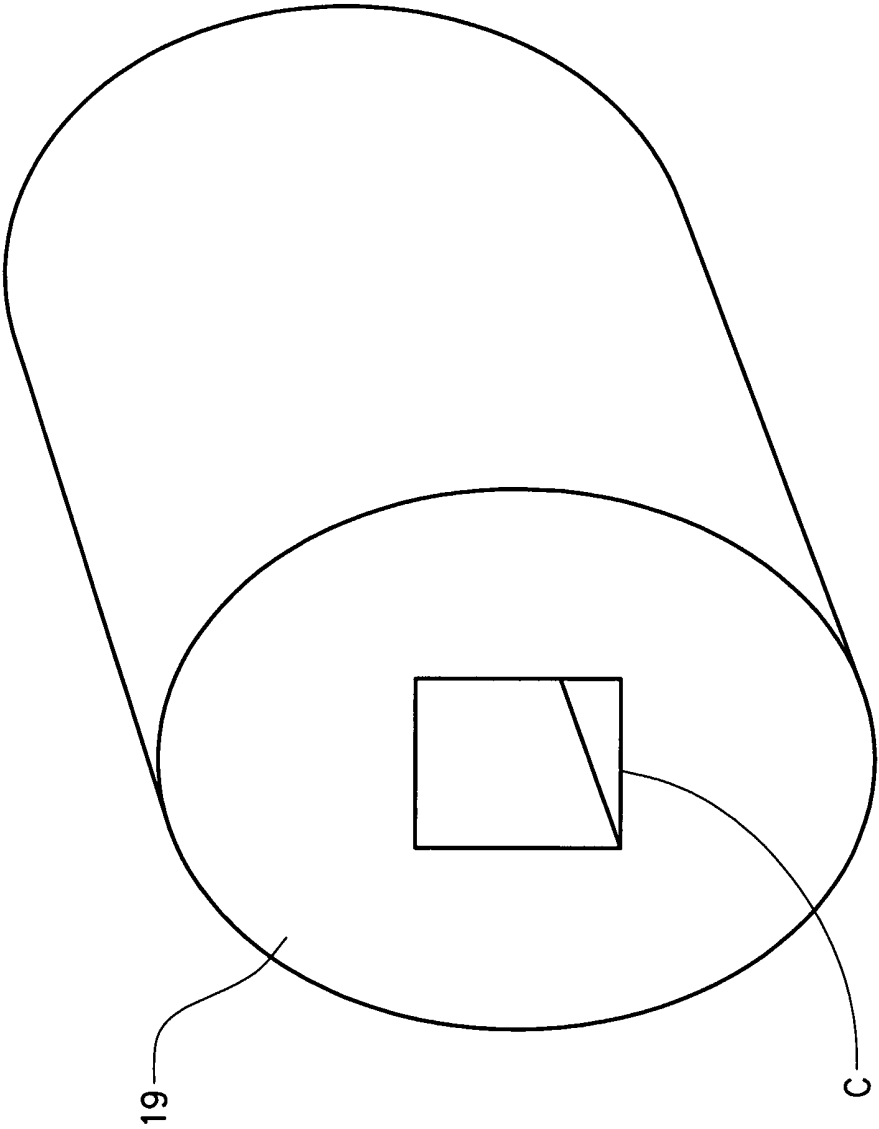


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 2005/000359

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B65B 63/02, B65B 13/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B65B, B65D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4909388 A1 (WATANABE), 20 March 1990 (20.03.1990) --	1-21
A	US 4762061 A1 (WATANABE ET AL), 9 August 1988 (09.08.1988) --	1-21
A	US 4679379 A (CASSOLI), 14 July 1987 (14.07.1987) --	1-21
A	EP 1366993 A1 (T M C SPA), 3 December 2003 (03.12.2003) --	1-21

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search

19 October 2005

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 2005/000359

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2270667 A (FORT STERLING LTD), 23 March 1994 (23.03.1994) --	1-21
A	US 2668405 A (JOSEPH W DROLL), 9 February 1954 (09.02.1954) -- -----	1-21

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				GB	2173765	A,B	22/10/1986
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				GB	8611815	D	00/00/0000
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