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(54) **Elastic tubular knitted fabric and process for obtaining the same**

Elastische schlauchförmige Strickware und Verfahren zu deren Erhaltung

Tricot élastique tubulaire et procédé de son obtention

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US-A- 3 645 299
US-A- 4 060 999
US-A- 4 402 409
US-A- 5 104 714
US-A- 5 664 306

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The file contains technical information submitted after the application was filed and not included in this specification

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Description

[0001] Plastic or paper bags, Raschel fabric sacks and either knitted or extruded tubular net bags have heretofore been used in order for such fruit and vegetable products as citrus fruits, potatoes, onions and the like to be packed. Tubular net has become the most widely used material for bags weighing up to five kilograms.

[0002] Knitted tubular net has a number of advantages over extruded tubular net, such as offering a better ratio between strength and weight of the net, less quantity and volume of plastic material per bag, lowering the cost of recycling, greater flexibility which allows a greater length to be loaded on the tube of the packing machine, less thickness and rigidity which makes it more suitable for frail products, and allowing a wide range of openwork shapes to be provided, such as diamonds, hexagons, rectangles, etc., whereas extruded net may only have a diamond-shaped openwork.

[0003] However, a major advantage of extruded over knitted tubular net is its greater capacity to be compressed and hence to be adapted to the shape of the product contained. This is due to the fact that its various filaments are joined by spot welds and the connections are thus rigid, which means that upon the loop being opened, the same always tends to retrieve its original diameter. This exclusive property has resulted in extruded net being preferred by packers when bags are to be made with products in lines, such as garlic, onions, etc., or when the net is required to adapt to the shape of the product contained. Now, it would therefore be desirable to combine the advantages of knitted and extruded tubular net as a single net, and moreover improve the flexibility of both nets, in order to be able to provide an alternative to plastic bags for packing such frail products as tomatoes, apples, peppers, etc. Such properties as compression, adaptability and good flexibility have however never been successfully combined in the past in a single net because when a more compressive net was to be obtained, this resulted in a more rigid net, therefore detracting from its flexibility, and where a more flexible net was obtained, it was barely compressible.

[0004] US-A-4 060 999 discloses a method for forming yarn elements which may be used for the production of knitted bags having minimum stretch characteristics and which are particularly adapted for encasing and supporting food.

[0005] The method involves the slitting of a web of thermoplastic material, such as polypropylene film, into strips of predetermined width and thereafter stretching each strip under controlled conditions of heat and force application. Thus, a relatively flat yarn element is obtained which is capable of being directed into a textile machine, such as a knitting machine, to form a desired product, e. g. a tubular knit structure.

[0006] US-A-4 060 999, however, proposes polypropylene, polyethylene, vinyl and other plastic film material for the thermoplastic material used in the method, and does not make any reference to the loop structure of the knitted product.

[0007] US-A-5 104 714 relates to a plastic knitted netting which may be used for wrapping heavy loads, e. g. loads on pallets or agricultural loads such as bales of hay. This document further discloses a method of making thermoplastic ribbons which are used to knit this netting, e.g. by employing Raschel knitting machines. These ribbons consist essentially of linear low density polyethylene which are oriented and have a ratio of stretched oriented length to original substantially unoriented length of between 1:4 and 1:5. More specifically, this prior art document refers to a knitted netting comprising longitudinal and lateral ribbons having a thickness of 0.04 to 0.05 mm and 0.02 to 0.03 mm, respectively. Linear low density polyethylene which has been copolymerized with the alpha olefin, octene, is the preferred thermoplastic material. However, this prior art document does not refer to the production of tubular knitted fabrics.

[0008] The object of the present Patent application is an elastic tubular knitted fabric and a process for obtaining the same which, in addition to the function for which it was designed, contributes a number of advantages that shall be set out hereinafter, besides others inherent in the arrangement and construction thereof.

[0009] More specifically, the invention lies in an elastic tubular knitted fabric made of thermoplastic polymer and a method for making the same in order to obtain a net that is both elastic and has an ultimate elongation such as to combine the compression and adaptability of the extruded net perfectly with the advantages of a flexible and scarcely rigid conventional knitted net. Furthermore, due to the characteristics of the thermoplastic with which it is made, the inventive net greatly improves such properties as the flexibility and scarce rigidity of a conventional knitted net.

[0010] Because of the above-described characteristics, the tubular net of the invention is especially suited for packing products in line, such as garlic, onions, etc., or when the net is required to adapt to the shape of the product contained, for the extent of compression exerted on the packed product may be varied at will due to its elasticity. It is moreover especially suitable for packing frail products, being as it is that there is an almost negligible chance of damaging the packed product due to its great flexibility, not heretofore achieved by any net.

[0011] Furthermore, the elastic tubular net subject of the invention can be used in any of the packing machines existing in the market, be they manual, semiautomatic or automatic, without a seal, with a staple or weld seal.

[0012] The problems underlying the present invention are solved by an elastic tubular knitted fabric, said fabric being formed of ribbons made of thermoplastic material, said ribbons being produced by extrusion of an elastic film of said thermoplastic material, and cutting and stretching this film.

[0013] Said fabric is further characterized by the following features:

- said ribbons are knitted from said elastic film essentially made of an ethyleneoctene copolymer, a pigmentary dispersion and a lubricating agent, to form a tubular loop structure, with chains of loops running parallel to the longitudinal axis of the tubular fabric, and ribbons which are perpendicular to said axis and which interconnect said chains of loops, wherein said longitudinal chains of loops are formed by two types of ribbons, one type which is knitted only into said longitudinal chains, and another type of ribbons which interconnect said longitudinal chains of loops, and
- said fabric has an ultimate elongation in excess of 100 % and an elastic limit in excess of 20 %.

[0014] In addition, the problems underlying the present invention are solved by a process for producing an elastic tubular knitted fabric, said fabric being formed of ribbons made of thermoplastic material, said process comprising the steps of making an elastic film of said material by using an extrusion process, and cutting and stretching said film to produce ribbons. This process is additionally characterized in that

- said elastic film is essentially made of an ethyleneoctene copolymer, a pigmentary dispersion and a lubricating agent, and
- the dimensional ratio between the thickness of the outlet opening of the extruder head and the thickness of the extruded film is approximately 17, and the dimensional ratio between the perimeter of the outlet opening and the width of the sheet of film is approximately 0.7, and
- said ribbons are knitted to form a tubular loop structure, with chains of loops running parallel to the longitudinal axis of the tubular fabric, and ribbons which are perpendicular to said axis and which interconnect said chains of loops, wherein said longitudinal chains of loops are formed by two types of ribbons, one type which is knitted only into said longitudinal chains, and another type of ribbons which interconnect said longitudinal chains of loops (1).

[0015] Moreover, the problems underlying the present invention are solved by the embodiments described in the sub-claims.

DESCRIPTION OF THE INVENTION

[0016] The elastic tubular knitted fabric of the present invention is obtained by means of a process comprising making an elastic film, essentially made of a thermoplastic polymer, a pigmentary dispersion and a lubricating agent, obtained in an extrusion process with certain dimensional ratios between the opening for the outlet of material, in the extruder head, and the sheet of film; cutting and stretching the film in certain conditions as to stretch and temperature ratio; and knitting the resultant ribbons with a preferred loop structure so that the tubular fabric has an ultimate elongation and an elastic limit respectively in excess of 100% and 20%.

[0017] The thermoplastic polymer is an ethyleneoctene copolymer; the pigmentary dispersion is a pigment dispersion devoid of such extenders as titanium dioxide in low density polyethylene; and the lubricating agent is a fatty amide lubricant. The mixture of these materials in the ideal proportions confer the film with the property of being elastic and properly processable in all the production process steps.

[0018] The dimensional ratios between the opening for the outlet of material, in the extruder head, and the sheet of film consist of a value of approximately 17 for the ratio between the thickness of the opening for the outlet of material and the thickness of the film, and a value of approximately 0.7 for the ratio between the perimeter for the outlet of material and the width of the sheet of film.

[0019] Said film is cut and stretched to form ribbons suitable to be knitted, with a stretch ratio of less than 1:4 and a temperature not in excess of 50 degrees centigrade.

[0020] The resultant ribbons are all knitted forming a tubular loop structure, with chains of loops running parallel to the longitudinal axis of the tubular fabric, and ribbons perpendicular to said axis interconnecting the chains of loops.

[0021] The chains of loops running parallel to the longitudinal axis are formed by two types of ribbons, one type being knitted only into said chains, and others which are perpendicular to the longitudinal axis and interconnect the chains of loops, preferably in a sequence of one loop consisting of one type of ribbon and the adjacent loop consisting of the other type of ribbon. Both types of ribbons can have different dimensions and their use in the loop structure may be unequal.

[0022] The fabric has an ultimate elongation in excess of 100% and an elastic limit in excess of 20%, and a tensile strain recovery in excess of 25% when stretched beyond 40%; the loop structure being preferably one in which the ribbons forming the structure are cut and stretched in certain conditions as to stretch and temperature ratio.

[0023] An outstanding property of the inventive tubular knitted fabric is that a high elasticity and ultimate elongation are successfully achieved, the tensile strength of the net being in excess of 6.5 kg of strength per gram of weight of the linear metre, which renders the net suitable as concerns its strength to make the most usual bags, i.e. weighing up to 4 kg.

[0024] The following are the most outstanding physical characteristics of the tubular knitted fabric of the invention, compared with those of standard tubular knitted fabrics made with high density polyethylene (HDPE).

	Inventive Fabric	Standard Fabric (HDPE)
Ultimate elongation	160%	20%
Elastic limit	30%	Negligible
Relative elongation	3.2 %/kg	0.3 %/kg
Tensile strength	7.5 kg/g	19.0 kg/g

[0025] The values listed in this table correspond to standard nets made, which are only some of the many embodiments which may be made following the same method.

[0026] The ultimate elongation is the deformation the net suffers, as a percentage of the initial length, when it is applied sufficient tensile stress to be broken.

[0027] The elastic limit is the percentage elongation, with reference to the initial length, which the net may suffer when it is applied a tensile stress, so as to retrieve its initial length when said stress stops acting.

[0028] Relative elongation is the deformation the net suffers, as a percentage over the initial length, for every kilogram of tensile stress exerted.

[0029] Tensile strength is the maximum tensile stress the net can stand until it breaks divided by the weight in grams of a linear metre.

[0030] In order to complete the description made hereinafter and for an easier understanding of its characteristics, attached to this specification is a set of drawings whose figures show the most significant details of the invention for illustrative and non-limiting purposes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] Figure 1. Is a partial perspective view of an elastic tubular knitted fabric obtained by means of the process according to the invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

[0032] With reference to the above figure and in accordance with the numbering used, the same shows a preferred embodiment, which does not however limit the invention, consisting of an elastic tubular knitted fabric made with the process described above, wherein the resultant ribbons are knitted so as to form a tubular loop structure as shown in figure 1, and may be seen therein to have chains of loops -1- running parallel to the longitudinal axis -5- of the fabric, and ribbons -2-perpendicular to said axis -5- and parallel to the cross axis -6- of the fabric, interconnecting the chains of loops.

[0033] The chains of loops -1- running parallel to the longitudinal axis also comprise two types of ribbons, some -3- knitted only into said chains and others -4- perpendicular to the longitudinal axis, interconnecting the chains of loops -1- in a sequence of one loop comprising one type of ribbon, whereas the adjacent loop is made of the other type of ribbon.

Claims

1. An elastic tubular knitted fabric, said fabric being formed of ribbons made of thermoplastic material, said ribbons being produced by extrusion of an elastic film of said thermoplastic material, and cutting and stretching this film, wherein said fabric is **characterized in that**

   - said ribbons are knitted said elastic film essentially made of an ethyleneoctene copolymer, a pigmentary dispersion and a lubricating agent, to form a tubular loop structure, with chains of loops (1) running parallel to the longitudinal axis (5) of the tubular fabric, and ribbons (2) which are perpendicular to said axis and which interconnect said chains of loops (1), wherein said longitudinal chains of loops (1) are formed by two types of ribbons, one type (3) which is knitted only into said longitudinal chains (1), and another type of ribbons (4) which interconnect said longitudinal chains of loops (1), and
   - said fabric has an ultimate elongation in excess of 100 % and an elastic limit in excess of 20 %.

2. An elastic tubular knitted fabric in accordance with claim 1, **characterized in that** said pigmentary dispersion is a pigment dispersion which is devoid of extenders such as titanium dioxide, and said lubricating agent is selected from the group of fatty amides.

3. An elastic tubular knitted fabric in accordance with claim 1 or 2, **characterized in that** said ribbons (3, 4) are formed by an elastic film stretched with a stretch ratio of less than 1:4 and a temperature not in excess of 50 °C.

4. An elastic tubular knitted fabric in accordance with any one of claims 1 to 3, **characterized in that** said loops of said chains of loops (1) are arranged in an alternating sequence of one loop consisting of said one type of ribbon (3) and the adjacent loop consisting of said other type of ribbon (4).

5. An elastic tubular knitted fabric in accordance with any one of claims 1 to 4, **characterized in that** it has a tensile strain recovery in excess of 25 % when stretched beyond 40 %.

6. A process for producing an elastic tubular knitted fabric, said fabric being formed of ribbons made of thermoplastic material, said process comprising the steps of making an elastic film of said material by using an extrusion process, and cutting and stretching said film to produce ribbons, **characterized in that**

- said elastic film is essentially made of an ethyleneoctene copolymer, a pigmentary dispersion and a lubricating agent, and
- the dimensional ratio between the thickness of the outlet opening of the extruder head and the thickness of the extruded film is approximately 17, and the dimensional ratio between the perimeter of the outlet opening and the width of the sheet of film is approximately 0.7, and
- said ribbons are knitted to form a tubular loop structure, with chains of loops (1) running parallel to the longitudinal axis (5) of the tubular fabric, and ribbons (2) which are perpendicular to said axis and which interconnect said chains of loops (1), wherein said longitudinal chains of loops (1) are formed by two types of ribbons, one type which is knitted only into said longitudinal chains (1), and another type of ribbons (2) which interconnect said longitudinal chains of loops (1).

7. A process in accordance with claim 6, **characterized in that** said pigmentary dispersion is a pigment dispersion which is devoid of extenders such as titanium dioxide, and said lubricating agent is selected from the group of fatty amides.

8. A process in accordance with claim 6 or 7, **characterized in that** said film is cut and stretched with a stretch ratio of less than 1:4 and a temperature not in excess of 50 °C.

9. A process in accordance with any one of claims 6 to 8, **characterized in that** the tubular fabric is knitted in such way that said loops of said chains of loops (1) are arranged in an alternating sequence of one loop consisting of said one type of ribbon (3) and the adjacent loop consisting of said other type of ribbon (4).

Patentansprüche

1. Elastische schlauchförmige Strickware, wobei die Strickware aus Bändern aus thermoplastischem Material gebildet ist und wobei diese Bänder durch Extrusion einer elastischen Folie aus besagtem thermoplastischen Material und durch Schneiden und Recken dieser Folie hergestellt wird, **dadurch gekennzeichnet, dass**

- die Bänder aus der elastischen Folie gestrickt sind, welche im Wesentlichen aus einem Ethylen-Octen-Copolymer, einer Pigmentdispersion und einem Gleitmittel hergestellt ist, so dass eine schlauchförmige Maschenstruktur gebildet wird, welche Ketten aus Maschen (1) aufweist, die parallel zur Längsachse (5) der Schlauchstrickware verlaufen, sowie Bänder (2), die senkrecht zu dieser Achse verlaufen und die besagten Ketten aus Maschen (1) miteinander verbinden, wobei die längsverlaufenden Maschenketten (1) aus zwei Arten von Bändern gebildet sind, nämlich einer Art (3), die nur in die besagten längsverlaufenden Ketten (1) eingestrickt ist, und einer Art von Bändern (4), welche die besagten längsverlaufenden Maschenketten (1) miteinander verbinden, und
- die besagte Strickware eine Dehnungsgrenze von über 100 % und eine Elastizitätsgrenze von über 20 % aufweist.

2. Eine elastische schlauchförmige Strickware nach Anspruch 1, **dadurch gekennzeichnet, dass** die Pigmentdispersion eine Pigmentdispersion ist, welche keine Verschnittmittel, wie z.B. Titandioxid, enthält, und das Gleitmittel aus der Gruppe der Fettamide ausgewählt ist.

3. Eine elastische schlauchförmige Strickware nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Bänder (3, 4) aus einer elastischen Folie gebildet sind, die in einem Reckverhältnis von weniger als 1:4 und bei einer Temperatur von nicht über 50 °C gereckt ist.

4. Eine elastische schlauchförmige Strickware nach einem der Ansprüche 1-3, **dadurch gekennzeichnet, dass** die Maschen der Maschenketten (1) in abwechselnder Reihenfolge angeordnet sind, wobei eine Masche aus dem einen Bandtyp (3) und die jeweils benachbarte Masche aus dem anderen Bandtyp (4) besteht.

5. Elastische schlauchförmige Strickware nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** sie eine Zugbeanspruchungsrückverformung von mehr als 25 % aufweist, wenn sie über 40 % hinaus gedehnt wird.

6. Verfahren zur Herstellung einer elastischen schlauchförmigen Strickware, wobei die Strickware aus Bändern aus thermoplastischem Material hergestellt wird und das Verfahren die Schritte der Herstellung einer elastischen Folie dieses Materials unter Verwendung eines Extrusionsverfahrens und des Schneidens und Reckens der Folie, um Bänder herzustellen, umfasst, **dadurch gekennzeichnet, dass**

   - die elastische Folie im wesentlichen aus einem Ethylen-Octen-Copolymer, einer Pigmentdispersion und einem Gleitmittel besteht, und
   - das Größenverhältnis zwischen der Dicke der Austrittsöffnung des Extruderkopfes und der Dicke der extrudierten Folie ungefähr 17 beträgt, und dass das Größenverhältnis zwischen dem Umfang der Austrittsöffnung und der Breite der Folienbahn ungefähr 0,7 beträgt und
   - die Bänder gestrickt werden, um eine schlauchförmige Maschenstruktur zu bilden, mit Maschenketten (1), die parallel zur Längsachse (5) der schlauchförmigen Strickware verlaufen, und Bändern (2), die senkrecht zu dieser Achse verlaufen und welche die Maschenketten (1) miteinander verbinden, wobei die besagten längsverlaufenden Maschenketten (1) aus zwei Arten von Bändern gebildet sind, von denen eine Art nur in die besagten längsverlaufenen Maschenketten (1) eingestrickt wird und eine andere Art von Bändern (2) die längsverlaufenden Ketten (1) miteinander verbindet.

7. Verfahren nach Anspruch 6, **dadurch gekennzeichnet, dass** die Pigmentdispersion eine Pigmentdispersion ist, welche keine Verschnittmittel, wie z.B. Titandioxid, enthält, und dass das Gleitmittel aus der Gruppe der Fettamide ausgewählt ist.

8. Verfahren nach Anspruch 6 oder 7, **dadurch gekennzeichnet, dass** die Folie geschnitten und mit einem Reckverhältnis von weniger als 1:4 und bei einer Temperatur von nicht über 50 °C gereckt wird.

9. Verfahren nach einem der Ansprüche 6 bis 8, **dadurch gekennzeichnet, dass** die schlauchförmige Ware derart gestrickt wird, dass die Maschen der besagten Maschenketten (1) in abwechselnder Reihenfolge angeordnet sind, wobei eine Masche aus der einen Bandart (3) und die jeweils benachbarte Masche aus der anderen Bandart (4) besteht.

Revendications

1. Tissu tricoté tubulaire élastique, ledit tissu étant constitué de rubans faits de matière thermoplastique, lesdits rubans étant produits par l'extrusion d'un film élastique de ladite matière thermoplastique, et en coupant et en étirant ce film, dans lequel ledit tissu est **caractérisé en ce que**

   - lesdits rubans sont tricotés à partir dudit film élastique principalement fait d'un copolymère d'éthylène-octène, d'une dispersion pigmentaire et d'un agent lubrifiant, pour former une structure en boucle tubulaire, des chaînes de boucles (1) étant parallèles à l'axe longitudinal (5) du tissu tubulaire, et des rubans (2) qui sont perpendiculaires audit axe et qui relient ensemble lesdites chaînes de boucles (1), dans lesquelles lesdites chaînes de boucles longitudinales (1) sont constituées par deux types de rubans, un type (3) qui est tricoté seulement en dites chaînes longitudinales (1), et un autre type de rubans (4) qui relient ensemble lesdites chaînes de boucles longitudinales (1), et

- ledit tissu a une élasticité maximale supérieure à 100% et une limite élastique supérieure à 20%.

2. Tissu tricoté tubulaire élastique selon la revendication 1, **caractérisé en ce que** ladite dispersion pigmentaire est une dispersion de pigment qui est exempte d'unités d'extension telles que le dioxyde de titane, et ledit agent lubrifiant est choisi parmi le groupe d'amides grasses.

3. Tissu tricoté tubulaire élastique selon la revendication 1 ou 2, **caractérisé en ce que** lesdits rubans (3, 4) sont constitués d'un film élastique étiré avec un rapport d'étirage inférieur a 1/4 et une température n'excédant pas 50°C.

4. Tissu tricoté tubulaire élastique selon l'une quelconque des revendications 1 a 3, **caractérisé en ce que** lesdites boucles desdites chaînes de boucles (1) sont positionnées en séquence alternant une boucle composée dudit premier type de ruban (3) et la boucle adjacente composée dudit autre type de ruban (4).

5. Tissu tricoté tubulaire élastique selon l'une quelconque des revendications 1 a 4, **caractérisé en ce qu**'il a une récupération de contrainte de tension supérieure à 25% lorsqu'il est étiré au-delà de 40%.

6. Procédé pour produire un tissu tricoté tubulaire élastique, ledit tissu étant constitué de rubans faits de matière thermoplastique, ledit procédé comprenant les étapes de fabrication d'un film élastique de ladite matière en utilisant un procédé d'extrusion, et en coupant et en étirant ledit film pour produire des rubans, **caractérisé en ce que**

- ledit film élastique est principalement fait d'un copolymère d'éthylène-octène, d'une dispersion pigmentaire et d'un agent lubrifiant, et
- le rapport dimensionnel entre l'épaisseur de l'orifice de sortie de la tête de l'extrudeuse et l'épaisseur du film extrudé est d'approximativement 17, et le rapport dimensionnel entre le périmètre de l'orifice de sortie et la largeur de la feuille de film est d'approximativement 0,7, et
- lesdits rubans sont tricotés pour former une structure en boucle tubulaire, des chaînes de boucles (1) étant parallèles à l'axe longitudinal (5) du tissu tubulaire, et des rubans (2) qui sont perpendiculaires audit axe et qui relient ensemble lesdites chaînes de boucles (1), dans lesquelles lesdites chaînes de boucles longitudinales (1) sont constituées par deux types de rubans, un type qui est tricoté seulement en dites chaînes longitudinales (1), et un autre type de rubans (2) qui relient ensembles lesdites chaînes de boucles longitudinales (1).

7. Procédé selon la revendication 6, **caractérisé en ce que** ladite dispersion pigmentaire est une dispersion de pigment qui est exempte d'unités d'extension telles que le dioxyde de titane, et ledit agent lubrifiant est choisi parmi le groupe d'amides grasses.

8. Procédé selon la revendication 6 ou 7, **caractérisé en ce que** ledit film est coupé et étiré avec un rapport d'étirage inférieur à 1/4 et une température n'excédant pas 50°C.

9. Procédé selon l'une quelconque des revendications 6 à 8, **caractérisé en ce que** le tissu tubulaire est tricoté de sorte que lesdites boucles desdites chaînes de boucles (1) sont positionnées en séquence altemant une boucle composé dudit premier type de ruban (3) et la boucle adjacente composée dudit autre type de ruban (4).

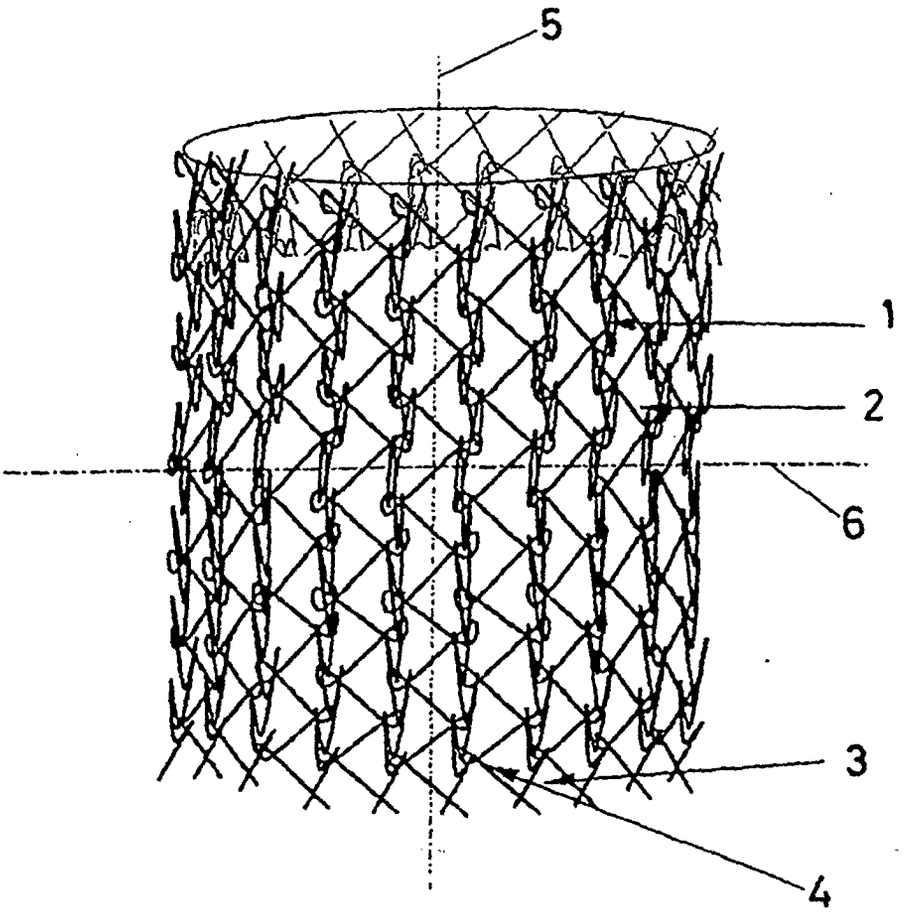

FIG. 1