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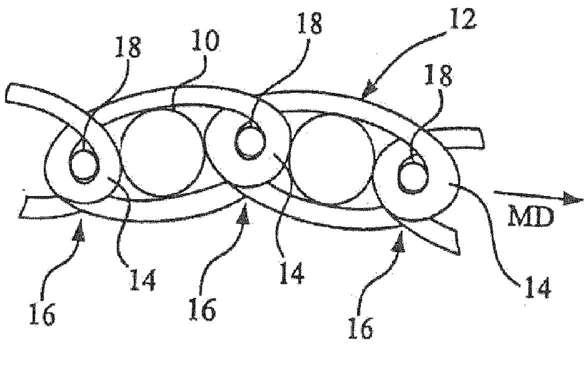

Fig. 1A

(57) **Abstract**: A monofilament in particular for use as a component in a spiral fabric is formed from a resin composition including a thermoplastic polymer, the thermoplastic polymer having a number average molecular weight of less than 14200 g/mol. In accordance with another embodiment, a monofilament is formed from a resin composition including a thermoplastic polymer, the thermoplastic polymer having a free thermal shrinkage of less than 1 %. In accordance with still another embodiment, a monofilament is formed from a resin composition including a thermoplastic polymer, the thermoplastic polymer having an intrinsic viscosity of less than 0.72 dl/g. In accordance with still another embodiment, a monofilament is formed from a resin composition including a thermoplastic polymer, the thermoplastic polymer having a melt viscosity of less than 3000 P.

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Monofilament, Spiral Fabric and Method for Forming same

The present invention relates to a monofilament in particular for use as a component in a spiral fabric, wherein the monofilament is formed from a resin composition including a thermoplastic polymer.

Spiral fabrics manufactured from coiled polymeric monofilaments are widely used in dryers, conveyors and other industrial applications. For example, endless belts of spiral fabrics are important constituents of the dryer sections of paper machines, which are also called paper machine clothings (PMC). Such paper machine clothings are disclosed, for example, in GB 2141749 A and US 2008/0169039 A1.

A spiral fabric may comprise pintles extending through intermeshed portions of the coiled monofilaments and linking the individual monofilaments together. Furthermore, a spiral fabric may be provided with stuffer elements or filler elements which extend through central portions of the coiled monofilaments and which serve to control the air permeability properties of the fabric as well as to support the fabric's structural integrity. The pintles and/or the stuffer elements may equally be formed from monofilaments, preferably from elongated instead of coiled monofilaments. The coiled monofilaments are usually converted into shaped spiral products by means of a thermomechanical process, in order to form a spiral fabric. Such a thermomechanical process for manufacturing a spiral fabric usually comprises two heat-setting steps, which are carried out at elevated temperatures of e.g. more than 180°C. While the first heat-setting step serves to release structural stresses within the fabric and to stabilize the spiral shapes of the monofilaments, the second heat-setting step is necessary to stabilize the stuffer elements.

However, the heat-setting processes are energy-intensive and time-consuming. On account of these reasons there is a need to reduce the energy consumption and the production time required for manufacturing spiral fabrics.

On account of these reasons the object underlying the present invention is to provide a monofilament which has a low shrinkage.

In accordance with a first aspect of the present invention, this object is satisfied by a monofilament in particular for use as a component in a spiral fabric, wherein the monofilament is formed from a resin composition including a thermoplastic polymer, wherein the thermoplastic polymer has a number average molecular weight of less than 14200 g/mol.

Surprisingly, it has been found that monofilaments formed from a polymer having such a comparable low molecular weight are characterized by and an extraordinarily low shrinkage. Specifically, it has been determined that the shrinkage of a monofilament formed from such a polymer composition is sufficiently low to eliminate in the aforementioned fabric production process one of the two heat-setting steps. This omission of one of the heat-setting processes leads to a significant energy saving and sustainability. Moreover, this leads to a significant reduction of fabric processing time and production costs. Due to the low shrinkage of the monofilaments in accordance with the present invention, the monofilaments may even contain recycled polymer. Thus, the invention enables a reduction of carbon footprint in connection with fabric production.

In accordance with the present invention, the number average molecular weight is measured by gel permeation chromatography making use of polystyrene standards.

Particular good results are achieved, when the thermoplastic polymer has a number average molecular weight ranging from 5000 g/mol to 11000 g/mol.

In accordance with another aspect of the present invention, a monofilament in particular for use as a component in a spiral fabric has a free thermal shrinkage of less than 1%, wherein the free thermal shrinkage is determined as percentage of the change in the length of the monofilament after incubating the monofilament in an oven at 177°C for 5 min compared to the length of the monofilament before the heat treatment, i.e. wherein the free thermal shrinkage is (length of the monofilament before incubating the monofilament in an oven at 177°C for 5 min minus length of the monofilament after incubating the monofilament in an oven at 177°C for 5 min) / (length of the monofilament before incubating the monofilament in an oven at 177°C for 5 min). Monofilaments having such a low shrinkage, when used as stuffer yarns and/or pintles in a spiral fabric, offer the possibility to omit one heat-setting step during the production of the spiral fabric.

Notably good results are achieved, when the monofilament has a free thermal shrinkage of less than 0.5% and most preferably of less than 0.35%.

For some applications, there is a need for monofilaments, that show a free thermal shrinkage in the above mentioned range (<1%, or even < 0.5% or < 0.35%) even under harsher thermal conditions. Therefore, in accordance with another aspect of the invention, a monofilament in particular for use as a component in a spiral fabric has a free thermal shrinkage of less than 1%, wherein the free thermal shrinkage is determined as percentage of the change in the length of the monofilament after incubating the monofilament in an oven at 204°C for 5 min compared to the length of the monofilament before the heat treatment, i.e. wherein the free thermal shrinkage is (length of the monofilament before incubating the monofilament in an oven at 204°C for 5 min minus length of the monofilament after incubat-

ing the monofilament in an oven at 204°C for 5 min) / (length of the monofilament before incubating the monofilament in an oven at 204°C for 5 min).
Since the free thermal shrinkage at 204°C is higher or at least equal to the free thermal shrinkage at 177°C, the monofilaments fulfilling the ‘204°C’-condition can be considered to be a subset of the monofilaments fulfilling the ‘177°C-condition’

According to a preferred embodiment of the present invention, the thermoplastic polymer in both aforementioned aspects of the present invention is a polyethylene terephthalate (PET). PET has a high dimensional stability, a sufficient resistance to abrasion and a low moisture absorption and is moreover available at a moderate price. Furthermore, the tensile properties and the processability of PET are excellent. Therefore, PET monofilaments are especially suited for PMC applications.

In accordance with an alternative embodiment of the present invention, the thermoplastic polymer is a polyphenylene sulfide, a polyamide , a polyolefin or a PCTA . Such polymers may be advantageous in certain applications.

The thermoplastic polymer may be a homopolymer or a copolymer.

In a further development of the present invention, it is proposed that the resin composition includes a hydrolytic stabilizer, which is preferably a monomeric carbodiimide or a polymeric carbodiimide. Preferably, the content of the hydrolytic stabilizer with respect to the resin composition ranges from 1 to 2 % by weight.
Apart from a hydrolytic stabilizer, the resin composition may, if necessary, include other additives, such as e.g. one or more plasticizers.

The resin composition may include a heat stabilizer to minimize thermal degradation.

According to yet another preferred embodiment of the present invention, the monofilament has a circular, oval or rectangular cross section. Specifically, the cross-sectional shape of the monofilament may be selected depending on the type of spiral fabric to produce for and depending on the application field of the fabric.

Alternatively, the cross sections of the monofilaments may have ‘capsule-shape’, ‘leaf-shape’, ‘concave –shape’, ‘UFO-shape’ or any other suitable shape.

In accordance with still another preferred embodiment of the present invention, the monofilament has a maximum diameter ranging from 0.005 mm to 5 mm, preferably from 0.05 mm to 4 mm. According to the present invention, the term "maximum diameter" means the maximum dimension in the cross-section of the monofilament. Monofilaments having a dimension falling in this numeric value range have been found to be specifically suited for PMC applications.

Accordingly, it is preferred that the monofilament has a linear mass density of at least 50 dtex.

A third aspect of the present invention relates to a monofilament in particular for use as a component in a spiral fabric, wherein the monofilament is formed from a resin composition including a thermoplastic polymer, the thermoplastic polymer having an intrinsic viscosity of less than 0.72 dl/g. In accordance with the present invention, the intrinsic viscosity is measured according to ASTM D4603 making use of a solvent containing 60% phenol and 40% 1,1,2,2-tetrachloroethane. As the intrinsic viscosity of a thermoplastic polymer is directly correlated to its number average molecular weight, the monofilament in accordance with this aspect of the present invention has the same advantages as the aforementioned monofilaments according to the first and second aspect of the present invention.

Notably good results are obtained, when the thermoplastic polymer has an intrinsic viscosity ranging from 0.35 dl/g to 0.6 dl/g.

A fourth aspect of the invention relates to a monofilament in particular for use as a component in a spiral fabric, wherein the monofilament is formed from a resin composition including a thermoplastic polymer, the thermoplastic polymer having a melt viscosity of less than 3000 P, wherein P denotes Poise. Like the intrinsic viscosity, the melt viscosity is a parameter which is correlated with the number average molecular weight of the thermoplastic polymer, wherefore the monofilament in accordance with this aspect of the present invention has the same advantages as the aforementioned monofilaments according to the first to third aspect of the present invention.

In a further development of the present invention, it is proposed that the thermoplastic polymer has a melt viscosity of less than 2000 P. Such a polymer enables the forming of specifically stable monofilaments.

Moreover, the present invention is directed to a spiral fabric comprising:

- a plurality of coiled monofilaments arranged side-by-side in intermeshing relationship,
- a plurality of elongated pintles extending through intermeshed portions of the coiled monofilaments, and
- a plurality of stuffer yarns extending through central portions of the coiled monofilaments between adjacent pintles,

wherein the stuffer yarns and/or the pintles are formed from a resin composition including a thermoplastic polymer, and wherein the thermoplastic polymer has a number average molecular weight of less than 14200 g/mol.

Such a spiral fabric is easy to produce, cost-effective and sufficiently stable to be used as a dryer belt or conveyor belt in a high temperature environment, such as the dryer section of a paper machine. Surprisingly, it has been found that the use of monofilaments formed from a comparable low molecular weight polymer enables the omission of one of the two heat-setting steps in the fabric production process. This omission of one of the heat-setting processes leads to a significant energy saving and sustainability. Moreover, this leads to a significant reduction of fabric processing time and production costs. The low shrinkage of the monofilaments in accordance with the present invention may even contain recycled polymer. Thus, the invention enables a reduction of carbon footprint in connection with fabric production.

According to a further preferred embodiment of the present invention, the thermoplastic polymer has a number average molecular weight ranging from 5000 g/mol to 11000 g/mol. This range of molecular weight has turned out to provide especially good results.

Alternatively or in addition, the thermoplastic polymer may have an intrinsic viscosity of less than 0.72 dl/g and/or a melt viscosity of less than 3000P.

Moreover, it is preferred that the stuffer yarns and/or the pintles have a free thermal shrinkage of less than 1%, more preferably of less than 0.5% and most preferably of less than 0.35%. Stuffer yarns and/or pintles having such a low shrinkage offer the possibility to omit one heat-setting step during the production of a spiral fabric.

According to a further preferred embodiment of the present invention, the fabric forms an endless belt. Such an endless belt can be used as a conveyor belt or, preferably, as a dryer belt in a paper machine.

Therefore, according to still another embodiment of the invention, the fabric has a sufficient mechanical and thermal stability to be used as a dryer belt in a paper machine.

In addition, the present invention relates to a method for forming a monofilament in particular for use as a component in a spiral fabric, which comprises the steps of:

- providing a resin composition including a thermoplastic polymer, the thermoplastic polymer having a number average molecular weight of less than 14200 g/mol,
- extruding the resin composition through a spinneret to form a monofilament and
- drawing the monofilament for one or more times.

Apart from using a low molecular weight polymer, the drawing of the monofilament may be performed according to the principles that are generally known in the field of monofilament production. The provision of a low molecular weight polymeric resin enables the drawing of monofilaments which are characterized by a high thermal stability and by an extraordinarily low shrinkage.

Alternatively or in addition, the thermoplastic polymer may have an intrinsic viscosity of less than 0.72 dl/g and/or a melt viscosity of less than 3000 P.

Moreover, it is preferred that the monofilaments have a free thermal shrinkage of less than 1%, more preferably of less than 0.5% and most preferably of less than 0.35%. Monofilaments having such a low shrinkage, when used as stuffer yarns and/or pintles in a spiral fabric, offer the possibility to omit one heat-setting step during the production of the spiral fabric.

In a further development of the present invention, it is proposed that the resin composition is prepared at least partially from a recycled polymer. The use of a recycled polymer does not only reduce the production costs, but reduces also the carbon footprint.

According to yet another preferred embodiment of the present invention, the monofilament is drawn for one or more times at an overall draw ratio ranging from 3.0 to 6.0. Such draw ratios are advantageous with respect to the mechanical properties of the monofilament.

Notably good results are obtained, when the monofilament is drawn for one or more times in an oven at a temperature ranging from 90°C to 250°C.

According to another aspect, the invention relates to a method for forming a spiral fabric comprising the steps of:

a providing a plurality of coiled monofilaments,

b arranging the coiled monofilaments side-by-side in intermeshing relationship,

c extending a plurality of elongated pintles through intermeshed portions of the coiled monofilaments,

d extending stuffer elements having a free thermal shrinkage, measured in an oven at 177°C for 5 min, of less than 1%, preferably of less than 0.5%, and most preferably of less than 0.3%, through central portions of the coiled monofilaments between adjacent pintles, and

e heat-setting the arrangement of coiled monofilaments and pintles at an elevated temperature, whereby structural stresses of the monofilaments are released.

Manufacturing a spiral fabric using stuffer yarns having a low shrinkage provides for a more efficient production process. Specifically, it has been found that the use of low shrinkage stuffer elements eliminates the need for a second heat-setting step, thus contributing to energy saving and sustainability.

In another aspect of the invention, it may be necessary to have stuffer elements with even better resistance to free thermal shrinkage. Therfore, it may be unseful to replace step d fo the above mentions method by

b* *extending stuffer elements having a free thermal shrinkage, measured in an oven at 204°C for 5 min, of less than 1%, preferably of less than 0.5%, and most preferably of less than 0.3%, through central portions of the coiled monofilaments between adjacent pintles, "*

According to a further preferred embodiment of the present invention, the stuffer elements are drawn from a resin composition including a thermoplastic polymer, the thermoplastic polymer having a number average molecular weight of less than 14200 g/mol.

Alternatively or in addition thereto, the stuffer elements may be drawn from a resin composition including a thermoplastic polymer, wherein the thermoplastic polymer has an intrinsic viscosity of less than 0.72 dl/g and/or a melt viscosity of less than 3000 P.

Preferably, the pintles are equally formed from monofilaments having a free thermal shrinkage of less than 1%, preferably of less than 0.5%, and most preferably of less than 0.3%, wherein the free thermal shrinkage is determined as percentage of the change in the length of the monofilament after incubating the monofilament in an oven at 177°C for 5 min compared to the length of the monofilament before the heat treatment. Again, for special applications, pintles with higher resistance to free thermal shrinkage may be needed. Here the pintles may be formed from monofilaments having a free thermal shrinkage of less than 1%, preferably of less than 0.5%, and most preferably of less than 0.3%, wherein the free thermal shrinkage is determined as percentage of the change in the length of the monofilament after incubating the monofilament in an oven at 204°C for 5 min compared to the length of the monofilament before the heat treatment

According to a further preferred embodiment of the present invention, the stuffer elements are extended through the central portions of the coiled monofilaments between adjacent pintles before the step of heat setting the arrangement of coiled monofilaments and pintles at an elevated temperature.

Alternatively, the stuffer elements may be extended through the central portions of the coiled monofilaments between adjacent pintles after the step of heat setting the arrangement of coiled monofilaments and pintles at an elevated temperature.

Preferably, the arrangement of coiled monofilaments and pintles is not subjected to any further thermal treatment after the step of heat setting.

Furthermore, the present invention relates to the use of the aforementioned monofilaments for forming a spiral fabric.

Subsequently, the present invention is explained in more detail based on exemplary embodiments with reference to the accompanying figures, wherein:

Fig. 1A is an enlarged side view of a spiral fabric made up from coiled monofilaments, pintles and stuffer yarns;

Fig. 1B is an enlarged side view of a spiral fabric according to an alternative embodiment;

Fig. 2 is a plan view of the spiral fabric of Fig. 1;

Fig. 3 is a perspective view of an endless belt formed from the spiral fabric of Fig. 1 and 2; and

Fig. 4 is a diagram showing the correlation between the inherent viscosity of a PET solution and the number average molecular weight of the PET.

Figs 5a, 5b, 5c and 5d are schematic depictions of several cross sections for monofilament according to the present invention.

In Figs. 1A, 1B and 2, there is shown a fabric 12 formed from a plurality of coiled monofilaments 14 intermeshing to form continuous loops in a machine direction MD. The fabric 12 is formed to provide an endless belt 20 as shown in Fig. 3. At the intersections 16 of the coiled monofilaments 14, there are arranged pintles 18 which extend transverse to the machine direction MD. After the coiled monofilaments 14 are interweaved and the pintles 18 are inserted, stuffer elements 10 are inserted so as to extend transverse to the machine direction MD. The stuffer elements 10 shown in Fig. 1A have a circular cross section, whereas the stuffer elements 10' shown in Fig. 1B have an essentially rectangular cross section with slightly rounded corners. In order to stabilize the spiral form of the monofilaments 14 and to release thermal stresses within the monofilaments 14, the fabric 12 is subjected to a thermal treatment called heat-setting, carried out at a temperature of more than 180°C.

While the monofilaments, especially for the use as stuffer yarns may have standard cross section shapes like round, rectangular (usually with rounded corners) or oval, other shapes are possible and may be beneficial for certain applications. Some examples are schematically shown in Figs. 5a – 5d. It should be noted that the geometrical details like aspect ratio or radii of the bending are only meant as an example. The real values can be different in real applications.

Fig 5a shows a ‘capsule-shape’, with straight top and bottom sides, and strongly bend left and right sides. These can for example be half circles.
Fig 5b shows a ‘leaf-shape’, with curved top and bottom side. This shape can also be described as the shape of a lense
Fig. 5c shows a ‘concave-shape’. Here, top, bottom and side edges are bent ‘to the inside of the filament. The four corners may be pointy or –as shown in Fig 5c- may be rounded.
Fig 5d shows an ‘UFO-shape’, where the middle part is bulky –circular in Fig 5d, while there are small extensions to the right an the left, giving the filament cross sections the appearance of an UFO.

The stuffer elements 10, 10' and the pintles 18 are formed from a resin composition including a thermoplastic polymer and a carbodiimide, as it is described above and for an exemplary embodiment below.

EXAMPLES

Different samples of monofilaments were produced on the basis of a recycled polyethylene terephthalate (PET). More specifically, PET monofilament scrap was pelletized and a resin composition was prepared from the pelletized PET monofilament scrap. The intrinsic viscosity of the resin composition was measured according to ASTM D4603, with 60% phenol and 40% 1,1,2,2-tetrachloroethane solvent combination. Monofilaments were prepared by extrusion and then the monofilaments were drawn from each resin composition at different draw ratios and at different oven temperatures so as to have a length of one meter. The obtained samples were kept in an enclosed hot air oven at 177°C for 5 minutes in an unrestrained condition. (Alternatively, the samples may be kept in an enclosed hot air oven at 204°C for 5 minutes in an unrestrained condition, if heavy duty filaments are needed) After this hot air treatment, the change in the length of each samples was measured and therefrom the free shrinkage percentage was calculated.

The intrinsic viscosity correlates with the average molecular weight of the PET. The correlation between the inherent viscosity of a PET solution and the corresponding molecular weight, which is largely linear, is shown in Fig. 4. It has to be noted that the inherent viscosity is the ratio of the natural logarithm of the relative viscosity to the mass concentration of the polymer, whereas the intrinsic viscosity is the limiting value of the reduced viscosity or the inherent viscosity at infinite dilution of the polymer.

Table 1 shows the properties of two monofilament samples 1 and 2 according to the present invention as well as of two control examples. It can be deduced from table 1 that the use of a low viscosity PET composition, which is equivalent to the use of a low molecular weight PET, leads to a monofilament having a free shrinkage of less than 1%. Such a low shrinkage eliminates the need for a second heat-setting step in the production process of a spiral fabric as shown in Fig. 1.

Sample	Size /mm	Intrinsic viscosity	Draw ratio 1	Draw ratio 2	Draw ratio 3	Oven Temp 1 (°C)	Oven Temp 2 (°C)	Oven Temp 3 (°C)	Free Shrink %
Control	0.70	0.95	3.54	1.54	0.81	96	216	232	2.3
1	0.70	0.54	3.50	1.00	1.00	96	196	196	0.0
Control	0.55	0.72	4.35	1.16	0.89	96	243	243	1.0
2	0.55	0.54	4.35	1.16	0.89	96	243	243	0.3

Table 1: Tensile properties of monofilaments

List of Reference Numerals:

10, 10'	stuffer element
12	fabric
14	monofilament
16	intersection
18	pintle
20	endless belt
MD	machine direction

Claims

1. A monofilament (10, 10', 18) in particular for use as a component in a spiral fabric (12), wherein the monofilament (10, 10', 18) is formed from a resin composition including a thermoplastic polymer, the thermoplastic polymer having a number average molecular weight of less than 14200 g/mol.

2. The monofilament in accordance with claim 1, wherein the thermoplastic polymer has a number average molecular weight ranging from 5000 g/mol to 11000 g/mol.

3. A monofilament in particular in accordance with claim 1 or 2, wherein the monofilament (10, 10', 18) has a free thermal shrinkage of less than 1%, preferably of less than 0.5% and most preferably of less than 0.35%, wherein the free thermal shrinkage is determined as percentage of the change in the length of the monofilament after incubating the monofilament in an oven at 177°C for 5 min compared to the length of the monofilament before the heat treatment.

4. A monofilament in accordance with claim 3, wherein the monofilament (10, 10', 18) has a free thermal shrinkage of less than 1%, preferably of less than 0.5% and most preferably of less than 0.35%, wherein the free thermal shrinkage is determined as percentage of the change in the length of the monofilament after incubating the monofilament in an oven at 204°C for 5 min compared to the length of the monofilament before the heat treatment.

5. The monofilament in accordance with any of the preceding claims, wherein the thermoplastic polymer is polyethylene terephthalate.

6. The monofilament in accordance with any of claims 1 to 4, wherein the thermoplastic polymer is polyphenylene sulfide, polyamide,polyolefin or PCTA.

7. The monofilament in accordance with any of the preceding claims, wherein the thermoplastic polymer is a homopolymer.

8. The monofilament in accordance with any of claims 1 to 6, wherein the thermoplastic polymer is a copolymer.

9. The monofilament in accordance with any of the preceding claims, wherein the resin composition includes a hydrolytic stabilizer, preferably a monomeric carbodiimide or a polymeric carbodiimide.

10. The monofilament in accordance with any of the preceding claims, wherein the resin composition includes a heat stabilizer.

11. The monofilament in accordance with any of the preceding claims, wherein the monofilament (14) has a circular, oval or rectangular cross section.

12. The monofilament in accordance with any of the preceding claims, wherein the monofilament (14) has a maximum diameter ranging from 0.005 mm to 5 mm, preferably from 0.05 mm to 4 mm.

13. A monofilament in particular for use as a component in a spiral fabric (12), wherein the monofilament (10, 10', 18) is formed from a resin composition

including a thermoplastic polymer, the thermoplastic polymer having an intrinsic viscosity of less than 0.72 dl/g.

14. The monofilament in accordance with claim 13, wherein the thermoplastic polymer has an intrinsic viscosity ranging from 0.35 dl/g to 0.6 dl/g.

15. A monofilament in particular for use as a component in a spiral fabric (12), wherein the monofilament is formed from a resin composition including a thermoplastic polymer, the thermoplastic polymer having a melt viscosity of less than 3000 P.

16. The monofilament in accordance with claim 14, wherein the thermoplastic polymer has a melt viscosity of less than 2000 P.

17. A spiral fabric (12) comprising:

a plurality of coiled monofilaments (14) arranged side-by-side in intermeshing relationship,

a plurality of elongated pintles (18) extending through intermeshed portions of the coiled monofilaments (14), and

a plurality of stuffer yarns (10, 10') extending through central portions of the coiled monofilaments (14) between adjacent pintles (18),

wherein the stuffer yarns (10, 10') and/or the pintles (18) are formed from a resin composition including a thermoplastic polymer,

the thermoplastic polymer having a number average molecular weight of less than 14200 g/mol.

18. The spiral fabric in accordance with claim 17, wherein the thermoplastic polymer has a number average molecular weight ranging from 5000 g/mol to 11000 g/mol.

19. A spiral fabric in particular in accordance with claim 17 or 18, wherein the stuffer yarns (10, 10') and/or the pintles (18) have a free thermal shrinkage of less than 1%, preferably of less than 0.5% and most preferably of less than 0.35%, wherein the free thermal shrinkage is determined as percentage of the change in the length of the monofilament after incubating the monofilament in an oven at 177°C for 5 min compared to the length of the monofilament before the heat treatment.

20. The spiral fabric in accordance with any of claims 17 to 19, wherein the fabric (12) forms an endless belt (20).

21. The spiral fabric in accordance with any of claims 17 to 20, wherein the fabric (12) has a sufficient mechanical and thermal stability to be used as a dryer belt in a paper machine.

22. A method for forming a monofilament (10, 10', 18) comprising the steps of:

providing a resin composition including a thermoplastic polymer, particularly a thermoplastic polymer having a number average molecular weight of less than 14200 g/mol,

extruding the resin composition through a spinneret to form a monofilament and

drawing the monofilament (10, 10', 18) for one or more times.

23. The method in accordance with claim 22, wherein the resin composition is prepared at least partially from a recycled polymer.

24. The method in accordance with claim 22 or 23, wherein the monofilament is drawn for one or more times at an overall draw ratio ranging from 3.0 to 6.0.

25. The method in accordance with any of claims 21 to 23, wherein the monofilament is drawn for one or more times in an oven at a temperature ranging from 90°C to 250°C.

26. A method for forming a spiral fabric (12) comprising the steps of:
providing a plurality of coiled monofilaments (14),
arranging the coiled monofilaments (14) side-by-side in intermeshing relationship,
extending a plurality of elongated pintles (18) through intermeshed portions of the coiled monofilaments (14),
extending stuffer elements (10, 10') formed from monofilaments in accordance with any of claims 1 to 14 through central portions of the coiled monofilaments (14) between adjacent pintles (18) and
heat setting the arrangement of coiled monofilaments (14) and pintles (18) at an elevated temperature, whereby structural stresses of the monofilaments (14) are released.

27. The method in accordance with claim 26, wherein the stuffer elements (10, 10') are drawn from a resin composition including a thermoplastic polymer, the thermoplastic polymer having a number average molecular weight of less than 14200 g/mol.

28. The method in accordance with claim 26 or 27, wherein the stuffer elements (10, 10') are drawn from a resin composition including a thermoplastic polymer, the thermoplastic polymer having an intrinsic viscosity of less than 0.72 dl/g.

29. The method in accordance with any of claims 26 to 28, wherein the stuffer elements (10, 10') are drawn from a resin composition including a thermoplastic polymer, the thermoplastic polymer having a free thermal shrinkage

of less than 1%, preferably of less than 0.5% and most preferably of less than 0.35%, wherein the free thermal shrinkage is determined as percentage of the change in the length of the monofilament after incubating the monofilament in an oven at 177°C for 5 min compared to the length of the monofilament before the heat treatment.

30. The method in accordance with any of claims 26 to 29, wherein the pintles (18) are equally formed from monofilaments having a free thermal shrinkage of less than 1%, preferably of less than 0.5%, and most preferably of less than 0.3%, wherein the free thermal shrinkage is determined as percentage of the change in the length of the monofilament after incubating the monofilament in an oven at 177°C for 5 min compared to the length of the monofilament before the heat treatment.

31. The method in accordance with any of claims 26-30, wherein the stuffer elements (10, 10') are extended through the central portions of the coiled monofilaments (14) between adjacent pintles (18) before the step of heat setting the arrangement of coiled monofilaments (14) and pintles (18) at an elevated temperature.

32. The method in accordance with any of claims 26-30, wherein stuffer elements (10, 10') are extended through the central portions of the coiled monofilaments (14) between adjacent pintles (18) after the step of heat setting the arrangement of coiled monofilaments (14) and pintles (18) at an elevated temperature.

33. The method in accordance with any of claims 26-32, wherein the arrangement of coiled monofilaments (14) and pintles (18) is not subjected to any further thermal treatment after the step of heat setting.

34. Use of a monofilament (10, 10', 18) in accordance with any of claims 1 to 16 for forming a spiral fabric (12).

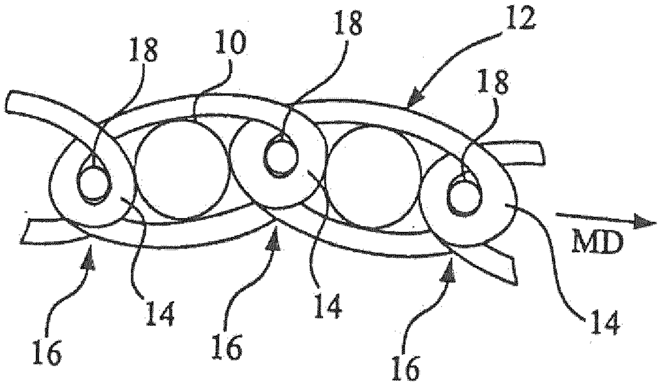


Fig. 1A

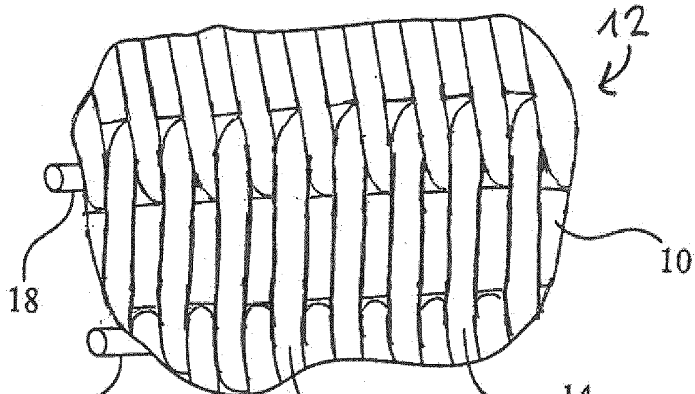


Fig. 2

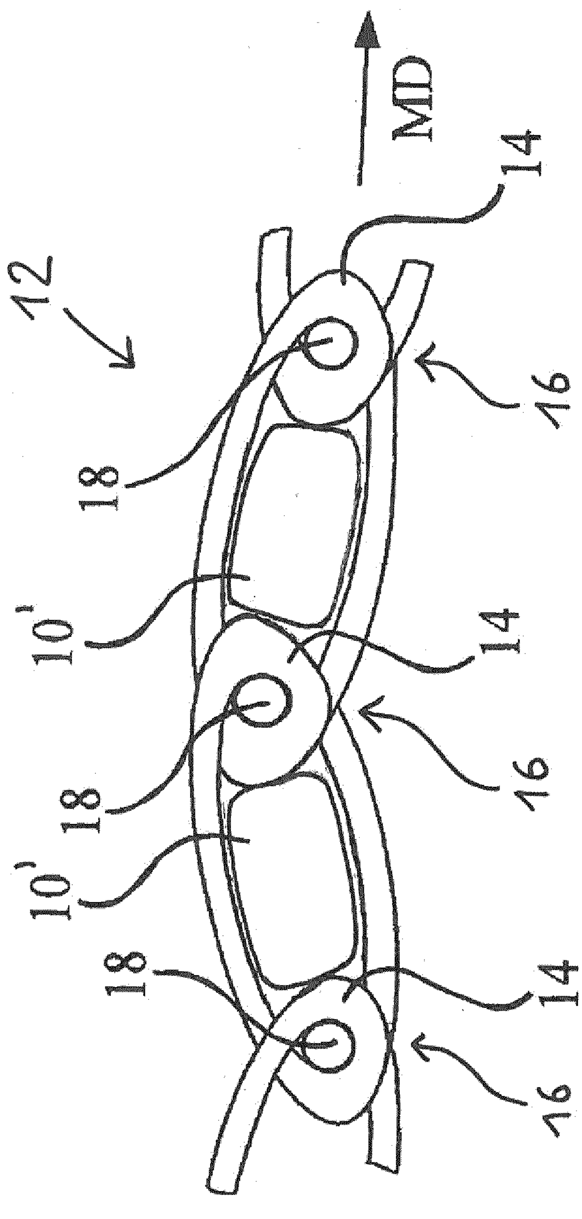


Fig. 1B

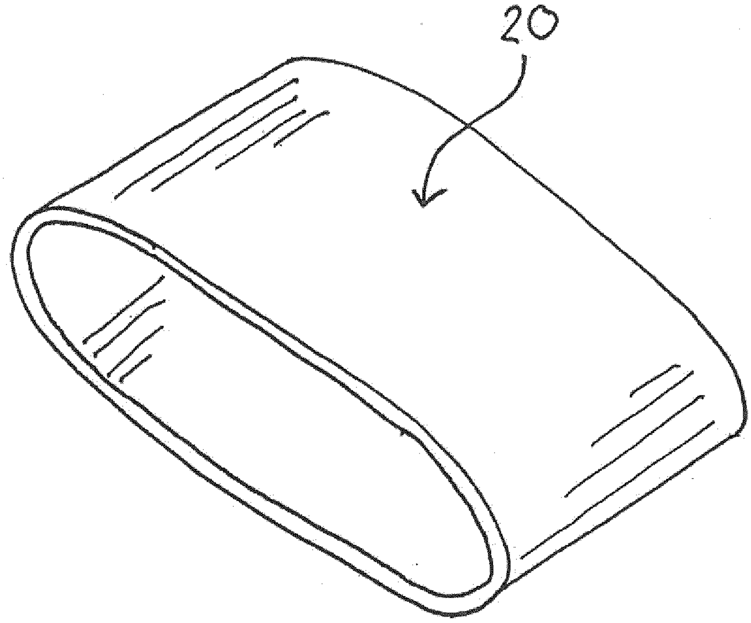
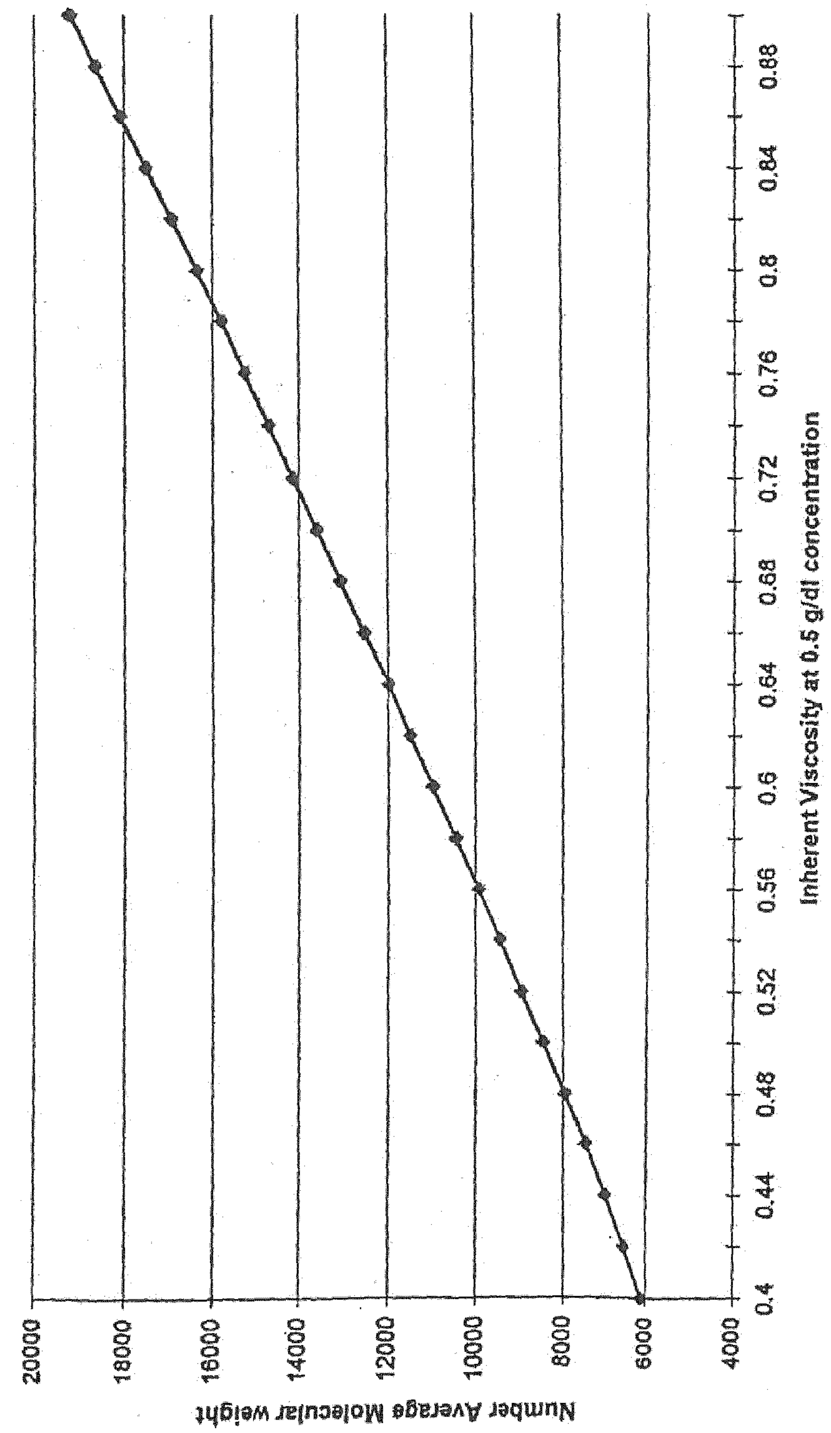
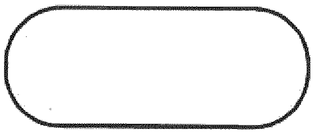


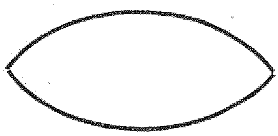
Fig. 3

Fig. 4

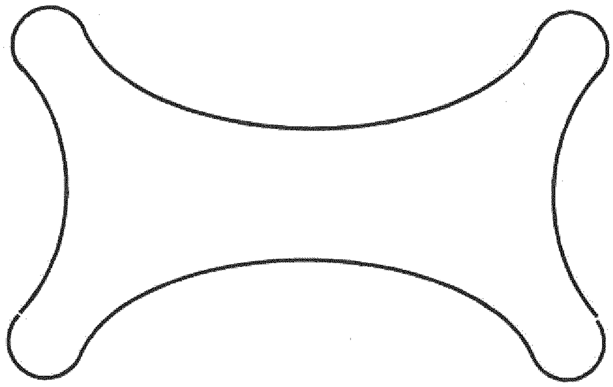

Number Average Molecular weight
20000
18000
16000
14000
12000
10000
8000
6000
4000
Inherent Viscosity at 0.5 g/dl concentration
0.4
0.44
0.48
0.52
0.56
0.6
0.64
0.68
0.72
0.76
0.8
0.84
0.88



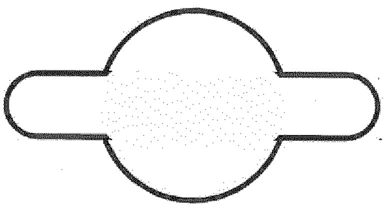
Figur 5a



Figur 5b



Figur 5c



Figur 5d