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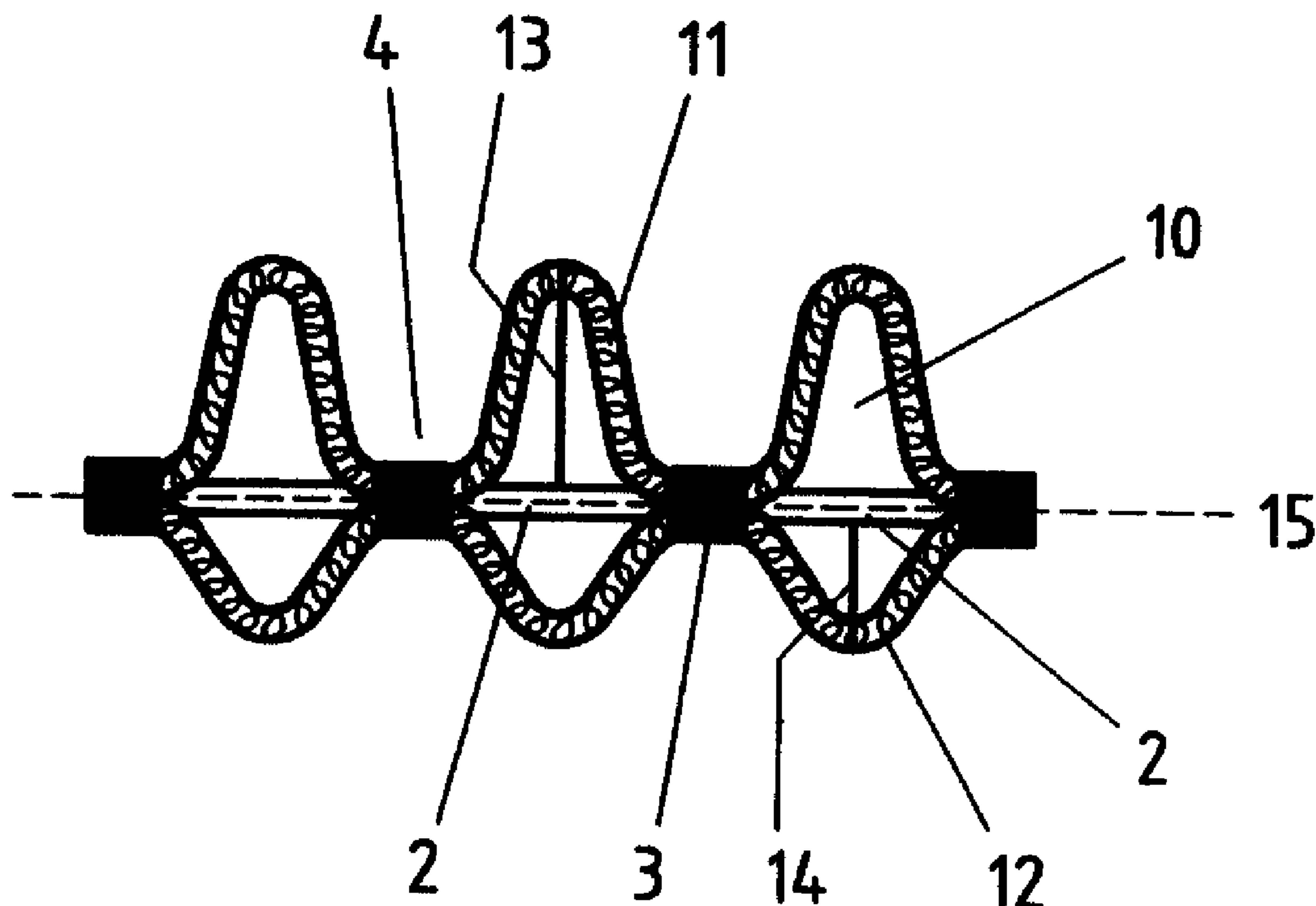
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(54) Titre : COMPOSITE ELASTIQUE, PROCEDE DE FABRICATION ET UTILISATION

(54) Title: ELASTIC COMPOSITE, PROCESS FOR MANUFACTURE AND USE



(57) Abrégé/Abstract:

An elastic composite material is disclosed which includes at least one non-woven material layer, at least one further sheet material layer and therebetween a parallel oriented group of elastic threads. The non-woven material is thermally melt bonded with the further sheet material in the form of a predetermined pattern of melt bonding regions and the elastic threads are melt embedded in the tensioned condition at selected locations into the melt bonding regions between the non-woven material and the further sheet material. The materials of the non-woven and sheet material layers and of the elastic threads are selected such that the material of the elastic threads is not melt bonded with the materials of the non-woven and sheet material layers in the melt bonding regions. The resulting composite material can be used for the manufacture of hygiene articles, especially diapers including diaper pants.

ABSTRACT

An elastic composite material is disclosed which includes at least one non-woven material layer, at least one further sheet material layer and therebetween a parallel oriented group of elastic threads. The non-woven material is thermally melt bonded with the further sheet material in the form of a predetermined pattern of melt bonding regions and the elastic threads are melt embedded in the tensioned condition at selected locations into the melt bonding regions between the non-woven material and the further sheet material. The materials of the non-woven and sheet material layers and of the elastic threads are selected such that the material of the elastic threads is not melt bonded with the materials of the non-woven and sheet material layers in the melt bonding regions. The resulting composite material can be used for the manufacture of hygiene articles, especially diapers including diaper pants.

Elastic Composite, Process For Manufacture And Use

Field of the Invention

The present invention relates to elastic composites suitable especially for the manufacture of hygiene products, to processes for their manufacture, and to their use in the manufacture of hygiene products, such as disposable diapers.

Background Art

Elastic components have been used for different purposes for years in disposable diapers for adults and children or in diaper pants. The leg cuff of such diapers includes individual, coarse elastic threads glued between two layers of non-woven in order to guaranty an optimal fit to the body shape and to thereby prevent the leakage of body fluids. The waist band region of a diaper can be made of elastic composites, also for the purpose of an optimal fit to the body.

For the same reason, the hook portion of a mechanical fastening system of a diaper can be fixed to an elastic carrier. In disposable diapers as well as in diaper pants, few individual elastic threads of a very high titer of several hundred to several thousand dtex are incorporated during the diaper manufacture processes. The elastic threads are thereby adhered in stretched condition between two non-woven layers. The adhesive is normally a pressure sensitive adhesive (PSA-adhesive), which is applied continuously or partially onto the surface of at least one of the two non-woven layers. The distance between the individual, adjacent threads oriented in parallel to one another is relatively large and is in the range of several mm to one cm. After relaxation of the stretched elastic threads, a very voluminous, coarse and optically little pleasing structure is generated by the coarse corrugations or folding of the inelastic non-woven layers. Furthermore, the direct body contact of such a coarse folding generates an unpleasant feeling during wear which in the extreme case is associated with imprints on the human skin and possibly fosters the generation of skin irritations (skin redness).

Elastic woven fabrics which do not have the above mentioned disadvantages have so far not taken over, since they are too expensive and of too high a value to be used in a disposable article. The working in of stretched elastic threads of relatively fine titer (Raschel technique; Maliwatt) in the range of 44 to about 200 dtex leads to optically very pleasing, elastic textile fabrics, especially when the number of stitches (number of loops in

warp direction = Machine direction) as well as the so called division (ie. the number of threads or yarns per unit of length transverse to the machine direction) is very high. The problem of such stitch bonded elastic products lies however in that the elastic threads are not fixed in the fabric and therefore loosen from the composition after cutting or stamping upon mechanical loading (tensioning and relaxation). For the manufacture of an elastic diaper pant made of a front portion and back portion, the threads would have to be melt bonded or adhered with the non-woven along the edges prior to the stamping out. This would make the manufacture of a diaper or an elastic pant too difficult.

As is already known, the amount of maximum stretch can be adjusted at will by the amount of stretching of the elastic threads prior to adhesion to one or both inelastic carriers. The manufacture of a composite of two non-woven layers (polyester-spunlaced or polypropylen spunbond non-woven) with intermediate Spandex-Elastan threads is described in WO-A-00/20202. The bonding of these Spandex-Elastan threads is carried out by additional application of a melt bonding adhesive according to the so called melt blown principle in order to guaranty the adhesion of the elastic threads to the non-woven layers.

Composites are described in US-A-6,179,946 in which Spandex-Elastan threads deposited in transverse direction are bonded with the help of sprayed-on melt bonding adhesive to the two non-woven layers.

Both parts of an elastic waist band of a diaper are described in US-A-6,086,571, at the end of which a hook portion or a loop in portion of a mechanical closure system is applied. It is also mentioned therein that the stretched elastic threads are bonded to the polypropylen spunbond non-wovens with the help of adhesion or a melt bonding adhesive.

A lateral leak guard for a diaper is described in EP-A-677,284 in which an elastometric thread is bonded in a special manner between two hydrophobic polpropylen spunbond non-woven layers. Instead of a folding of a spunbond non-woven about the inserted elastomeric thread and hot melt adhesion of the same with the two spunbond non-woven layers for the purpose of encapsulation of the thread, two separate non-woven layers are at their ends thermally melt bonded in a first embossment pattern so that the elastic thread can laterally not escape. The interrupted embossment patterns can be positioned on one or both sides of the elastic thread. A second intermittent embossment pattern is overlaid the stretched elastic threads between the two non-woven layers in order to hold the thread captive between the two weld lines of the two non-woven layers. The

additional application of hot melt adhesive could be saved and a stiffening of the product prevented thereby, which means a better softness was achieved.

The products with additional application of hot melt adhesive resulting from the described prior art lead to a stiffening of the fabric sheet and to a high raw material use for the bonding of a stretched elastic thread, to a complication of the lamination process and to relatively high cost.

Although a hot melt adhesive free incorporation of an elastic thread was principally successful according to EP-A-677,284, that method is limited to the lateral leak guard of a diaper with one or at most two embedded threads.

Summary of the Invention

It is an object of the present invention to overcome the disadvantages of the mentioned prior art and to provide elastic composites which can be used in the most different positions of a hygiene article, such as a diaper or a diaper pant.

It is a further object of the invention to provide elastic composites which are with respect to softness and textility very close to those of a stitch bonded material with non-woven as carrier or which surpass the known hot melt adhesive or pressure sensitive adhesive bonded elastic non-woven-thread laminates.

The elastic sheets in accordance with the invention have compared to the known non-woven-thread laminates improved textility and optical design which allows them to improve the fit and adaptability to body shapes and thereby also the carrying comfort of a diaper and/or diaper pant after their incorporation therein as components thereof and to reduce the risk of leakage of body fluids compared to known products.

It is a further object of the invention to provide elastic composites for which composition and manufacture one can do completely without the use of an additional adhesive for the bonding of the elastic threads to the non-woven layers, without decreasing the intensity of embedding or anchoring of the elastic threads in the composite.

The present invention relates to a composite including at least one non-woven, at least one further sheet material and a group of elastic threads extending parallel to one another and positioned therebetween, wherein the non-woven is thermally melt bonded to the further sheet material in the form of a predetermined pattern and the elastic threads are embedded in the stretched condition at selected locations into the melt bonds between the non-woven and the further sheet material.

By the embedding of the elastic threads between the non-woven and the further sheet material at the locations of the thermal melt bonding, they are embedded into the composite in the stretched condition without slippage and damage. This can be carried out without the presence of an additional adhesive or binder material on the elastic threads and/or between the non-woven and the further sheet.

The composite in accordance with the invention has at least one layer of non-woven and at least one layer of a further sheet material. The latter can also be a non-woven or a foil. The non-woven and/or the further sheet material can have little shrink or can be constructed in such a way that it has a tendency to shrink, or reduction of its surface, upon exposure to humid and/or dry heat. The non-woven and/or the further sheet material can themselves be elastic or rigid. The non-woven is preferably non-elastic.

The non-woven used in accordance with the invention can be made of any fiber type of the most different titer ranges, for example of a titer of 0.5 to 10 dtex, preferably 0.8 to 6.7 dtex, especially 1.3 to 3.3 dtex. Apart from homofilic fibers, heterofilic fibers, for example bi-component fibers, can be used in crimped or uncrimped condition or mixtures of the most different fiber types.

The fibers preferably have white pigmentation. Pigments can be added for pigmentation to the melted material of the polymer forming the fibers.

For the achievement of an especially soft material, non-wovens made of two dimensionally or three dimensionally crimped bi-component fibers are preferred.

The non-wovens used in accordance with the invention can be formed with different laying down methods. Wet laid non-wovens, carded staple fiber non-wovens, endless filament non-wovens, meltblown non-wovens, spunbond-meltblown-spunbond non-wovens (SMS) and, spunbond-meltblown non-wovens can be used as non-woven layers. In the last case, it is advantageous when the meltblown layer is directed inwards in the composite, which means it comes into contact with the elastic threads.

Apart from the spunbond non-wovens, staple fiber non-wovens are preferably used, especially preferably unbonded non-wovens (webs).

Loose fiber webs can also be used as non-wovens which were formed according to known fleece laying techniques. The fibers can be laid down isotropically or in a preferred direction, which means anisotropically. The fiber web can be solidified prior to the lamination to at least one fibrous non-woven layer according to known methods. The fiber

web can consist of the same or different titers of the same fiber. The fibers forming the non-woven or web can be made of the most different fibers, for example homophilic fibers, but also of 100 % bi-component fibers or a mixture of bi-component fibers and homophilic fibers, with the proviso that the higher melting polymer in the case of a sheath-core fiber is used as the core component. Preferred bi-component fibers are those of the polymer combinations polypropylene/co-polypropylene and polypropylene/polyethylene, whereby such mixtures of bi-component fibers and homophilic fibers are especially preferred in which the homophilic fiber is identical with the lower melting component of the bi-component fiber. An example herefor is a mixture of the bi-component fiber polypropylene/polyethylene with the homophilic fiber polyethylene.

The web or non-woven layer can be perforated using known methods or can have a net like structure.

Those methods of perforation or structuration are preferred which are based on the principle of a patterned pushing aside of the fibers. Such material non-destroying processes are described in EP-A-919,212 and EP-A-789,793.

The perforation processes described below for the foil can also be used.

The non-wovens used in accordance with the invention are preferably shrink free under the manufacture conditions of the composite.

The non-wovens used or their unbonded precursors (webs) typically have surface weights of 6 to 70g/m².

Non-wovens with low surface weights of 6 to 40g/m² are especially preferably used. Especially light weight and at the same time highly absorbent composites can be manufactured from these non-wovens.

Endless filament non-wovens of homophilic fibers or bi-component fibers of an olefinic polymer composition are especially preferably used.

Examples herefor are those made of polypropylene, polyethylene and olefin copolymers, which were manufactured, for example, either by way of Ziegler-Natta or Metallocene-catalysts.

The further sheet material can be of any type. It can thereby be a fibrous sheet, for example a knitted fabric a woven fabric, a netting, a grating or a laid fabric or especially a non-woven, or it can be a foil as long as this further sheet material can be melt bonded with the first non-woven.

The further sheet material can consist of stretched, linearly oriented and mutually parallel threads or yarns. The stretched or racked threads or monofilaments can also include threads/monofilaments or yarns oriented at an angle to the first stretched or non-stretched or less stretched threads/monofilaments or yarns. The mutually crossing fibers, threads or monofilaments can be bonded to the others by self bonding, for example by mechanical binding or by melt bonding at the cross over points. The bonding can however also be carried out by a binder, such as aqueous dispersions.

The further sheet material of the composite can consist of a uniaxially or biaxially stretched foil. The foil can be manufactured according to known manufacturing processes, for example with the blow molding process, which means stretched in tube form. However, it can also be made by extrusion through a wide slit nozzle and expanded by mechanical drawing in machine direction or drawn transverse to the machine direction by way of a clamping frame or by passing through an interengaging roller pair with grooves in machine direction.

The common stretching ratio of the foil is thereby up to 5:1 in one or both stretch directions. Stretching ratio defines the length ratio of the foil after relative to before the stretching.

The extrudate of the foil can be provided with generally known fillers or structure formers, for example organic particles, such as chalk, talcum or kaolin. A microporous structure can thereby be produced by the stretching in a generally known manner, which provides the advantage of improved breathability.

The foil can also be perforated prior to the stretching with generally known methods so that the perforations expand after the stretching to larger perforations.

The foil can also be slitted prior to stretching so that especially by stretching at an angle of 90° to the longitudinal extent of the slits, the latter are expanded to perforations.

The foil can be weakened in a pattern prior to the stretching so that the weakened locations are expanded to perforations during the stretching. The patterned weakening of the foil can be carried out by a calendar roll passage, which means by heat and pressure, or by ultrasound treatment.

Independent of whether perforated, weakened in a pattern, or slitted, the foil can consist of a single layer or can be constructed of several layers by co-extrusion, which means at least two layers. One of the two or both outer layers of the co-extruded foil can consist of a lower melting thermoplastic than the other layer, or the middle layer. The

fibers of the non-woven layers surrounding the shrink foil can be bonded exclusively to the lower melting layer(s) of the co-extruded foil and not to the middle layer.

The foil preferably consists of a single polymer component or at least two layers with a higher and a lower melting polymer and is produced by co-extrusion. The melting or softening range of the foil or the lower melting layer of the co-extruded foil is preferably very similar to the melting or softening range of the fibers of the non-woven.

The material of the fibers of the non-woven preferably are from the same polymer class.

Preferred material combinations are non-wovens of polypropylene or co-polypropylene and a foil of polypropylene or a copolymer of propylene with another olefin or a mixture of polyethylene.

The melting or softening range of the foil can be adapted to that of the endless fibers and the non-woven by the degree of stretching of the foil. For example, a polypropylene spunbond non-woven of polyethylene of high density (HDPE) or polyethylene of low density (LLDPE) as one layer can be melt bonded to a blow formed and thereby only little stretched PP foil or a cast, un-stretched PP foil, since the melt bonding temperatures are largely matched by the highly different degrees of stretch of the spunbond non-woven and the foil.

The invention also includes the use of a hydrophobic monolithic, which means not water vapor permeable foil.

For most uses of the elastic composite, a water vapor permeable material combination is preferred, however, for reasons of improved wear comfort and to prevent maceration of the skin.

As is known, micro porous foils of hydrophobic polymer material or with hydrophobic treatment are water vapor permeable and especially preferred for special environments of this invention.

The higher softness and higher opacity of the micro-porous foils support the preferred use as a layer of the composite in accordance with the invention.

For applications in a disposable diaper, micro-porous foils of hydrophobic polyolefins and copolymers thereof are advantageous.

Polyurethane foils the micro porosity of which was generated by embedding mineral fillers coated with stearic acid, such as chalk, into the polymer and subsequent drawing are especially suited for the use in disposable diapers.

The co extrusion methods can here also be used for the foil manufacture.

The micro-porous polyolefin foils are preferably adapted to the melting or softening range of the non-woven layer by variation of the drawing ratio (the more stretched the higher the melting or softening range). The drawing can be carried out in machine direction, transverse to the machine direction or in both directions. With respect to a maximum micro porosity, it can also be conversely advantageous to strongly draw the foil and matching the fiber polymer of the non-woven layer by co polymerization to the melting or softening conditions of the micro-porous foil.

The foil can be pigmented white or colored just like the non-woven for the purpose of opacity increase and/or coloration.

An especially preferred variant of the invention is the combination of segmented polyester or polyetherurethane ureas for the manufacture of the elastic threads and polyolefin fibers for the generation of the non-woven of the two layers.

Uni-axially or bi-axially drawn, extruded plastic nettings can also be used as a layer of the composite structure. The degree of drawing in both directions can be the same or different.

Preferably, however, at least one preferred direction is strongly drawn. A stretching ratio of at least 3:1 is understood to represent a strong degree of stretching or drawing.

The thickness of the threads is normally 150 to 2000 μm . One understands extruded plastic netting to be sheet structures with a grid structure which is formed in that first monofilament groups oriented in parallel are crossed at a certain constant angle with second monofilament groups also oriented in parallel and self melt bonded with one another at the crossover point. In plastic nettings, the two monofilament groups are normally made of the same polymer. The thickness and degree of stretch of the two filament groups can however be different.

Laid fabrics can also be used as further sheet structures, which are differentiated from plastic nettings or grids in that the crossing filament groups are at their crossover points not bonded by self-bonding with one another but by a binder application, for example an aqueous polymer dispersion. In that case, the two monofilament groups

oriented in parallel can be made of different polymers. Drawn monofilament threads as well as homo-filaments can be used in laid fabrics. The angle of the mutually crossing filament groups can principally be arbitrary. However, an angle of about 90° is preferred for practical reasons. The filament groups of the laid fabric or plastic netting are preferably parallel in machine direction and second filament groups are oriented transverse which means at an angle of 90° to the machine direction. The distance between the first filaments oriented in parallel in machine direction is normally in the range between about 0.5 and about 20 mm, preferably between 2 and 10 mm and that of the second filament groups oriented in parallel between 3 and 200 mm.

Woven fabrics and knitted fabrics can also be used apart from the already described further sheet materials.

The elastic threads used in accordance with the invention can be of any type as long as they are of elastic nature and can be embedded in the tensioned condition into the material of the surrounding non-woven layers or layers of further sheet materials. Typically, the elastic threads are not thermally bonded with the surrounding layers at the melt bonding locations, but are mechanically fixed in the stretched condition by the melt bonding of the two layers. However, material combinations may be used in which the elastic threads engage into connection with the material of the surrounding layers at the melt bonding locations. However, the elastic threads are at those locations preferably only mechanically fixed.

Monofilaments, staple fiber yarns or multifilament yarns of endless filaments can be used as elastic threads. The yarns can be used as smooth yarns or in twisted yarn form.

The elastic threads used in accordance with the invention can be made of different elastomeric materials.

They are normally elastomeric plastics. Example therefore are elastomers on the basis of block polyether amides, block polyether esters, polyurethanes, polyurethane ureas, elastic polyolefins, thermoplastic styrol-butadiene-styrol, styrol-isoprene-styrol, styrol-ethylene/propylene-styrol, styrol-ethylene-butadiene-styrol, hydrated styrol-butadiene-rubber and their mixtures with other polymers, such as, for example, with polystyrol or with polyolefins.

Elastic threads of segmented polyester or polyether urethane ureas are preferably used. They are preferably spun from di-methyl acetamide or di-methyl formamide solution.

Depending on the requirement for the retraction force, elastomeric thermoplastic threads spun from the melt, for example elastomeric polyurethane, elastomeric polyesters or elastomeric polyamides, can be used.

Before or after lamination to a composite, the elastic threads can be further crosslinked, whereby the elastomeric is converted into a duroplast up to a certain extent.

The groups of mutually parallel extending elastic threads have a spacing of the individual threads of typically 0.5 to 15 mm, preferably 1.0 to 10 mm.

The titer of the elastic threads is typically in the range of 22 to 500 dtex, preferably in the range of 44 to 300 dtex.

The elastic threads can be replaced by elastic foil ribbons.

An elastomeric foil serves as starting material herefor which either was cast from a polymer solution or manufactured from an elastomeric melt by cast extrusion. The foil is cut into small ribbons which are preferably bonded in machine direction between the two layers, preferably two non-wovens, in stretched condition and oriented parallel to one another. The foil ribbons can thereby extend planar (parallel) or at any angle of 0 to 180°, between the two layers.

In cases where the width of the ribbon is the same as or larger than the spacing of the foil center lines in the composite, an orientation of the ribbons in the perpendicular is preferred.

After the calendar melt bonding of the two layers, preferably PP-spunbonded non-woven layers, the foil ribbons can be embedded planar thereinbetween or can be present in a more or less strongly folded form.

The foil ribbons oriented parallel to one another are generally fed through a comb. When the spacing of the comb teeth is smaller than the width of the ribbon, the foil ribbon is folded or orients upright in the perpendicular.

The foils for the manufacture of the foil ribbons typically have surface weights of 10 to 400 g/m², preferably 20 to 200 g/m².

The foil width is typically 4 to 20 mm, preferably 4 to 10 mm.

The foil ribbon titers calculated therefrom are 40 to 8,000 dtex, preferably 80 to 4,000 dtex.

The spacing of the folded or unfolded foil ribbon centerline to the centerline of the neighboring (next following) foil ribbon transverse to the machine direction is typically 2 to 30 mm, preferably 5 to 15 mm. The spacing is normally at most half of the foil ribbon width. This corresponds to a surface weight of the foil ribbon portion of at least 20 g/m^2 and at most 800 g/m^2 , preferably however, 40 g/m^2 to 400 g/m^2 .

The orientation of the fiber groups preferably corresponds to the machine direction.

The elastic composite in accordance with the invention consists of at least two layers, especially two non-woven or fiber web layers and elastomeric threads or yarns between the two layers extending parallel to one another and preferably oriented in machine direction, whereby the composite of the rigid, inelastic non-woven and the stretched elastic fibers is achieved without the use of an added adhesive (hot melt adhesive or pressure sensitive adhesive).

In the fully stretched, which means pleat-free condition, the composite in accordance with the invention typically has surface weight of 15 to 150 g/m^2 , preferably 15 to 70 g/m^2 .

The maximum stretch m of the elastic composite up to the pleat-free condition is typically in the range of 10 to 350%, preferably 20 to 250%.

The surface weights of the fully relaxed composite are typically 16.5 to 680 g/m^2 , preferably however 22 to 350 g/m^2 .

In a preferred embodiment, the composite in accordance with the invention consists of two layers, whereby both layers are non-woven layers, between which the parallel oriented elastic threads are embedded.

In a further preferred embodiment, the composite in accordance with the invention consists of at least three layers, whereby two of those layers consist of non-wovens between which the parallel oriented elastic threads are embedded and at least one further layer, preferably a staple fiber non-woven, covers at least one of the non-wovens.

The two layers of the composite in accordance with the invention, between which the elastic fibers are embedded, at least partially consist of fibers of the same fiber polymer, whereby the fiber titer can be different.

Preferably, the two layers respectively consist wholly of the same melt bonded fibers, which were laid down either as short cut, as staple or as endless fibers.

During selection of the polymer combinations for the composite in accordance with the invention it must be considered that the elastomer of the fibers does essential not thermally bond to the polymer of the non-woven layer or the layer of the further sheet material and that thermal melt bonding preferably occurs only between the two sheet materials.

Preferred combinations of fiber elastomer and fiber in the non-woven or the further sheet material are listed in the following table.

Fiber elastomer	Polymer in non-woven/sheet material
Polyurethanes	Polyolefins
Polyesterelastomers	Polyolefins
SBS ¹⁾ and/or SEBS ²⁾	Copolyester
SBS and/or SEBS (Kraton)	Copolyamide

¹⁾ Styrol-butadiene-styrol

²⁾ Styrol-ethylene-butadiene-styrol

Polyolefins, copolyesters and copolyamides can also form the lower melting portion of a bi-component fiber.

It was completely surprising that the stretched elastic fibers, despite their bonding unfriendliness with the polymer of surrounding the layers of the two sheet structures are so strongly squeezed at the heat forming zones that even after numerous repeated/relaxing cycles no loosening whatsoever of the elastic threads occurred.

The fibers of the non-woven layer(s) or the material of the further sheet structure must be thermally melt bondable. Fibers or materials are understood hereunder which melt into one another or bond to one another under heat and pressure, ultrasound as well as infrared energy.

The melting or softening temperatures of the materials of the two layers, for example the fiber layers, must be lower than those of the elastic threads, typically at least 25°C lower.

It is also conceivable to subject the elastic thread to a cross-linking before the composite manufacture in order to either elevate its melting point or to even transfer the elastomer into an unmeltable condition.

The melt bonding between non-woven and sheet structure and the thereby resulting clamping of the parallel extending elastic threads of the composite in accordance with the invention is preferably carried out by heat and pressure in the calender nip and/or by ultrasound.

When shrinkable non-wovens and/or sheet structures are used, the shrinking can thereby occur in one preferred direction or also in both or in more than two directions. The amounts of shrink in several directions as well as in both directions, which means in machine direction and at a right angle to the machine direction, can be the same or completely different.

The composite in accordance with the invention can consist of a non-woven and a further sheet structure thermally melt bonded therewith in the form of a pre-selected pattern, between which the parallel extending elastic threads are embedded in the tensioned condition.

The further sheet structure can also be covered on both sides with a non-woven, either symmetrically or asymmetrically, which means the weights of the non-woven layers can be different or the same. Parallel extending elastic threads are embedded in the tensioned condition between the surrounding layers at least between a non-woven layer and the further sheet structure which can also be a non-woven. The stretched elastic threads are at the heat melt bonding zones pinched without destruction or damage between the two sheet structures without melt bonding therewith. Two groups of respectively parallel extending elastic threads can be located between the upper and lower non-woven layer and the further sheet structure, which threads are embedded in the stretched condition into the surrounding layers. The directions of the fiber groups can thereby be the same or different from one another.

The pattern of the thermal melt bonding of the non-wovens or the sheet structure for the fixation of the elastic threads between the superjacent and subjacent sheet structures of the composite in accordance with the invention can be arbitrarily selected, as long as it allows a complete immobilization of the elastic threads in the tensioned condition in the melt bonding zones of the sheet structures surrounding these threads. Engraving geometries with linearly oriented individual dots or other arbitrary shapes are

then not suitable when the linear orientation is parallel, which normally means in machine direction, to the orientation of the elastic threads, since with such an orientation of the melt bonding pattern no fixation of the elastic threads in the tensioned condition between the sheet structures can be achieved.

Preferred patterns for a thermal melt bonding are continuous lines of different width in parallel arrangement. However, other patterns are also conceivable which lead to diamond-shaped, wavy, zig-zag or circular melt bonding zones.

The melt bonding areas connecting the two layers are typically in the range of 10 to 40%, preferably 15 to 30%, of the total area.

In the fully stretched condition, the composite in accordance with the invention generally has a two-dimensional structure. Upon relaxation, a three-dimensional structure is formed. Pleats occur, the shape, spacing and height of which can be changed within wide limits by the engraving design and the degree of stretch.

The composite material in accordance with the invention is distinguished from the prior art in that it has in direction of the group of the parallel extending elastic threads, in general in machine direction, inelastic and elastic regions in repeating arrangement. The elastic region is the region between two respectively adjacent melt bonding lines on an elastic thread. The elastic, stretched threads are in the inelastic regions mechanically pinched and embedded into the surrounding two layers.

The retraction force of the composite material can be strongly varied by change of the titer of the elastomeric threads and their spacing from one another.

The invention also relates to a process for the manufacture of the above described composite material including the steps of:

- a) combining at last one non-woven with a further sheet structure and a group of parallel oriented elastic threads positioned in tensioned condition between the non-woven and the further sheet structure, and
- b) welding the group of parallel oriented elastic threads between the non-woven and the further sheet structure in the form of a pre-selected pattern, preferably by heat and calendar pressure or by ultrasound, so that selected regions of each elastic thread are embedded in the tensioned condition at the heat forming locations between the non-woven and the further sheet structure.

The thermal melt bonding of non-woven with the further sheet structure can be carried out in any manner, for example by calendering with an embossment calender, one roll of which has a pre-determined pattern, preferably a regular line pattern, or by melt bonding with ultrasound or with infrared radiation which respectively act in a predetermined pattern on the non-woven and the further sheet structure.

The group of elastic threads can extend in any direction the machine direction. Preferably, it extends to the machine direction.

The elastic threads oriented parallel to another over the whole width of the product are embedded in such a way between two layers of non-woven or further sheet structure that the elastic threads themselves along a pre-selected portion have no adhesion to the material of the two layers and are only connected with the layers at pre-selected bonding locations, and preferably are connected with the material of the two layers along continuous, uninterrupted melt bonding lines.

The melt bonding lines can principally have any desired shape and typically form an angle between 45 and 90° with the parallel oriented threads. The angle can be, but need not be, the same at all locations.

In the process in accordance with the invention, the elastic threads or the foil ribbons are placed in the stretched condition between the two layers, preferably the two non-woven layers.

The amount of desired stretch can be adjusted by the speed differential between the feeding and removing arrangements of the manufacturing apparatus, for example the thread feed and the calender rollers. The elastic threads can be wound onto warp looms or partial warp looms. The feed can also be unwound from spools which are stuck on a frame, and fed to a calender nip.

Above and below the stretched threads or foil ribbons, the two layers, preferably of embossment bound polyolefin spunbond non-wovens are fed to a calender press nip.

In a preferred embodiment, one roller is provided with a smooth surface and the other with a continuous line embossment. In the case of uneven weights of the two layers, the one with the lower surface weight is brought in contact with the smooth roller.

The edges of the line shaped engraving are preferably slightly rounded. This insures that a cutting or severing of the elastic, stretched and heated threads or foil ribbons compressed in the calender nip is effectively prevented.

The manufacture of the elastic composite can be achieved apart from the calendering with heat and pressure also with the help of ultrasound technology.

After the calendering into an elastic composite, the product can be wound up in the stretched condition. However, it is advantageous to relax the product after the calendering (for example by way of one or more rollers running slower than the calendering rollers) and in this relaxed condition subjected to a steam treatment according to the common practice for elastic textiles, for the purpose of a subsequent shrinking of the elastic threads, an evening out of the shrink force over the whole width and length of the product, but also for the purpose of the removal of solvent portions and avivages possibly remaining in the elastic threads from the spinning process.

Subsequent to this after treatment, the product is preferably wound up again in the tensioned condition.

The composite material in accordance with the invention can be used especially for the manufacture of hygiene products, especially of diapers, including diaper pants. This use is also an object of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be further described way of example only in reference to the attached drawings, wherein

Figure 1 describes one preferred embodiment of the composite in accordance with the invention;

Figure 2 shows a cross-section through the composite according to Figure 1 taken along line A-A;

Figure 3 shows a cross-section of the composite according to Figure 1 in relaxed condition taken along B-B;

Figure 4 illustrates an apparatus for the manufacture of a composite material in accordance with the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

One of the numerous variants of the fibrous sheet material in accordance with the invention is schematically illustrated in Figure 1. In the illustrated preferred embodiment,

the composite consists of a total of three non-woven layers. The composite (1) is shown in top view, whereby the elastic threads embedded between the non-woven layers are shown for better understanding.

The fibers (5) of the two non-woven layers or fiber webs are intensively melted together (autogeniously melt bonded) along the melt bonding lines (4).

The embodiment of the composite material illustrated in Figure 1 is in the relaxed (which means unstressed) condition of the embedded elastic threads. By combining the elastic threads in the stretched condition with the two rigid, inelastic non-woven layers to a composite material, three-dimensional structures with a pleating on both sides of the fiber surface are generated in a known manner after relaxation of the threads.

This is illustrated in Figure 2 in cross-section taken along the line A-A.

The two non-woven layers (6) and (7) are undulated after the relaxation having symmetric peaks (8) and (9) on both sides of the melt bonding locations (4). Voids (10) are defined by these undulations.

It is clear from Figure 1 that in the totally or partially relaxed composite, the elastic thread preferably oriented in machine direction has alternating regions of larger thickness (titer) and lower thickness (titer).

Within the melt bonding regions (4), the elastic thread is so strongly mechanically pinched that its stretched condition, which means the thickness (3) during the manufacture of the composite, remains totally frozen in contrast to the regions of the elastic thread between the melting bonding regions (4), wherein the thread mostly unimpeded by the non-woven can take up a larger thickness (2) according to the degree of relaxation.

The cross section of the elastic composite in the relaxed condition taken along the line B-B is illustrated in Figure 3. At the melt bonding locations (4), the elastic thread is illustrated with its thin portions (= stretched condition) (3) and its thick portions (2) (partially to fully relaxed condition). Outside the melt bonding locations (4) the thickness (11) of the upper non-woven and the thickness (12) of the lower non-woven is determined respectively by the weight and consolidation conditions of the respective non-woven. The amplitudes (12) or (13) of the undulations on each side of the thread claim can be the same or different and depend mostly on the manufacturing conditions, for example on the respectively used calendar roller pairs. If in the case of consolidation with heat and pressure a smooth calendar roller and an engraved calendar roller are used, the amplitudes of the relaxed composite on the side into which the engraving is embossed are larger than

on the opposite side. Amplitudes (13) or (14) within the framework of this description define the distance between the peaks (8) or (9) and the thread plane (15).

The voids (10) are the smaller the higher the percentage contraction (relaxation) and the softer and lighter the inelastic non-wovens. Especially at high relaxation, corresponding to a high pre-tensioning of the elastic thread during the composite manufacture, the void can completely disappear and the undulations or pleats can flip over especially when light and soft non-woven layers are used. This flipping over can be achieved by compression.

When fibers are used which are not filled with white pigment, the melt bonding regions (4) appear transparent. In applications which allow a high opacity, it is advantageous to use for both the non-woven as well as the elastic threads the highest possible white pigmentation, for example of titanium dioxide. A further advantageous additional measure for the increase of the opacity is the flattening of the undulations by calendaring and thereby covering of the more transparent melt bonding locations.

It is known to the person skilled in the art that this flattening of the composite should be carried out without heat application or at such low temperatures that an adhesion of the flipped-over non-woven material pleats cannot occur, since this would reduce the elasticity of the composite.

The composite materials illustrated in Figures 1 to 3 can be manufactured in an apparatus according to Figure 4.

The unrolled webs (20) and (21) are in this case two spunbond non-woven layers and the unrolled web (22) represents a warp beam feed with thread controller (for example with about 50.000 m). A calendar (23) is further illustrated to which the non-woven materials (24) and (25) as well as the group of parallel oriented elastic threads (26) are feed and connected with one another under the action of heat and pressure at predetermined locations. The composite (27) produced thereby is wound onto the roller (28).

The following examples illustrate the invention in greater detail without the invention being limited to the particular examples described.

Example 1:

Elastan threads on the basis of segmented polyether urethane solvent spun in dimethyl- acetamide with a titer of 78 dtex which were wound up at a pretension of 40%

were unwound at a speed of 2.5 m/min from a partial warp beam which was prepared for a warp of 18 threads/inch (corresponding to 18 threads/2.54 cm).

The parallel thread guiding was achieved by way of two rakes for 18 thread/ inch (corresponding 18 threads/2.54 cm), whereby the two rakes were orient at an angle of 90° to the machine direction. One of the two 50 cm wide rakes was installed immediately behind the warp beam and the second before the two calendar rollers. The rakes were taken from a Raschel machine. The Elastan threads oriented parallel in machine direction were feed to or pinched in a nip between a smooth calendar roller and an engraved calendar roller- respectively made of stainless steel. The speed of the calendar roller was 5 m/min. An engraved roller with line shaped protrusions almost transverse to the machine direction was used which is in the following referred to as line seal engraved roller.

Data of the Line Seal Engraved Roller:

Width of the lines 1.00 mm

Spacing of two line centers from one another: 4.00 mm

Melt bonding surface: 25%

Engraving depth: 0.90 mm

Angle of the lines measured transverse to the machine direction: 0.8°

The Line Seal Engraved roller was prior to use rounded at its edges with a purpose to prevent a pinching off or severing of the stretched Elastan threads during the calendaring.

The angle of 0.8° was chosen in order to guaranty a quiet running of the calendar rollers (without supporting edges) (which means to prevent a rattling of the rollers).

Immediately before the roller nip, respectively one polypropylene spunbond non-woven rendered wide matte with a surface weight of respectively 17 g/m² was fed above and below the tensioned Elastan threads and bonded in the calendar nip to a three layer composite with line seal melt bonds. The polypropylene spun bond non-wovens had a balanced ratio between highest tension force in longitudinal and transverse direction and were pigmented in the spinning mass with 0.9% titanium dioxide for the purpose of an increase in opacity.

The temperature of both rollers was 145°C and the line pressure was 35N/mm. The composite was rolled up at a speed of 5 m/min, which means in the tensioned condition. After the unrolling and complete relaxation of the composite, a product with symmetric pleats on each side of the Elastan thread surface and between the line seal melt bonds was produced.

It was surprising that the Elastan threads between the melt or melt bond locations of the two polypropylene spunbond non-woven layers even after multiple repeated stretching and relaxation cycles up to the complete removal of the pleats were not subject to any loosening or sliding out of the composite.

This is surprising in as much as a high difference exists between the thermal melt bonding temperature of the polypropylene spun bonded non-woven layers (here 145°C) and the segmented polyurethane urea of the Elastan threads exists (softening temperature about 190-200 °C).

In the stretched condition (which means in the pleat free condition of the spun bonded non-woven layers) of the composite elastic and machine direction the following surface weights resulted for the three layers:

Component of the composite	Surface weight in g/m ²
Polypropylene spunbond non-woven layer 1	17.00
78 dtex Elastan yarn with 18 yarns/inch	1.974
Polypropylene spunbond non-woven layer 2	17.00
Sum total	35.974

The surface weight F for the Elastan yarns was calculated according to the following formula:

$$F = \frac{T \cdot g \cdot 100}{10000 \cdot 2.54 \cdot (1 + 0.01 \cdot v) \cdot k/a}$$

Wherein:

T= Titer of the Elastan yarn in dtex

g= Yarn division in number/inch

v= Pre-stretching of the Elastan yarn on the warp beam in %

a= Speed of unrolling from the warp beam in m/min

k= Calendaring speed in m/min.

Calculation for example 1:

t= 78 dtex

g= 18/inch (corresponding 18/2.54 cm)

v= 40%

a=2.5 m/min

k= 5.0 m/min.

According to the above formula, this results in a value for F of 1.974 g/m².

The composite of example 1 was marked in a relaxed condition at two locations spaced apart in machine direction, then stretched until the pleats completely disappeared, and the spacing of the two markings measured again.

The stretch which is here referred to as maximum stretch was measured from the ratio of the spacing in the stretched and un-stretched conditions.

In example 1, a maximum elastic stretch of 95% was present.

In the composite in accordance with the invention according to example 1, one must distinguish between two alternating regions in machine direction. The line seal melt bonding regions, which made up a portion of 25% of the total surface, and the regions between the melt bonding lines which in the case of a stretching to the complete disappearance of the pleats made up a surface of 75%.

The melt bonded regions (25%) are completely inelastic and un-stretchable. The Elastan thread was present in a condition which corresponded to a stretch of 2.8 times and thereby a titer of 27.86 dtex and this completely independent of the stretch condition of the composite.

The maximum elastic stretch of the composite of only 95% (which means a stretch of 1.95 times) clearly shows that the two polypropylene spunbond non-woven layers prevent a total relaxation of the Elastan thread to its original titer of 78 dtex.

The surface weight portion f of the relaxed new composite can be calculated according to the following formula:

$$f = 0.01 * w * F + (1 + 0.01 * m - 0.01 * w) * F.$$

Wherein:

w = Surface portion of the melt bonding zones in %

p = Surface portion of the regions between the melt bonding zones at maximum (which means pleat free) stretch condition in % (corresponding to $p = 100 - w$)

m = Maximum stretch of the composite (up to the fold free condition) in %

F = Surface weight for the Elastan yarns

The calculation for example 1 resulted in:

$$w = 25\%$$

$$p = 75\%$$

$$m = 95\%$$

$$F = 1.974.$$

According to the above formula, a value for f is calculated of

$$f = 1.95 - 1.974 = 3.8493 \text{ g/m}^2 \text{ Elastan threads,}$$

whereby f is divided between the melt bonded and not melt bonded regions f_v and f_u as follows:

$$f_v = 0.01 * w * F$$

$$f_u = f - f_v$$

This results in values for f_v and f_u of

$$f_v = 0.25 * 1.974 = 0.4935 \text{ g/m}^2$$

$$f_u = 3.3558 \text{ g/m}^2$$

In order to determine at which titer and thereby also in which stretch condition the Elastan threads were present after relaxation in the composite of example 1, the following formula must be used:

$$M_p = \frac{1 + 0.01 * m - 0.01 * w}{0.01 * p} - 1) * 100 (\%)$$

Wherein:

M_p = Maximum stretch within the pleated regions in % and the remaining variables have the above stated meanings.

This results for example 1 in:

$$M_p = 126.66\%.$$

Based on the fact that 25% of the surface, relative to the pleat free stretched condition, remain completely inelastic, the maximum possible amount of stretch of 126.66 % is reduced to 92 % relative to the total surface.

In the relaxed as well as in the stretched condition of the new composite material of example 1, the Elastan yarn is present at a titer T_d of

$$T_d = \frac{T}{(1 + 0.01 * v) * k/a} \text{ dtex}$$

The variables thereby have the above stated meaning.

This results for example 1 in a value of $T_d = 78 / 2.8 = 27.857 \text{ dtex}$.

The titer T_e for the relaxed Elastan yarn regions between the melt bonding zones of the composite is calculated according to the following formula:

$$T_e = T_d * (1 + 0.01 * M_p).$$

The variables thereby have the above stated meaning.

This results for example 1 in a value of $T_e = 27.857 * 2.2666 = 63.14$ dtex

The at 17 g/m^2 heavy layers of polypropylene spun bonded non-woven material thus prevent a full relaxation of the Elastan yarns from 27.857 dtex to their original condition at 78 dtex and remain blocked at a titer of 63.14 dtex, which results in a snap back of only 126.66 % instead of 180 %.

The surface weight of the composite material stretched to the complete disappearance of the pleats was 38 g/m^2 and in the relaxed condition was 74 g/m^2 .

Test for elastic behavior:

The test for elastic behavior was carried out in accordance with DIN 53 835 part 1 and part 14.

Strips of 25 mm width from example 1 were herefor subjected to a force/stretching relaxation experiment over 3 cycles respectively to a maximum stretch with a pull off speed of 500 mm/min. The measurement was commenced with a force before distance of 0.05 N/25 mm. The first cycle ran for 20 seconds (10 seconds for load curve up to a 120 % maximum stretch and a further 10 seconds for the relaxation). Immediately thereafter, the second hysteresis cycle was started with the same duration as in the first cycle. After a stay for 60 seconds in a relaxed condition, the third cycle was run.

The tension forces Z at different degrees of stretch of 40, 60, 100 and 120% are reproduced in the following Table 1 as well as the stretch ϵ at 0.05 N/25 mm and 0.1 N/25 mm in the loading curve as well as in the relaxation curve of the three cycles.

Table 1

	Tension Force Z in N/25 mm at different % stretch				Stretch ϵ in % at	
Hysteresis	40 %	60 %	100 %	120 %	0.05 N / 25mm	0.1 N / 25 mm

1. cycle Loading	0.36	0.51	1.11	15.81	0.1	3.1
1. cycle relaxation	0.19	0.29	0.57	15.51	16.1	22.8
2. cycle loading	0.26	0.38	0.75	14.83	8.9	13.9
2. cycle relaxation	0.19	0.29	0.56	14.76	16.7	24.2
3. cycle loading	0.29	0.41	0.79	14.68	0.7	10.6
3. cycle relaxation	0.19	0.29	0.56	14.59	14.59	23.4

The tension force Z after the relaxation cycles is also referred to as the so called retraction force. The retraction force at 40% stretch after the 3. cycle relaxation is of special importance for diaper pants, for example.

Example 2:

The two 17 g/m² heavy polypropylene spunbond non-woven materials of example 1 were replaced by two lighter ones with a weight of only 8 g/m². The conditions described in example 1 remained unchanged.

In the stretched condition (which means in the pleat free condition of the spunbond non-woven layers) of the composite material elastic in machine direction the following surface weights resulted for the three layers:

Component of the composite	Surface weight in g/m ²
Polypropylene spunbond non-woven layer 1	8.000
78 dtex Elastan yarn with 18 yarns/inch	1.974
Polypropylene spunbond non-woven layer 2	8.000
Sum total	17.974

A maximum elastic stretch m of 120 % was determined, from which the following weights result for the composite material in the relaxed condition:

Component of the composite	Surface weight in g/m ²
Polypropylene spunbond non-woven layer 1	17.600
78 dtex Elastan yarn with 18 yarns/inch	4.343
Polypropylene spunbond non-woven layer 2	17.600
Sum total	39.543

The higher values achieved for m of 120 %, compared to example 1 (example 1: 95 %), clearly show that upon a lower surface weight of the two polypropylene spun bonded non-woven layers the stretched Elastan threads can after the relaxation snap back further than in example 1 and to their original condition (78 dtex).

The calculations for m = 120% result in the following data for example 2:

	Unit	Value
F	m ²	4.3428
f _v	g/m ²	0.4935
f _u	g/m ²	3.8493
M _p	%	160%
T _d	dtex	27.857
T _e	dtex	72.43

The Elastan yarns were thus present in the composite material after relaxation in a condition stretched by 7.7% relative to the condition at 78 dtex, while this value was significantly higher by 23.5% in example 1.

Measurement results of the hysteresis experiment

	Tension Force Z in N/25 mm at different % stretch				Stretch ϵ in % at	
	40 %	60 %	100 %	120 %	0.05 N / 25mm	0.1 N / 25 mm
1. cycle	0.34	0.47	0.78	1.00	0.8	3.2

Loading						
1. cycle relaxation	0.19	0.26	0.48	0.98	14.1	21.4
2. cycle loading	0.24	0.35	0.62	0.93	4.9	11.3
2. cycle relaxation	0.18	0.25	0.47	0.92	14.1	22.4
3. cycle loading	0.27	0.36	0.64	0.91	0.1	9.8
3. cycle relaxation	0.19	0.26	0.48	0.90	14.9	22.9

Example 3:

In example 3, the same starting materials for the manufacture of the elastic composite were used as in example 2, which means polyurethane yarn with 78 dtex and two layers of polypropylene spunbond material with respectively 8g/m^2 .

The unrolling speed from the warp beam was 1.0 m/min. The calendaring speed was 3.0 m/min.

The product was after passage through the calendar not tensioned, but rolled up in the relaxed condition at a speed of 1.10m/min.

The measurement of the maximum elastic stretch m was carried out after a 1 week storage of the product in the completely relaxed condition.

In contrast to examples 1 and 2, significantly different spacing ratios were measured in the condition of maximum elastic stretch than corresponded to the geometry of the line seal engraved roller. Theoretically, a value of 1.000 mm should result in the completely pleat free condition for the width of the melt bonding lines and a spacing of 3.000 mm for the regions between the melt bonding lines. However, after measurement of scanning microscopic (REM) photographs only a melt bonding width of on average $b_2 = 0.694$ mm (instead of $b_1 = 1.000$ mm) was determined and for the regions between the melt bonding lines a spacing of $b_4 = 2.046$ mm (instead of $b_3 = 3.000$ mm). Thus, the melt bonded as well as the not melted bonded regions were reduced by 29% on average, relative to the line seal roller geometry.

The surface weight of the elastic composite material according to example 3 in the relaxed condition was determined to be 61.31 g/m². A surface weight of 21.1 g/m² was calculated therefrom for the maximum stretch (pleat free) condition at 190% stretch.

Using the formula provided for the above, the following value was calculated for the Elastan thread weight F in the maximum stretch condition of the composite:

$$F = \frac{78 * 18 * 100}{10000 * 2.54 * 1.4 * 3} = 1.316 \text{ g/m}^2$$

The following surface weights would result therefrom for the construction of the composite material if the product were rolled-up in the tensioned, pleat free condition:

Component of the composite	Surface weight in g/m ²
Polypropylene spunbond non-woven layer 1	8.00
78 dtex Elastan yarn with 18yarns/inch	1.316
Polypropylene spunbond non-woven layer 2	8.00
Sum total	17.316

By way of the as much as possible tension free rolling up of the product, the width of the line seal melt bonding zone was however reduced from 1.000 to 0.704 mm. For which in all probability the resetting force of the Elastan thread should be exclusively responsible. This melt bonding zone shortening could only occur immediately after exit from the calendar nip, which means as long as the melted mass was still soft. The shortening of the melt bonding width was connected with a corresponding surface weight increase or titer increase of the yarn within the melt bonding zone.

$$1.316 * b_2/b_1 = 1.316 * 1/0.694 = 1.896 \text{ g/m}^2.$$

Accordingly, the weight portion of the two polypropylene spunbond non-woven layers should increase by the same factor.

According to the following formulas, several parameters of composites shortened in such a way can be calculated. The variables are defined as follows:

B1 = width of the line seal engraving in mm

B2 = width of the line seal melt bonding zone in the composite

S1 = surface weight of the spunbond non-woven layer used in g/m^2

S2 = surface weight of one spunbond non-woven layer in g/m^2 in the composite material

F1 = surface weight portion Elastan of a fully stretched (pleat free) rolled up product

F2 = surface weight portion Elastan of a product rolled up almost tension free

F3 = surface weight portion of one layer of non-woven in the embossment zone of the composite material of a product rolled up almost tension free

F4 = surface weight portion of one layer of non-woven in the unembossed zones of a fully tensioned (pleat free) product

Fv = surface reduction factor

Gkg = surface weight of the composite material of a fully stretched (pleat free) product

Gkr = surface weight of the composite material in a fully relaxed condition

These calculate as:

$$Fv = \frac{B2 + p/w * B1}{B1 + p/w * B1} = \frac{0.694 + 3 * 1}{1 + 3} = \frac{3.694}{4}$$

$$F1 = 1.316 \text{ g/m}^2$$

$$F2 = F1 * \frac{B1}{B2} = F1 * 1.441 = 1.316 * 1.441 = 1.8962 \text{ g/m}^2.$$

$$F3 = 0.01 * w * S1 * \frac{B1}{B2}$$

For example 3: $F3 = 0.25 * 8 * 1.441 = 2.882 \text{ g/m}^2$.

$$F4 = 0.01 * p * S1$$

For example 3: $F4 = 0.75 * 8 = 6 \text{ g/m}^2$.

$$Gkg = (F2 + 2 * F3 + 2 * F4) * 1/Fv =$$

$$(1.8962 + 2 * 2.882 + 2 * 6) * 4/3.694 = 21.289 \text{ g/m}^2.$$

In the relaxed condition at a maximum elastic stretch of 190% the result was

$$Gkr = (1 + 0.01 * m) * Gkg$$

For example 3 with $m = 190\%$

$$Gkr = 2.9 * 21.289 = 61.738 \text{ g/m}^2.$$

In the stretched condition (which means in the pleat free condition of the spunbond non-woven layers) of the composite elastic in the machine direction, the following surface weights therefore resulted for the three layers:

Components of the composite material	Surface Weight in $\text{g}/0.925 \text{ m}^2$	Surface Weight in g/m^2
Weight portion F4 of the PP-spunbond non-woven layer 1 in the un-embossed zones	6.000	6.497
Weight portion F3 of the PP-spunbond non-woven layer 1 in the embossed zone	2.882	3.121
78 dtex Elastan yarn with 18 yarns/inch	1.896	2.053
Weight portion F3 of the PP-spunbond non-woven layer 1 in the embossed zone	2.882	3.121
Weight portion F4 of the PP-spunbond non-woven layer 1 in the un-embossed zones	6.000	6.497
Sum total	19.99	21.289

Measurement results of the hysteresis experiments for a stretch of a maximum of 60%

	Tension Force Z in N/25 mm at different % Stretch				Stretch ϵ in % at	
hysteresis	30%	40%	50%	60%	0.05 N/25mm	0.1 N/25mm
1. cycle Loading	0.40	0.45	0.53	0.60	0.20	0.90
1. cycle relaxation	0.25	0.34	0.55	0.60	7.00	13.20
2. cycle loading	0.34	0.44	0.54	0.58		
2. cycle relaxation	0.24	0.32		0.58	8.30	13.70
3. cycle loading	0.36	0.43		0.58	2.10	3.90
3. cycle relaxation	0.25	0.31		0.58	8.70	13.00

Measurement results of the hysteresis experiments for a stretch of a maximum of 80%

	Tension Force Z in N/25 mm at different % stretch				Stretch ϵ in % at	
hysteresis	30%	40%	60%	80%	0.05 N/25mm	0.1 N/25mm
1. cycle Loading	0.35	0.40	0.55	0.72	0.00	1.50
1. cycle relaxation	0.21	0.27	0.42	0.70	9.60	14.90
2. cycle loading	0.29	0.36	0.50	0.70	3.50	8.10
2. cycle relaxation	0.20	0.27	0.41	0.70	9.70	15.10
3. cycle loading	0.39	0.39	0.51		0.70	5.30
3. cycle relaxation	0.19	0.26	0.42		9.30	17.10

Measurement results of the hysteresis experiments for a stretch of a maximum of 110%

	Tension Force Z in N/25 mm at different % stretch					Stretch ϵ in % at	
hysteresis	30%	40%	60%	100%	110%	0.05 N/25mm	0.1 N/25mm
1. cycle Loading	0.36	0.42	0.57	0.95	0.99	0.00	1.70
1. cycle relaxation	0.18	0.23	0.34	0.76	0.99	12.1	18.50
2. cycle loading	0.27	0.34	0.47	0.87	0.94	3.90	5.90
2. cycle relaxation	0.17	0.23	0.34	0.75	0.95	12.20	21.00
3. cycle loading	0.30	0.35	0.49	0.87	0.94	2.60	5.50
3. cycle relaxation	0.17	0.24	0.34	0.73		11.90	20.90

Measurement results of the hysteresis experiments for a stretch of a maximum of 150%

	Tension Force Z in N/25 mm at different % stretch				Stretch ϵ in % at	
hysteresis	40%	60%	100%	150%	0.05 N/25mm	0.1 N/25mm
1. cycle Loading	0.45	0.58	0.90	1.47	0.20	2.00
1. cycle relaxation	0.21	0.28	0.44	1.45	18.10	25.00
2. cycle loading	0.32	0.41	0.65	1.36	1.80	13.60
2. cycle relaxation	0.18	0.27	0.41	1.32	18.40	26.60
3. cycle loading	0.30	0.42	0.69	1.33	0.20	11.60
3. cycle relaxation	0.19	0.27	0.45	1.32	18.90	26.90

Measurement results of the hysteresis experiments for a stretch of a maximum of 200%

	Tension Force Z in N/25 mm at different % stretch				Stretch ϵ in % at	
hysteresis	40%	60%	100%	200%	0.05 N/25mm	0.1 N/25mm
1. cycle Loading	0.42	0.53	0.87	3.33	0.20	0.70
1. cycle relaxation	0.15	0.22	0.31	3.25	22.10	30.90
2. cycle loading	0.24	0.33	0.51	3.00	1.80	17.40
2. cycle relaxation	0.14	0.20	0.29	2.96	24.30	31.90
3. cycle loading	0.26	0.36	0.53	2.89	0.40	1.00
3. cycle relaxation	0.15	0.23	0.31	2.87	22.00	30.00

Example 4:

The same Elastan thread (78 dtex), the same thread division transverse to the machine direction (18/inch) and the same thread tension on the partial warp beam (40%) as in Examples 1 to 3, was used in Example 4.

A polypropylene spun bonded non-woven material of 8 g/m² weight ran below the tensioned Elastan thread plane and a longitudinally oriented, 18 g/m² web of copolypropylene-fibers with a titer of 2.2 dtex and a staple length of 40 mm thereabove. The melting temperature of the copolypropylene fibers was about 5 to 7°C below the one of a highly stretched polypropylene staple fiber.

The upper of the two rollers was the line seal engraved roller so that the staple fiber web was facing the engraved roller.

The calendaring temperatures were 130°C on the smooth roller and 127°C on the line seal engraved roller and the line pressure was 30 kp/cm.

The unrolling speed of the warp beam was 1.5 m/min and the calendaring speed was 3 m/min.

The product was wound up almost tension free and examined for its elastic stretch behavior after a 7 day storage.

The composite material of Example 4 was optically significantly distinguished from the composites of Examples 1 to 3. The pleats on the spunbond non-woven side (= smooth roller side) were almost no longer recognizable, while the pleats on the staple fiber side of 18 g/m² weight were very strongly present. The difference in the presence of the pleats was probably mainly based on four factors:

- the weight difference of the staple fiber web (18 g/m²) to the spunbond non-woven layer (6 g/m²),
- no pre-solidification of the staple fiber web in contrast to the spunbond non-woven,
- crimped fibers in the staple fiber web in contrast to the smooth fibers in a spunbond non-woven,
- spunbond non-woven layer facing the smooth roller.

A surface weight of 67.8 g/m² in the relaxed condition was determined for the composite manufactured according to Example 4. The width of the embossment lines was measured in a color video recording. As in Example 3, it was observed here as well that the width of the embossment lines of originally B1 = 1.00 mm was shortened to on average width B2 = 0.852 mm, a result of the tension free rolling up of the material. The maximum stretch up to the pleat free condition was determined as 116%.

The weight portions of the individual components, which means spunbond non-woven, staple fiber web and Elastan yarn, in a maximally stretched, pleat free condition and after the relaxation could be determined from these determined data already described in Example 3. It was found that:

$$F_v = 0.963$$

$$F_1 = 1.974 \text{ g/m}^2$$

$$F_2 = 2.317 \text{ g/m}^2$$

$$F_{3s} = 2.347 \text{ g/m}^2 \text{ for spunbond non-woven material (s for spunbond non-woven)}$$

$$F_{3c} = 5.282 \text{ g/m}^2 \text{ for staple fiber web (c for carded)}$$

$$F_{4s} = 6.0 \text{ g/m}^2$$

$$F_{4c} = 13.50 \text{ g/m}^2$$

In the stretched condition (which means in the pleat free condition of the spunbond non-woven material and the staple fiber web layer) of the composite material elastic in machine direction, the following surface weights thus resulted for the three layers:

Components of the composite material	Surface Weight in g/0.963 m ²	Surface Weight in g/m ²
Weight portion F4s of the PP-spunbond non-woven layer 1 in the un-embossed zones	6.000	6.231
Weight portion F3s of the PP-spunbond non-woven layer 1 in the embossed zone	2.347	2.437
78 dtex Elastan yarn layer F1 with 18 yarns/inch	1.974	2.050
Weight portion F3c of the PP-spunbond non-woven layer 1 in the embossed zone	5.282	5.485
Weight portion F4c of the PP-spunbond non-woven layer 1 in the un-embossed zones	13.50	14.019
Sum total	29.103	30.22

Calculated surface weight in the relaxed condition.

$$G_{kr} = 30.22 * 2.16 = 65.28 \text{ g/m}^2$$

This calculated value of 65.28 g/m² corresponds very well with the measured value of 67.80 g/m².

Measurement results of the hysteresis experiments for a stretch of a maximum of 100%.

	Tension Force Z in N/25 mm at different % stretch				Stretch ϵ in % at	
hysteresis	30%	40%	60%	100%	0.05 N/25mm	0.1 N/25mm
1. cycle Loading	0.38	0.45	0.61	1.63	0.00	130
1. cycle relaxation	0.17	0.23	0.35	1.49	15.30	20.20
2. cycle loading	0.26	0.32	0.47	1.29	5.90	11.20
2. cycle relaxation	0.17	0.22	0.33	1.28	15.40	21.80
3. cycle loading	0.28	0.34	0.50		0.70	8.90
3. cycle relaxation	0.17	0.22	0.34		14.00	20.50

Measurement results of the hysteresis experiments for a stretch of a maximum of 60%.

	Tension Force Z in N/25 mm at different % stretch				Stretch ϵ in % at	
hysteresis	30%	40%	60%		0.05 N/25mm	0.1 N/25mm
1. cycle Loading	0.44	0.51	0.58		0.10	1.40
1. cycle relaxation	0.28	0.41	0.60		4.60	11.30
2. cycle loading	0.37	0.48	0.56		1.80	3.70
2. cycle relaxation	0.30	0.35	0.59		7.50	11.60
3. cycle loading	0.40	0.49	0.57		0.60	2.30
3. cycle relaxation	0.30	0.38	0.61		5.10	10.20

Example 5:

Example 5 was distinguished from Example 4 in that the Elastan thread unrolling speed from the partial warp beam was elevated to 2.5 m/min. In contrast, the calendaring speed of 3 m/min was maintained.

A composite with significantly lower maximum elastic stretch was achieved thereby, which stretch was determined as $m = 57.60\%$. From the determined values

$$B1 = 1.00 \text{ mm}$$

$$B2 = 0.942 \text{ mm}$$

$$m = 57.50$$

one again calculated the weight portions of the individual components, which means spunbond non-woven, staple fiber web and Elastan yarn in the maximally stretched, pleat free condition and after relaxation as described in Example 4. It was determined that:

$$F_v = 0.9855$$

$$F1 = 3.290$$

$$F2 = 1.411$$

$$F3s = 2.123 \text{ for spunbond non-woven material (s for spunbond non-woven)}$$

$$F3c = 4.777 \text{ for staple fiber web (c for carded)}$$

$$F4s = 6.0 \text{ g/m}^2$$

$$F4c = 13.50 \text{ g/m}^2$$

In the stretched condition, (which means in the pleat free condition of the spunbond non-woven layer and the staple fiber web layer) of the composite elastic in machine direction, the following surface weights therefore resulted for the three layers:

Components of the composite material	Surface Weight in $\text{g}/0.9855 \text{ m}^2$	Surface Weight in g/m^2
Weight portion F4s of the PP-spunbond non-woven layer 1 in the un-embossed zones	6.000	6.088

Weight portion F3s of the PP-spunbond non-woven layer 1 in the embossed zone	2.123	2.154
78 dtex Elastan yarn with 18 yarns/inch	3.290	3.338
Weight portion F3c of the PP-spunbond non-woven layer 1 in the embossed zone	4.777	4.847
Weight portion F4c of the PP-spunbond non-woven layer 1 in the un-embossed zones	13.50	13.699
Sum total	29.690	30.127

The surface weight in the relaxed condition was calculated therefrom as:

$$G_{kr} = 30.127 * 1.575 = 47.45 \text{ g/m}^2$$

This calculated value somewhat deviated from the measured value of 50.1 g/m².

CLAIMS:

1. Composite material, comprising first and second opposing layers and a group of elastic threads extending in parallel and positioned therebetween, the first layer including at least one non-woven material layer and the second layer including at least one further sheet material layer, the first and second layers being thermally melt bonded in a predetermined pattern of melt bonding regions, and the elastic threads being embedded in tensioned condition at selected locations into the melt bonding regions between the non-woven and the further sheet material.
2. The composite material according to claim 1, wherein the further sheet material is a foil.
3. The composite material according to claim 1, wherein the further sheet material is a non-woven.
4. The composite material according to claim 1, wherein the non-woven includes white pigmented fibers.
5. The composite material according to claim 1, wherein the non-woven includes at least one of two dimensionally and three dimensionally crimped bi-component fibers.
6. The composite material according to claim 1, wherein the non-woven is a spunbond non-woven material or especially a staple fiber non-woven material.
7. The composite material according to claim 1, wherein the non-woven is a staple fiber non-woven material.
8. The composite material according to claim 1, wherein the further sheet material is a foil which consists of a single polymer component or of at least two layers with a higher and lower melting polymer whereby the melting or softening range of the foil or the lower melting layer of the co-extruded foil corresponds to the melting or softening range of the fibers of the non-woven.

9. The composite material according to claim 1, wherein the further sheet material is a co-extruded foil which consists of at least two layers respectively made of a higher and a lower melting polymer whereby the melting or softening range of the lower melting polymer layer of the co-extruded foil corresponds to the melting or softening range of the fibers of the non-woven.
10. The composite material according to claim 9, wherein the material of the foil and the fibers of the non-woven are of the same polymer class.
11. The composite material according to claim 9, wherein the material of the foil and the fibers of the non-woven are made of polypropylene and/or copolymers of propylene with an olefin.
12. The composite material according to claim 9, where in the foil is a microporous foil of hydrophobic polymer material or of hydrophobically treated polymeric material.
13. The composite material according to claim 9, where in the foil is a microporous foil of hydrophobically treated polymeric material.
14. The composite material according to claim 1, wherein elastic threads of segmented polyester or polyether urethane ureas are used.
15. The composite material of claim 1, wherein the groups of parallel oriented elastic threads have a spacing of individual threads of 1 to 10 mm.
16. The composite material according to claim 1, wherein the elastic threads are foil ribbons.
17. The composite material according to claim 1, wherein the direction of extent of the group of elastic threads corresponds with the machine direction.
18. The composite material according to claim 1, further comprising at least a third layer, whereby the first and second layers are non-woven material layers between which the

parallel oriented elastic threads are enclosed and the third layer is a layer covering one of the first and second layers. non-woven materials, especially a non-woven material.

19. The composite material according to claim 18, wherein the third layer is a non-woven material.

20. The composite material according to claim 1, including a combination of polymers of the elastic threads and the non-woven or the further sheet material, which polymers are selected from the group consisting of polyurethane/polyolefin, polyester elastomer/polyolefin, SBS/Copolyester, SEBS/Copolyester, SBS/Copolyamide and SEBS/Copolyamide.

21. The composite material according to claim 1, wherein the predetermined pattern of the thermal melt bonding regions is a group of parallel oriented regions which extend at an angle of 30 to 90° to the direction of the elastic threads.

22. A process for the manufacture of the composite material of claim 1, comprising the steps of:

- a. combining at least one non-woven material with a further sheet material and a group of parallel extending elastic threads placed in tensioned condition between the non-woven material and the further sheet material; and
- b. melt embedding the group of parallel oriented elastic threads between the non-woven material and the further sheet material in the form of a predetermined pattern of melt embedding regions, preferably by heat and calendaring pressure and/or by ultrasound, so that selected regions of each elastic thread are embedded in the tensioned condition at the melt bonding locations between the non-woven and the further sheet material.

23. The process according to claim 16, wherein the thermal melt bonding of the non-woven material and the further sheet material is carried out by calendaring with an embossment calendar of which at least one roller has predetermined pattern.

24. A process according to claim 23, wherein one roller of the calendar has a smooth surface and the opposing roller is provided with a continuous line embossment.

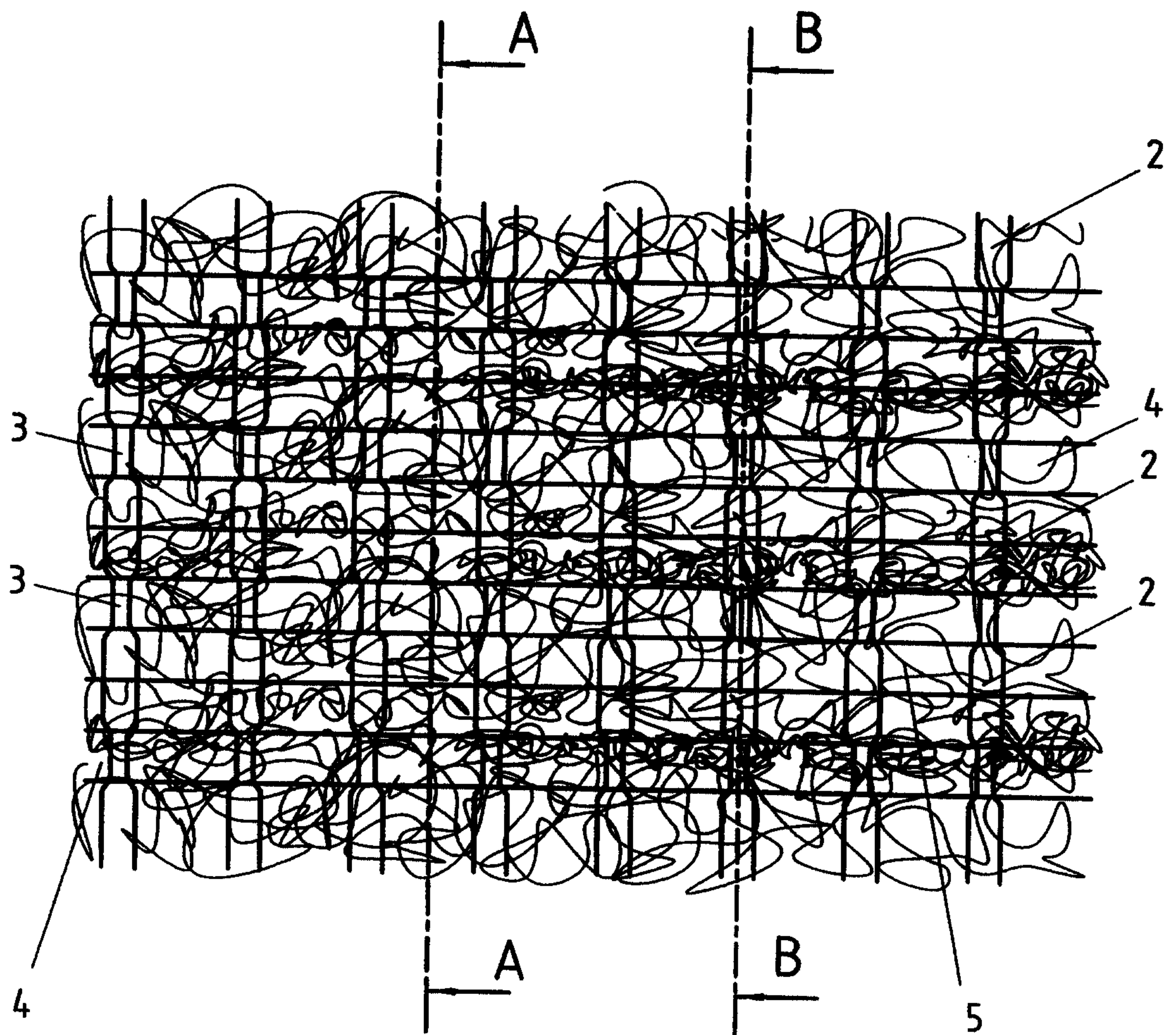
25. A process according to claim 23, wherein edges of the line shaped engraving are rounded.

26. Use of the composite material according to claim 1 for the manufacture of hygiene articles, especially diapers including diaper pants.

27. Use of the composite material according to claim 1 for the manufacture of diapers including diaper pants.

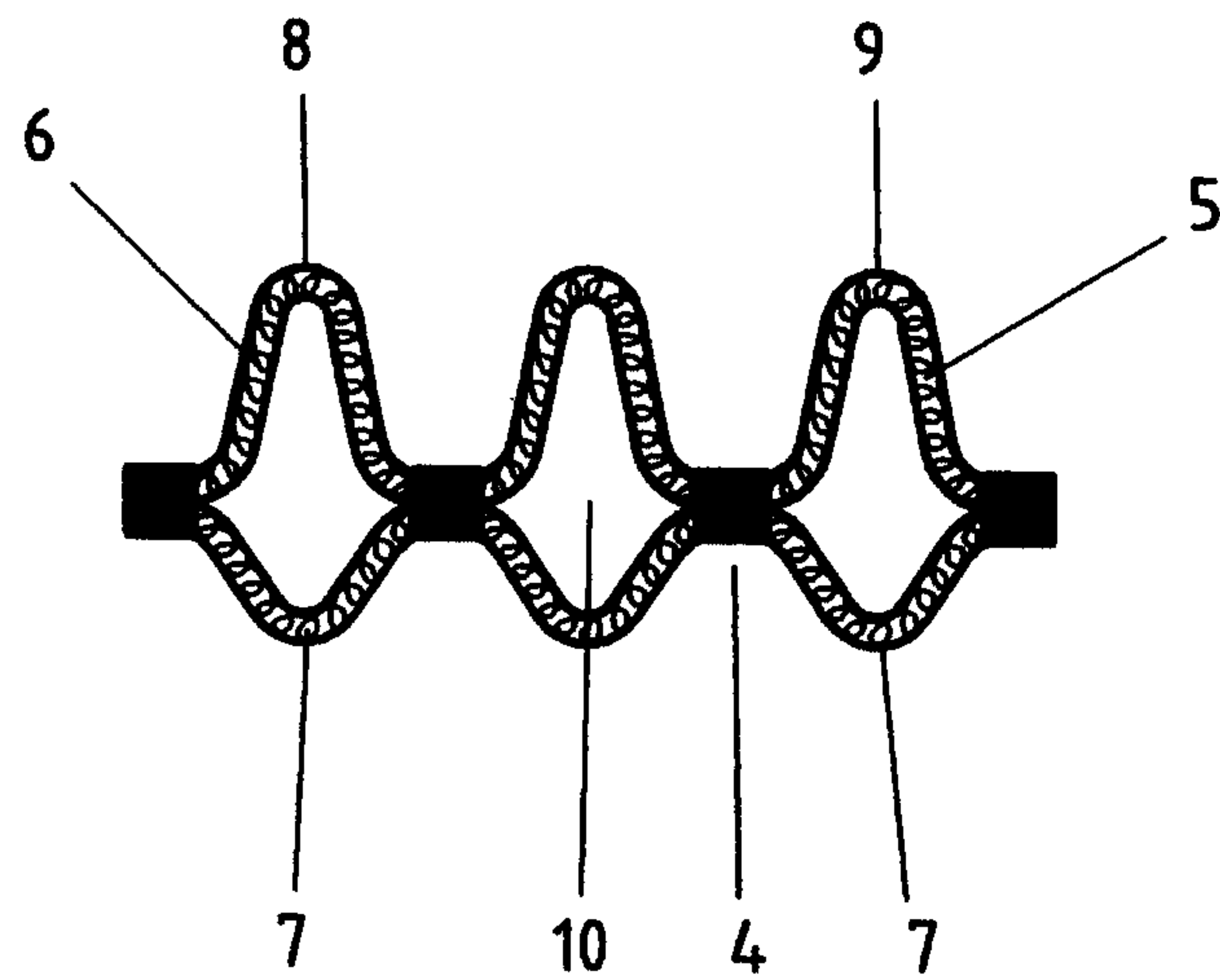
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Fig.1



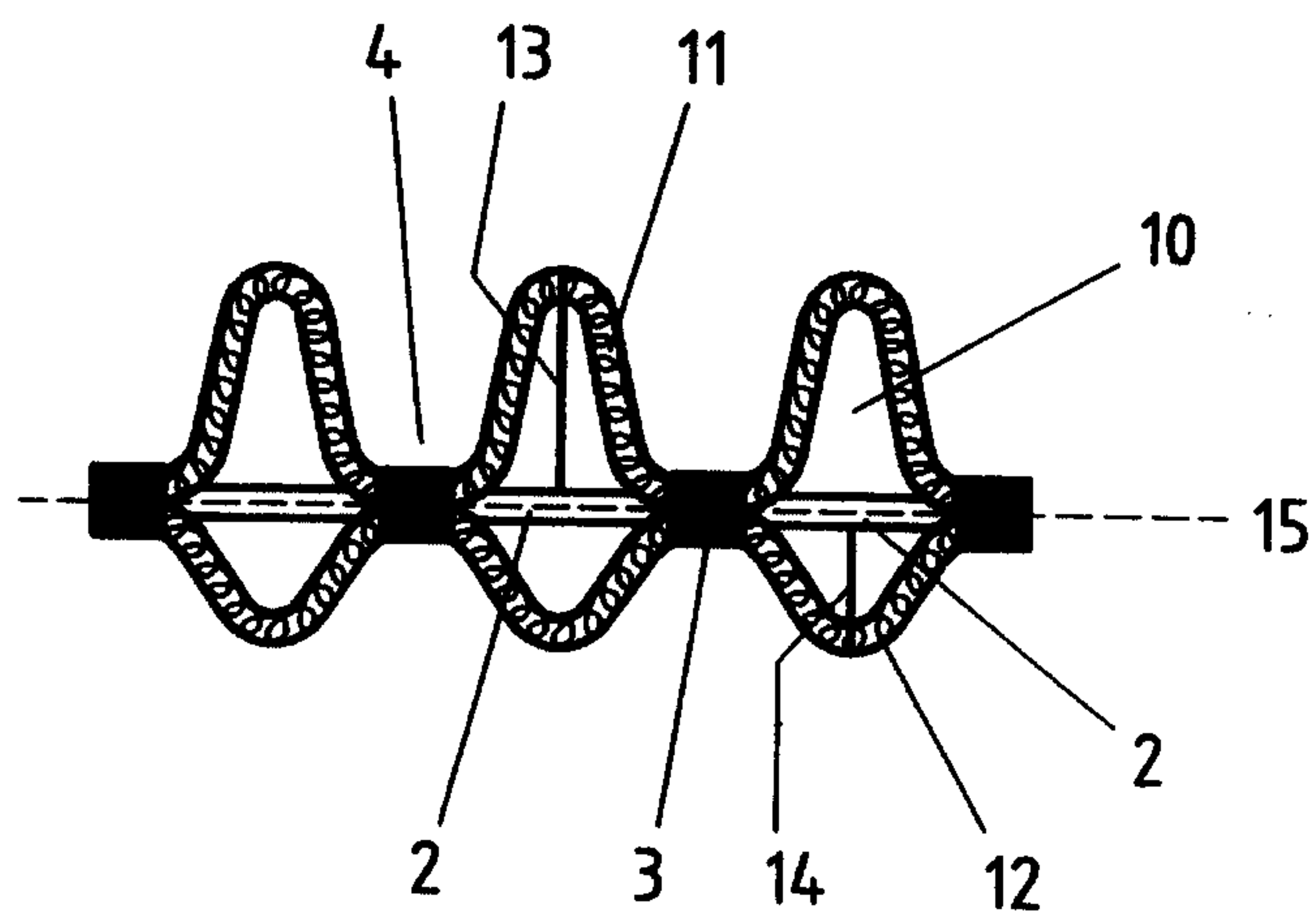
2/4

Fig.2



3/4

Fig.3



4/4

Fig.4

