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(54) **TWO TYPES OF FIBERS TUFTED INTO AN ARTIFICIAL TURF**

(57) Artificial turf mat comprising: a primary backing cloth (1), having a top surface and a bottom surface; a plurality of fibers (3, 3') extending above the top surface and that are tufted onto the primary backing cloth; and a primary coating on the bottom surface of the primary backing cloth, configured to fix the tufted fibers, wherein the plurality of fibers comprises a first type of fibers (3) and a second type of fibers (3'), wherein the first type are crimped fibers and the second type of fibers are substantially straight or spiral fibers and wherein at least half of the fibers of the second type extend above the fibers of the first type.

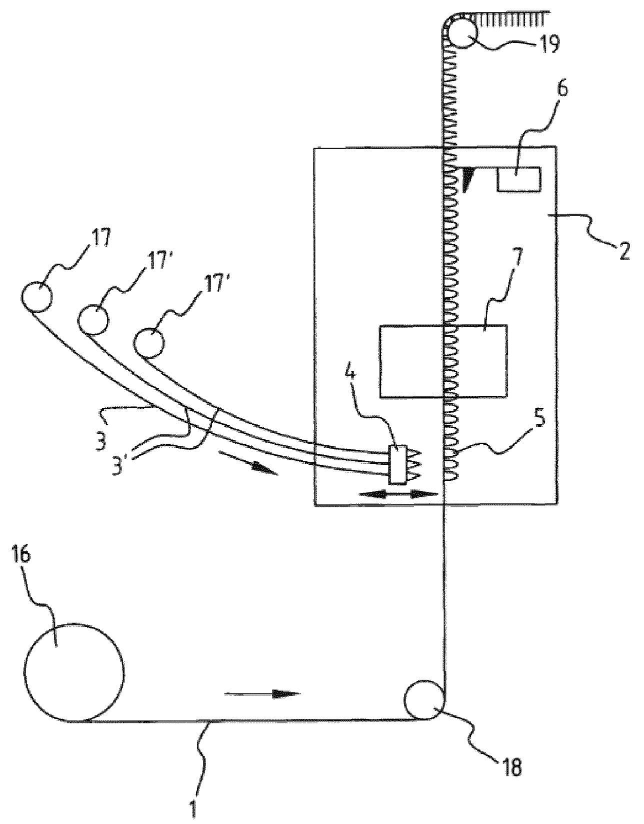

Fig. 1

Description

TECHNICAL FIELD

[0001] In a first aspect, the invention relates to an artificial turf mat.

[0002] In a second aspect, the invention relates to a method for manufacturing an artificial turf mat.

PRIOR ART

[0003] Artificial turf installations or synthetic turf mats are known as grass-like artificial surfaces made from synthetic materials such as polyethylene, polypropylene, polyamide, among others. Such artificial turf installations are generally used for sports that are originally or normally played on natural grass. An artificial turf installation is also used on lawns and in landscaping.

[0004] The first artificial turf installations for sports that were developed and installed in the early 1960s had a much harder surface than natural grass. As a result, it soon became known that such artificial turf installations caused more injuries when practicing sports. At the beginning of the 21st century, artificial turf installations with a sand and/or rubber infill were developed. Such artificial turf installations are often indistinguishable from natural grass from a distance and are generally regarded as much safer to play on than the first generation of artificial turf installations.

[0005] In general, an artificial turf installation consists of at least one type of artificial turf blades or tufts, a tuft cloth, a coating to keep the tufted artificial turf blades in place and, if applicable, an infill material and/or a shock-absorbing layer. The most common type of artificial turf installation uses synthetic grass blades, for example, of polyethylene, polypropylene or polyamide. These synthetic grass blades usually have a length between 10 and 65 mm and are tufted in a tuft cloth. The back of this tuft cloth is coated with a polyurethane or latex or polyolefin medium to fix the tufted synthetic grass blades in place.

[0006] The tufted artificial turf blades of the tufted and coated cloth are then filled with an infill material consisting of sand and/or performance infill granulate (e.g., rubber, cork, etc.). This keeps the artificial turf blades upright and improves the shock absorption and deformability of the artificial turf installation. The infill material usually forms a layer with a thickness of approximately 15 to 30 mm. The majority of manufacturers of FIFA-approved artificial turf installations use the technology described above.

[0007] EP 2 771 513 describes a shock-absorbing layer consisting of a three-dimensional intertwined mat of extruded filaments made of a thermoplastic elastomeric polymer, in particular a thermoplastic elastomeric polyester polymer or a thermoplastic elastomeric polyurethane polymer.

[0008] EP 3 354 794 describes a support layer for supporting an artificial turf installation, in which the support layer is made of a polymer foam, preferably with a density between 20 and 70 grams per liter, such as a polyolefin foam.

[0009] EP 3 126 573 describes a mat for forming an artificial turf installation consisting of a cushioning layer; and artificial fibers; the above-mentioned artificial fibers are attached to the above-mentioned cushioning layer by means of tufting techniques.

[0010] Notwithstanding the above-mentioned advances in artificial turf fields, there remains a need for a sports and recreational surface and subsurface that is stable, manages available moisture without degradation by water, is easy to drain, is easy and inexpensive to manufacture, and is hard enough to offer resistance, but is still resilient enough. Moreover, known shock-absorbing layers have disadvantages due to a limited ability to drain liquids, such as water, from the artificial turf installation. Adding sand or other infill increases the risk of injuries. The present invention aims to solve at least some of the above problems or drawbacks.

SUMMARY OF THE INVENTION

[0011] In a first aspect, the present invention concerns an artificial turf mat according to claim 1. The artificial turf mat comprises a plurality of crimped fibers that act as a shock-absorbing/cushioning layer. These fibers allow water to flow through to the primary backing cloth when it rains. The artificial turf mat is able to drain excess water easily and. The many crimped fibers ensure that the artificial turf mat is hard enough to provide resistance, but still resilient enough for an optimal playing experience. The artificial turf mat comprises a plurality of straight or spiral fibers that form a top layer. For example, the top layer ensures a good ball roll and a natural appearance. The artificial turf mat does not require infill to meet the requirements of EN 15330. This way there is no chance of microplastic infill spreading, there is less need for maintenance and there will be less wear on the fiber due to the absence of abrasive sand. Another advantage of the invention is that the shock-absorbing layer has improved shock absorption compared to existing artificial turf mats. In particular, the plurality of crimped fibers ensures a finally strong shock-absorbing layer that is also elastic. Preferred embodiments of the device are shown in claims 2 to 7.

[0012] In a second aspect, the present invention relates to a method according to claim 10. This method has the advantage, inter alia, that it is easy to attach the two types of fibers homogeneously to the primary backing cloth. In addition, an optimal distribution and quantity of each type of fiber is achieved. Preferred embodiments of the method are described in the dependent claims 8-13.

DESCRIPTION OF THE FIGURES

[0013] **Figure 1** shows a schematic representation of a method of tufting the primary backing cloth with 2 types of fibers according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0014] Unless otherwise defined, all terms used in the description of the invention, including technical and scientific terms, have the meaning as commonly understood by a person skilled in the art to which the invention pertains. For a better understanding of the description of the invention, the following terms are explained explicitly.

[0015] In this document, "a" and "the" refer to both the singular and the plural, unless the context presupposes otherwise. For example, "a segment" means one or more segments.

[0016] Quoting numeric intervals by the endpoints includes all integers, fractions, and/or real numbers between the endpoints, including those endpoints.

[0017] The term "polymer" refers to a compound consisting of at least two or more monomers.

[0018] In a first aspect, the invention concerns an artificial turf mat comprising: a primary backing cloth, having a top surface and a bottom surface; a plurality of fibers extending above the top surface and that are tufted onto the primary backing cloth; and a primary coating on the bottom surface of the primary backing cloth, configured to fix the tufted fibers, wherein the plurality of fibers comprises a first type of fibers and a second type of fibers, wherein the first type is crimped fibers and the second type of fibers is substantially straight or spiral fibers.

[0019] Substantially straight fibers refer to fibers made from straight yarn.

[0020] A spiral fiber refers to a type of fiber made from yarn wound around its own axis, resulting in a spiral or twisted structure. This fiber exhibits a permanent twist, whereby the length in the untwisted state is only minimally, not more than 5%, longer than in the original state. Preferably, straight or spiral fibers have a length that in the straight state is a maximum of 5%, preferably a maximum of 4%, more preferably a maximum of 3%, even more preferably a maximum of 2%, in particular a maximum of 1% longer than in the spiral state. By straight state is meant a condition in which the fiber is maximally straightened and untwisted but is not elastically stretched.

[0021] A crimped fiber refers to a type of fiber that has undergone a process called crimping. Crimping involves giving the fiber a wavy or zigzag pattern along its length, resulting in small folds or waves along the surface of the fiber. This makes the fiber considerably shorter than in the stretched state.

[0022] Preferably the difference between the length of the fiber in the stretched state and the length of the fiber when it is crimped will vary between 5% and 30%, preferably between 10% and 25%, more preferably between 15% and 20%. For example, if a fiber has a length of 10 centimeters when stretched, and when it is crimped the length is reduced to 7 centimeters, then the degree of crimp is 30%. Because the crimp is such that the fiber is reduced in length by applying crimp, a dense bottom layer is created that functions as a shock-absorbing layer. This dense layer with crimped fibers improves the playing properties and ensures that less or no infill is required.

[0023] Fiber crimping, or crimping is a manufacturing process used to introduce waves or zigzag patterns along the length of a textile fiber. The process can be performed on synthetic fibers, such as polyester or nylon, but also on natural fibers such as wool. Crimping is usually achieved through mechanical or heat treatment methods. In the mechanical crimping process, the fibers are passed through a series of rollers or gears with irregular surfaces. As the fibers move through these rollers, the irregular surfaces create twists and turns in the fiber, creating the characteristic wavy or zigzag pattern. The degree of crimp can be adjusted by controlling the speed and pressure applied to the fibers during the process. Heat crimping is often used for synthetic fibers and involves subjecting the fibers to controlled heat. The fibers are exposed to hot air or steam, or they can be passed through heated rollers. When the fibers are heated, they become more pliable and can be molded into the desired crimped shape. After the fibers are formed, they are allowed to cool and retain the crimped structure. The main idea behind crimping is to introduce irregularities into the fiber structure, resulting in a three-dimensional wave pattern. This crimped structure gives the fiber several desirable properties, including increased volume, improved resilience, better cohesion and improved elasticity.

[0024] Because the artificial turf mat comprises a plurality of crimped fibers, these fibers act as a shock-absorbing layer. These fibers allow water to flow through to the primary backing cloth when it rains. The artificial turf mat is able to drain excess water easily. The plurality of crimped fibers ensures that the artificial turf mat is hard enough to provide resistance, yet resilient enough for an optimal playing experience. Because crimped fibers are used, a dense, shock-absorbing layer is created. This means that a filling with rubber or sand is not necessary. Sand also has an abrasive effect. The artificial turf field will therefore cause fewer wounds to the players and also causes less wear and tear on the fibers.

[0025] According to an embodiment, at least half of the fibers of the second type extend above the fibers of the first type. Because at least half of the fibers of the second type extend above the fibers of the first type, two layers are formed: a dense bottom layer, mainly containing the fibers of the first type, which functions as a shock-absorbing layer; and a more open top layer, with mainly fibers of the second type, which ensures desired playing properties such as optimal ball roll. According to an embodiment, at least 70% of the fibers of the second type extend above the fibers of the first type, preferably at least 75%, preferably at least 80%; preferably at least 90%, preferably at least 95%.

[0026] According to an embodiment, the pile height of at least 90% of the fibers of the second type is 20-150%, preferably 30-140%, preferably 40-130%, preferably 50-120%, preferably 60-110%, preferably 70-100%, preferably 80-90% higher than the pile height of the fibers of the first type. This means that the pile height of the fibers of the first type must be multiplied by a factor between 1.2 and 2.5, preferably between 1.4 and 2.2, preferably between 1.6 and 2.0, preferably between 1.7 and 1.9 in order to obtain the pile height of at least 90% of the fibers of the second type. Because the pile height of at least 90% of the fibers of the second type is 20-150% higher than the pile height of the fibers of the first type, a bottom dense layer is created with crimped fibers and a top layer with fibers of the second type. The pile height is measured from the top of the primary backing cloth to the end of the fiber. The fiber is not stretched during this measurement. According to an embodiment, the pile height of at least 95% of the fibers of the second type is 70-150% higher than the pile height of the fibers of the first type.

[0027] According to an embodiment, the stretched pile length of the fibers of the first type is 10-40 mm, preferably 15-35 mm, preferably 20-30 mm, preferably 22-28 mm, in particular about 25 mm and the pile height of the fibers of the second type 20-60 mm, preferably 25-55 mm, preferably 30-50 mm, preferably 32-45 mm, preferably 34-40 mm, in particular about 35 mm. According to an embodiment, the stretched pile length of the fibers of the first type is 20-30 mm and the pile height of the fibers of the second type is 25-40 mm. Because the stretched pile length of the fibers of the first type is 20-30 mm and the pile height of the fibers of the second type is 25-40 mm, two layers are formed: a dense bottom layer, mainly containing the fibers of the first type, which functions as a shock-absorbing layer; and a more open top layer, with mainly fibers of the second type, which ensures desired playing properties such as optimal ball roll. According to an embodiment, the stretched pile length of at least half of the fibers of the first type is 20-30 mm and the pile height of at least half of the fibers of the second type is 25-40 mm. According to an embodiment, the stretched pile length of at least 95% of the fibers of the first type is 20-30 mm and the pile height of at least 95% of the fibers of the second type is 25-40 mm.

[0028] The difference in pile height plays a crucial role in creating the desired technical properties in a ball game, such as ball roll, which refers to the behavior of the ball when it is in motion. A desired ball roll usually involves smooth, controlled and predictable movement over a certain distance. In the case of the mentioned difference in pile height, the ball roll will typically be between 4 and 10 meters. This way, players can adjust their shot power, precision and spin control and clearly see the effect thereof in a repeatable way. Finally, thanks to the open structure of the top layer and the dense bottom layer, the player's foot will optimally press into the bottom layer, providing the desired grip, which is essential for stability and agility during technical movements. The open structure of the top layer ensures better friction between the foot and the surface, while the dense bottom layer provides the necessary support and resistance to strengthen the grip. This aspect contributes to the player's performance and confidence while practicing their sport or activity.

[0029] According to an embodiment, the ratio of the linear mass density of the fibers of the first type over the linear mass density of the fibers of the second type is between 1:10 and 1:1, preferably between 1:5 and 1:1 and more preferably between 1:3 and 2:3. The linear mass density is expressed in dtex. Dtex is a measure of linear mass density of fibers and is defined as the weight in grams per 10,000 meters. This ratio of the linear mass density of the fibers of the first type over the linear mass density of the fibers of the second type is optimal for obtaining an artificial turf mat with desired playing properties.

[0030] According to an embodiment, the fibers of the first type and the fibers of the second type have a yarn count of between 1000 and 30,000 dtex. Dtex is a measure of linear mass density of fibers and is defined as the weight in grams per 10,000 meters. According to an embodiment, the weight of the tufted fibers is between 1000 and 20,000 dtex, preferably between 1500 and 15,000 dtex, preferably between 2000 and 10,000 dtex, preferably between 3000 and 9000 dtex, preferably between 4000 and 8000 dtex, preferably between 5000 and 7000 dtex.

[0031] In an embodiment, the fibers of the first type have a yarn count between 1000 and 30,000 dtex, preferably between 2000 and 20,000 dtex, preferably between 3000 and 10,000 dtex, preferably between 4000 and 9000 dtex, preferably between 5000 and 8000 dtex and in particular about 7000 dtex. In an embodiment, the fibers of the second type have a yarn count between 1000 and 30,000 dtex, preferably between 5000 and 20,000 dtex, preferably between 10,000 and 15,000 dtex, preferably between 10,100 and 1400 dtex, preferably between 10,200 and 13,000 dtex, preferably between 10,300 and 12,000 dtex. Using two fibers with different yarn thicknesses in an artificial turf mat offers several advantages and allows manufacturers to create an artificial turf product that meets specific needs and requirements. By combining two different fibers, manufacturers can optimize the properties of the artificial turf mat. For example, higher dtex fibers can provide higher fiber density, durability and resilience, while lower dtex fibers can provide softness and a natural appearance. The combination of both fibers can lead to a turf with an ideal balance between density, durability and aesthetics. The use of fibers with different dtex values can improve the performance of the artificial turf mat. For example, fibers with a higher dtex can make the artificial turf stronger and more resistant to intensive use and stress. On the other hand, lower dtex fibers can provide softness and comfort, which can be important for certain applications such as playgrounds. Finally, the artificial turf will have a more realistic appearance, the combination of fibers with different yarn thicknesses will ensure that the grass looks more natural, comparable to real grass.

[0032] According to an embodiment, the fibers of the first type are extruded monofilaments with a dtex of 5000-9000 and a thickness of 150-250 μm. Because the fibers of the first type are extruded monofilaments with a dtex of 5000-9000 and a thickness of 150-250 μm, the fibers of the first type are sufficiently strong to form a dense bottom layer but sufficiently flexible to be shock-absorbing and resilient, but not too hard. According to an embodiment, the fibers of the first type are extruded monofilaments with a dtex of 6000-8000. According to an embodiment, the fibers of the first type are extruded monofilaments with a thickness of 120-230 μm, preferably of 160-200 μm. According to an embodiment, the ratio of the thickness of the fibers of the first type to the thickness of the fibers of the second type is between 1:10 and 1:1, preferably between 1:5 and 1:1 and more preferably between 1:3 and 2:3.

[0033] The term "extruded monofilaments" should be understood as plastic fibers that are produced by means of an extrusion process. They are single fibers with a round cross-section, in contrast to multi-filament fibers that consist of multiple components. The production process of extruded monofilaments begins with the melting of thermoplastic plastic materials, such as polypropylene (PP) or polyethylene (PE). The melted plastic is then forced through an extrusion mold with one opening, which gives the fiber its round shape. The molten plastic is then quickly cooled and stabilized, making the material stiff and durable. The advantages of extruded monofilaments include their high strength, durability, flexibility and resistance to abrasion. They can also be adapted to specific needs by varying the choice of material, fiber diameter and surface properties.

[0034] According to an embodiment, the fibers of the first type comprise at least 4 monofilaments per stitch and at most 50 monofilaments per stitch, preferably at least 5 monofilaments per stitch and at most 20 monofilaments per stitch, at least 6 monofilaments per stitch and at most 10 monofilaments per stitch, at least 7 monofilaments per stitch and at most 9 monofilaments per stitch.

[0035] According to an embodiment, the fibers of the second type comprise at least 2 monofilaments per stitch and at most 30 monofilaments per stitch, preferably at least 3 monofilaments per stitch and at most 10 monofilaments per stitch, at least 4 monofilaments per stitch and at most 8 monofilaments per stitch, at least 5 monofilaments per stitch and at most 7 monofilaments per stitch.

[0036] The number of monofilaments per stitch in an artificial turf mat has various technical effects on the performance and properties of the artificial turf. A higher number of monofilaments per stitch results in a higher fiber density, which leads to a denser and fuller turf and promotes a more natural appearance. In addition, a higher number of monofilaments improves the resilience of the artificial turf, making the fibers better able to maintain their original position after compression, even with intensive use. In addition, a larger number of monofilaments contributes to the durability of the artificial turf, making it more resistant to wear and deformation. The increased load-bearing capacity and structural integrity of the artificial turf enhance the overall performance. In addition, artificial turf with more monofilaments generally feels softer, which can be relevant for situations where comfort is important. On the other hand, artificial turf products with a higher number of monofilaments per stitch may incur higher production costs due to the additional materials and labor required. Choosing the right number of monofilaments per stitch is influenced by several factors, including intended use, desired performance and budget, allowing manufacturers to employ different configurations to produce artificial turf that meets the specific demands and needs of customers.

[0037] According to an embodiment, the fibers of the bottom layer have more monofilaments per stitch than the fibers of the top layer. Further preferably, the fibers of the bottom layer have approximately 8 monofilaments per stitch and the fibers of the top layer have approximately 6 monofilaments per stitch. This combination creates a mat with a balanced structure and functionality. Further preferably, the bottom layer of the artificial turf has a lower dtex value but has more tufts than the top layer. This makes the bottom layer fuller than the top layer. This interplay of a lower dtex value and a larger number of tufts in the bottom layer results in an artificial turf mat with a balanced structure and functionality. The sturdy base of the bottom layer provides a solid surface for the artificial turf, while the higher fiber density contributes to a realistic appearance and a soft texture of the artificial turf in the top part. In addition, the lower fiber density of the bottom layer promotes good water drainage and air flow in the artificial turf, making it less susceptible to flooding and drying faster after rainfall. This makes the artificial turf very functional and suitable for various purposes.

[0038] The higher fiber density also increases the resilience of the fibers, making them better able to recover their original upright position after loads, such as stepping on the mat. This ensures that the artificial turf looks fresh and cared for for a long time, even with intensive use. The combined properties of the bottom layer and the top fiber create an artificial turf mat with a good balance between stability, resilience and aesthetics. This makes the mat suitable for various applications, such as sports fields and playgrounds. The support of the bottom layer ensures that the artificial turf remains flat and stable, while the top fiber provides an attractive appearance and comfort for users. The right balance between the two types of fibers contributes to the overall performance and durability of the artificial turf, making it a suitable choice for a variety of environments and uses.

[0039] According to an embodiment, the fibers of the first type and the fibers of the second type comprise polyethylene or polypropylene and preferably the fibers of the first type and the fibers of the second type concern polyethylene (PE) or polypropylene (PP). Because the fibers of the first type and the fibers of the second type comprise and preferably concern polyethylene or polypropylene, the fibers can be easily recycled. Moreover, the PP or PE can be reused in the same or another application. Another object of the present invention is to provide an artificial turf that has a high durability and can be composed of commercially available materials. According to an embodiment, the fibers of the first type are substantially made of at least one elastic polymer.

[0040] According to an embodiment, the fibers of the second type are monofilaments with a dtex of 10,000-15,000 and a thickness of 250-400 μm. Because the fibers of the second type are monofilaments with a dtex of 10,000-15,000 and a thickness of 250-400 μm, these fibers are sufficiently strong to stand upright and provide the desired playing properties. For example, the rolling of the ball is influenced by the thickness of the fibers of the second type. According to an embodiment, the fibers of the second type are monofilaments with a dtex of 10,000-12,000. According to an embodiment, the fibers of the second type have a thickness of 270-400 μm. According to an embodiment, the fibers of the second type are extruded monofilaments.

[0041] The fibers of the first and second types are preferably green and resemble blades of grass. According to an embodiment, the fibers of the second type are suitable for obtaining normal, frequently used blades of artificial turf, which are known to a person skilled in the art. According to an expert, the fibers of the second type are suitable for obtaining classic tuft fibers or tufts that protrude from the primary backing cloth. The function of the fibers of the first type is mainly to provide shock absorption and grip. The desired properties for playing sports on the artificial turf field can be obtained. An aim of the present invention is to provide a special type of artificial turf that imitates as much as possible the favorable properties of natural grass, in particular in the field of resilience and sliding.

[0042] According to an embodiment, at least 10% of the tufted fibers are of the first type, preferably at least 30%, more preferably at least 50%, even more preferably at least 70% and most preferably at least 90%. According to an embodiment, 5-50% of the tufted fibers are of the second type, preferably 5-30, more preferably 5-20 and most preferably 10-15%. According to an embodiment, 50-99.9% of the tufted fibers are of the first type and 0.1-50% of the tufted fibers are of the second type. According to an embodiment, 70-95% of the tufted fibers are of the first type and 5-30% of the tufted fibers are of the second type. According to an embodiment, 95-99.9% of the tufted fibers are of the first type and 0.1-5% of the tufted fibers are of the second type. According to an embodiment, 80-90% of the tufted fibers are of the first type and 10-20% of the tufted fibers are of the second type.

[0043] According to an embodiment, the fibers of the first and second types comprise an ethyl vinyl acetate, polyamide, polystyrene, polyvinylidene fluoride, high density polyethylene, medium density polyethylene, low density polyethylene, linear low density polyethylene, anhydride modified polyethylene, polypropylene (PP), polyethylene (PE), polyester or a combination of these, preferably they consist of this. According to an embodiment, these fibers comprise polyethylene, preferably they consist of this.

[0044] According to an embodiment, the fibers of the second type comprise a superabsorbent polymer. According to an embodiment, the primary backing cloth comprises a top layer, wherein the top layer comprises a superabsorbent polymer, preferably the top layer is a nonwoven fabric with a thickness of maximum 0.1 cm. According to an embodiment, the artificial turf mat comprises a third type of fibers, wherein the third type of fibers are fibers that comprise a superabsorbent polymer. According to an embodiment, the SAP-comprising fibers comprise an acrylate and a polyester, polypropylene or polyethylene, preferably a combination of acrylate and polyester. According to an embodiment, the SAP-comprising fibers are manufactured by coextruding PP, PE or polyester with SAP. Because the SAP and PP, PE or polyester are extruded together, the SAP is strongly bonded to the PP, PE or polyester. There is no need for a complex production process with, for example, a membrane. According to another embodiment, the SAP-comprising fibers comprise a combination of a first polymer selected from: ethyl vinyl acetate, polyamide, polystyrene, polyvinylidene fluoride, high density polyethylene, medium density polyethylene, low density polyethylene, linear low density polyethylene, anhydride modified polyethylene, polypropylene (PP), polyethylene (PE), polyester or a combination thereof; and an SAP. According to an embodiment, the SAP-comprising fibers comprise a polypropylene (PP), polyethylene (PE) or polyester fiber coated with SAP. According to an embodiment, the SAP-comprising fibers comprise a PP, PE or polyester fiber to which SAP has been applied by atomizing, spraying or pressing. According to an embodiment, the SAP-comprising fibers are manufactured by wrapping a fiber of PP, PE or polyester with a fiber that includes SAP. According to an embodiment, SAP is dissolved in a solvent and a PP or PE fiber is then immersed in the solvent with SAP. After drying, SAP remains attached to the surface of the fiber. A "SAP" or "superabsorbent polymer" comprises a hydrophilic network capable of retaining large amounts of aqueous fluid relative to the weight of the polymer particle (e.g., in the dry state, the superabsorbent polymer absorbs a quantity by weight of water equal to or greater than its own weight). The polymer may comprise a variety of organic polymers that can react with or absorb water and swell when in contact with an aqueous liquid. In an embodiment, the SAP-comprising fibers comprise a sodium polyacrylate, polyacrylamide copolymer, ethylene maleic anhydride copolymer, carboxymethyl cellulose, polyvinyl alcohol copolymer, polyethylene oxide, starch grafted copolymer of polyacrylonitrile, potassium polyacrylate, a polysaccharide, poly(alkyl(meth)acrylate), poly(hydroxyalkyl(meth)acrylate), such as (2-hydroxyethyl acrylate), poly(meth)acrylamide), poly(vinylpyrrolidine), poly(vinyl acetate), copolymers of (meth)acrylamide with maleic anhydride, vinyl acetate, ethylene oxide, ethylene glycol or acrylonitrile, or a combination of the foregoing. A combination of different polymers can be used. According to an embodiment, the SAP-comprising fibers comprise an acrylate and a polyester, polypropylene or polyethylene.

[0045] According to an embodiment, the primary backing cloth comprises one to three layers of woven or nonwoven fabrics. These fabrics can be made of polypropylene, polyester or other synthetic materials. In some embodiments, the primary backing cloth may have a two-layer structure.

[0046] In some embodiments, the primary backing cloth may have a three-layer structure, wherein the outer layers comprise a woven and nonwoven-like material and the middle layer comprises a dimensionally stabilizing woven or nonwoven material. The primary backing cloth may include a polymeric coating, which may be formed by applying a liquid polymer to the primary backing cloth. The polymeric coating may, for example, comprise latex or urethane or polyolefin. According to an embodiment, the primary backing cloth is a fabric suitable for tufting the fibers into. The primary backing cloth can be made of jute, cord, cotton, woven or nonwoven synthetic materials. In an embodiment, the primary backing cloth comprises, for example, a woven polypropylene layer and a glass fiber network attached to the polypropylene layer by means of the adhesive material.

[0047] According to an embodiment, the rotational resistance is between 25 and 50 Nm, measured according to EN 15301-1. This means that the artificial turf mat offers sufficient grip. This is ideal for users and prevents slipping and therefore injuries. To keep this property at a desired level, it is important to provide sufficient crimped fibers per m^2.

[0048] The term "rotational resistance" refers to the resistance a player experiences on the field when trying to rotate their foot. It indicates how easy or difficult it is to perform a twisting or rotating movement on the grass surface. An artificial turf mat with the correct rotational resistance provides sufficient grip, preventing players from slipping and reducing the risk of injuries.

[0049] According to an embodiment, the vertical deformation is 4.0-9.0 mm, measured according to EN 14809. Because the vertical deformation is 4.0-9.0 mm, measured according to EN 14809, the artificial turf mat is hard enough to provide resistance, but still resilient enough. This is ideal for users and prevents injuries. To keep this property at a desired level throughout a full match, it is necessary to provide sufficient crimped fibers, suitable to provide sufficient cushioning.

[0050] The term "vertical deformation" refers to the extent to which the artificial turf surface can be vertically compressed or deformed when loads are applied to it, such as when walking on or playing on the artificial turf. Vertical deformation is an important property of artificial turf and influences factors such as comfort, safety and performance. It measures the change in height or compression of the artificial turf when pressure is applied to it.

[0051] The proposed vertical deformation is essential to the performance of artificial turf. The artificial turf will have sufficient resilience to absorb shocks, distribute the load and provide a soft feeling underfoot. At the same time, it provides enough stability to prevent players from sinking or slipping. Too much vertical deformation will lead to an unstable playing surface, reduced performance and an increased risk of injuries. It will affect the game by creating irregularities, making the ball roll unpredictable and reducing players' reaction speed. According to an embodiment, the primary backing cloth is a woven polyolefin cloth with optional glass fiber reinforcement. According to an embodiment, the primary backing cloth has a weight between 250-350 g/m^2, preferably 260-340 g/m^2, preferably 270-330 g/m^2, preferably 280-320 g/m^2, preferably 290-310 g /m^2, and in particular about 300 g/m^2.

[0052] According to an embodiment, the primary tuft cloth is reinforced with glass fiber. This specific weight refers to the amount of fibers per square meter of cloth. The glass fiber reinforcement provides extra strength and durability to the tuft cloth, making it resistant to the loads and stresses that occur during use of the artificial turf mat. The glass fiber reinforcement helps maintain the structural integrity of the artificial turf mat even under heavy use and exposure to different weather conditions. The primary tuft cloth with glass fiber reinforcement therefore plays a crucial role in ensuring the quality, durability and performance of the artificial turf mat during its lifespan.

[0053] According to an embodiment, the fibers are attached to the primary backing cloth with a secondary coating, wherein the secondary coating preferably comprises and preferably consists of a polyolefin. The secondary coating has a weight of 500-1000 g/m^2, preferably 600-900 g/m^2, preferably 700-800 g/m^2 and in particular about 750 g/m^2. This provides excellent binding of the fibers. According to an embodiment, the fibers are attached to the primary backing cloth with a secondary coating, wherein the secondary coating comprises a latex or polyurethane.

[0054] It should be noted that the above weights refer to the dry application weight of the secondary coating used to attach the fibers to the primary backing cloth. This means that it refers to the weight of the coating material itself, without taking into account any moisture or other components present. It is used to measure and control the amount of coating material being applied. The dry application weight is an important parameter in the design and manufacture of artificial turf as it affects the adhesion and quality of the coating, which in turn affects the performance and durability of the artificial turf product.

[0055] According to an embodiment, the ball roll is between 4 and 10 m, as required by EN 15330-1. Because this is between 4 and 10 m, a good ball roll is achieved.

[0056] According to an embodiment, the artificial turf mat comprises fibers of a fourth type, wherein the fibers of the fourth type have a linear density of 6000-8000 dtex, preferably between 6500 and 7500 dtex, preferably about 7000 dtex and a thickness between 80-150 μm, preferably between 90-140 μm, preferably between 100-130 μm, preferably between 110-120 μm. Preferably, the fiber of the fourth type is a knit-de-knit fiber (KDK fiber).

[0057] The terms "KDK yarn," "KDK fiber" or "Knit-de-Knit" are synonyms and refer to a type of yarn that is commonly used in the artificial turf industry. The name "Knit-de-Knit" refers to the process used to make this yarn. After the material is extruded from extrusion machines, it undergoes a knitting process where fibers are knitted into a wavy shape. The yarn is then exposed to high temperature and air pressure, which changes its shape again. The end result is a yarn with a unique structure and appearance. Compared to traditional curled yarn (ATY), KDK yarn has several advantages. It is more filled and completed, has better resilience and can keep its shape for more than 6 years, while ATY yarn lasts about 3 years. KDK yarn also offers more customization options, such as changing color, Dtex, material and yarn shape. In artificial turf applications, KDK yarn is widely used due to its high density, making it suitable for playgrounds, circle ball fields, golf fields and non-infill sports turf. The flat, low-friction surface ensures smooth ball roll and fair play. In addition, KDK yarn continues to look great in the long term, unlike traditional artificial turf that can wither over time. In the production of KDK yarn, the yarn is knitted onto a tube using rings and heat. The raw material, made from resin granules, is melted under high temperature to form the fibers used for artificial turf. UV inhibitors are added to ensure the longevity of the green surface. The yarn is then steam treated and dyed if necessary. The last step is unknitted the fabric, resulting in the characteristic shape of KDK yarn.

[0058] According to an embodiment, the artificial turf mat comprises a shock-absorbing layer for an artificial turf installation, comprising a backing cloth with a top surface and a bottom surface, a plurality of tufts and a coating suitable for fixing the tufts, wherein the plurality of tufts are attached to the backing cloth, wherein the plurality of tufts are substantially made of at least one elastic polymer. Improved shock absorption is therefore particularly advantageous for avoiding injuries in athletes who practice sports on an artificial turf installation which comprises a shock-absorbing layer according to the present invention. According to a further embodiment, the shock-absorbing layer also comprises a plurality of perforations. Such an embodiment has the advantage that the ability to discharge liquids, such as water, is greatly increased. According to a further embodiment, the elastic polymer comprises a resilient polymer such as, for example, a thermoplastic polymer. A resilient polymer is understood to mean a material that in particular has resilient properties and can therefore return to its original shape or position after being compressed. Such polymers can be made from polyvinyl chloride (PVC), polyethylene (PE), polypropylene (PP), polyamide (PA), ethylene propylene diene monomer (EPDM) or any other suitable polymer. In a further embodiment the elastic polymer comprises a recycled elastic polymer.

[0059] In a second aspect, the invention concerns a method for manufacturing an artificial turf mat comprising:

tufting a plurality of fibers into a primary backing cloth having a top surface and a bottom surface;

obtaining tufted fibers, which extend above the top surface and are attached to the primary backing cloth;

applying a primary coating to the bottom surface of the primary backing cloth, suitable for fixing the tufted fibers;

wherein the tufted fibers comprise a first type of fibers and a second type of fibers, the first type being crimped fibers and the second type of fibers being substantially straight or spiral fibers.

[0060] Substantially straight fibers refer to fibers made from straight yarn. Spiral fibers refer to fibers made from yarn wound around its axis. Crimped fibers are defined as fibers that rotate around their axis at least once per cm and are at least 20% longer when stretched.

[0061] Because the artificial turf mat comprises a plurality of crimped fibers, these fibers act as a shock-absorbing layer. These fibers allow water to flow through to the primary backing cloth when it rains. The plurality of crimped fibers ensures that the artificial turf mat is hard enough to provide resistance, yet resilient enough for an optimal playing experience.

[0062] According to an embodiment, the fibers of the first type are arranged in rows in the primary backing cloth and the fibers of the second type are arranged in rows substantially parallel or coinciding with the rows of fibers of the first type. Because the fibers of the first type are arranged in rows in the primary backing cloth and the fibers of the second type are arranged in rows substantially parallel or coinciding with the rows of fibers of the first type, the artificial turf mat can be easily manufactured. According to an embodiment, the fibers of the first type and the fibers of the second type are applied to the primary backing cloth at a substantially equal speed. According to an embodiment, the fibers of the first type and the fibers of the second type are tufted simultaneously into the primary backing cloth. Because the fibers of the first type are arranged in rows in the primary backing cloth and the fibers of the second type are arranged in rows substantially parallel or coinciding with the rows of fibers of the first type, the fibers are well distributed over the entire backing cloth. Moreover, the fibers can be applied simultaneously. This method makes it easy to attach the fibers homogeneously to the primary backing cloth. According to an embodiment, the bottom layer is tufted first, then the top layer is tufted through the primary backing cloth and the bottom layer.

[0063] Because the fibers are positioned in parallel rows, it is easy to maintain a certain ratio between the fiber of the first type and the fiber of the second type over the primary backing cloth. According to an embodiment, on average per row of fibers of the second type, 0.1 to 5 rows of fibers of the first type, preferably 0.4 to 1.2 rows, are positioned in the primary backing cloth. Because there are on average 0.1 to 5 rows of fibers of the first type per row of fibers of the second type, the desired shock absorption and water permeability are achieved for good playing properties of the artificial turf mat. According to an embodiment, the primary backing cloth contains as many rows of fibers of the first type as rows of fibers of the second type ± 3%. According to an embodiment, the primary backing cloth contains twice as many rows of fibers of the second type as rows of fibers of the first type ± 3%.

[0064] Preferably, said fibers are tufted into a primary backing cloth in the backing layer. In an embodiment, the gauge of the tufting machine is 3/16" (4.67 mm) and the number of stitches per row is 15 to 50 per 10 cm. The gauge of the tufting machine is a measure of the distance between the tufting needles. In one embodiment, the thickness of the tufting machine is 5/32" (3.97 mm) and the number of stitches per row is 15 to 50 per 10 cm. In one embodiment, the gauge of the tufting machine is 5/16" (7.9 mm) and the number of stitches per row is from 10 to 50 per 10 cm. In one embodiment, the gauge of the tufting machine is 5/8" (15.8 mm) and the number of stitches per row is from 10 to 50 per 10 cm. In one embodiment, the gauge of the tufting machine is 3/8" (9.53 mm) and the number of stitches per row is from 10 to 50 per 10 cm. In one embodiment, the gauge of the tufting machine is 3/4" (19.6 mm) and the number of stitches per row is from 10 to 50 per 10 cm. The gauge of the tufting machine refers to the number of needles per inch and corresponds to the number of stitches per inch in a direction perpendicular to rows. The number of stitches per row is influenced by the size of the needles in the stitch-through machine and the thickness of the yarn. In one embodiment, the pile yarns are woven and the distance between consecutive pile yarns in a row is 1 to 10 mm and the distance between adjacent rows is 1 to 10 mm. In one embodiment, the pile yarns are bonded by Matrix weaving and the spacing between successive pile yarn bundles in the direction of the rows is 5 to 20 mm and the spacing between adjacent pile yarn bundles in the direction perpendicular to rows is 5 to 20 mm. In one embodiment, the pile yarns are bonded by tufting and the distance between consecutive pile yarns per row is 3 to 15 mm and the distance between adjacent rows is 3 to 25 mm. In one embodiment, the pile yarns are bonded by Matrix tufting and the distance between consecutive pile yarn bundles in the direction of the rows is 5 to 15 mm and the interval between adjacent pile yarn bundles in the direction perpendicular to rows is 5 to 20 mm.

[0065] According to an embodiment, the stitch count of the first type of fiber is one and a half to three times the stitch count of the fiber of the second type, preferably double. According to an embodiment, the fibers of the first type are tufted with a stitch count of 10-50, preferably 12-45, preferably 14-40, preferably 16-35, preferably 18-30, preferably 20-28, preferably 22-26 stitches per 0.1 m. Because the fibers of the first type are tufted with a stitch count of 10-50 stitches per 0.1 m, optimal shock absorption and rotational resistance are obtained. A lower number of stitches per 0.1 m would result in an artificial turf mat with too little shock absorption and little resistance. A higher number of stitches per 0.1 m would lead to an artificial turf mat with excessive shock absorption and rotation resistance and possibly lead to production problems.

[0066] According to an embodiment, the fibers of the second type are tufted with a stitch count of 10-15 stitches per 0.1 m. Because the fibers of the second type are tufted with a stitch count of 10-15 stitches per 0.1 m, an artificial turf mat is formed with good playing properties. The second fibers are important for good ball roll and increase the similarity to natural grass.

[0067] According to an embodiment, 2-15 times more fibers of the first type are applied per m^2 of backing cloth than fibers of the second type. According to an embodiment, 4-10 times more fibers of the first type are applied per m^2 of backing cloth than fibers of the second type, preferably 5-8 times more. According to an embodiment, 500,000 to 1,000,000 fibers of the first type are applied per m^2 of backing cloth and 70,000 to 300,000 fibers of the second type are applied per m^2 of backing cloth. According to an embodiment, 700,000 to 950,000 fibers of the first type are applied per m^2 of backing cloth and 100,000 to 200,000 fibers of the second type are applied per m^2 of backing cloth. Because 500,000 to 1,000,000 fibers of the first type are applied per m^2 of backing cloth and 70,000 to 300,000 fibers of the second type are applied per m^2 of backing cloth, an artificial turf mat is created that is suitable for meeting the EN guidelines for an artificial turf field without infill. This simplifies the production process, reduces labor required during installation and maintenance and reduces waste and environmental impact.

[0068] According to an embodiment, arranging a plurality of fibers in a primary backing cloth with a top surface and a bottom surface involves tufting the primary backing cloth with fibers. This results in tufted fibers. These tufted fibers extend above the top surface and are attached to the primary backing cloth. They are partly in this. According to an embodiment, the method comprises two separate steps, forming the loops or blades and fixing them to create the tufted fibers. Fixing takes place in a long latexing or coating line. There the carrier is coated with latex or polyolefin dispersion. The latex is then allowed to harden after which the artificial turf is rolled onto rollers. Other techniques are also known for fixing the synthetic fibers to the carrier, such as fixing the fibers to the backing cloth with polyurethane. In this way, the plastic fibers can be fused to the carrier. Here, pressure rollers are used that transfer heat to the carrier. A primary coating along the bottom surface of the primary backing cloth fixes the tufted fibers better in the primary backing cloth. In order to improve or accelerate fixing, an auxiliary layer can be applied to the bottom of the carrier. This layer can, for example, improve the adhesion of the glue or hot melt adhesive to the carrier. Another application could be that this layer heats up quickly during ultrasonic welding or infrared irradiation. Although the layer is often applied before fixing, applications are possible in which the layer is applied after the actual fixing, for example to reduce the hardening time of an adhesive.

[0069] According to an embodiment, a filler or infill is applied to the surface of the artificial turf mat, the filler being applied to a level of 5-50% of the average height of the fibers of the first type, preferably to a level of 5 -30% of the average height, and more preferably of 10-30%.

[0070] Because a filler is applied to the surface of the artificial turf mat, the fibers remain upright and the shock absorption and deformability of the artificial turf mat is improved. The filler generally forms a layer with a thickness of approximately 5 to 30 mm. According to an embodiment, the filler comprises a styrene butadiene rubber (SBR), a thermoplastic elastomer (TPE), ethylene propylene diene monomer rubber (EPDM), PP, PE, sand, clay, loam or recycled rubber. According to another embodiment, no filler is present. According to an embodiment, no performance infill is present. According to an embodiment, sand is applied to the surface of the artificial turf mat, the amount of sand being 5-50% of the normal amount of sand. According to an embodiment, 1-10 kg of sand is applied per m^2 of artificial turf mat.

[0071] According to an embodiment, the method comprises attaching different artificial turf mats to each other, applying filling material, and cutting artificial turf strips in order to obtain an artificial turf field.

[0072] One skilled in the art will appreciate that an artificial turf mat according to the first aspect is preferably manufactured according to a method according to the second aspect and that a method according to the second aspect preferably produces an artificial turf mat according to the first aspect. Each feature described in this document, both above and below, can therefore relate to any of the described aspects of the present invention.

[0073] In what follows, the invention is described by way of non-limiting examples illustrating the invention, and which are not intended to and should not be interpreted as limiting the scope of the invention.

FIGURES

[0074] **Figure 1** shows a schematic representation of a method of tufting the primary backing cloth with 2 types of fibers according to an embodiment of the present invention.

[0075] The primary backing cloth **1** is supplied from a roll **16** to a **5** tufting machine **2.** The fibers of the first type **3** and the fibers of the second type **3'** are supplied from rolls **17** and **17',** respectively. During tufting, an assembly of needles **4** pushes the fibers of the first type **3** and the fibers of the second type **3'** through the primary backing cloth **1.** Loops **5** are thus formed, which in the embodiment shown are cut open at a later stage by a knife **6,** thereby forming blades. After tufting, the primary backing cloth **1** is further transported in the direction of a fixing station **7.** This transport takes place by a guide system that is driven at the same speed. The embodiment shown can also apply an auxiliary layer or a stabilization layer. The difference between the fibers of the first type and the fibers of the second type is not visible in the figure.

EXAMPLES

EXAMPLE 1

[0076] Example 1 concerns the playing properties of an artificial turf mat according to the invention. The rebound of a soccer ball is between 0.6 m - 1.0 m, measured according to EN 12235. The roll of the ball, measured according to EN 12234, is 4.0-10.0 m. The shock absorption is between 55 and 70%, measured according to EN 14808. Vertical deformation (mm), measured according to EN 14809, is between 4 and 9 mm. The rotational resistance, measured according to EN 15301-1, is 25-50 Nm.

Claims

1. An artificial turf mat comprising: a primary backing cloth, with a top surface and a bottom surface; a plurality of fibers extending above the top surface and that are tufted onto the primary backing cloth; and a primary coating on the bottom surface of the primary backing cloth, configured to fix the tufted fibers, **characterized in that** the plurality of fibers comprises a first type of fibers and a second type of fibers, wherein the first type are crimped fibers and the second type of fibers are substantially straight or spiral fibers and wherein at least half of the fibers of the second type extend above the fibers of the first type, wherein a difference between a length of the crimped fiber in the stretched state and the length of the crimped fiber when crimped varies between 5% and 30%, said spiral fibers are a maximum of 5% longer in the straight state, wherein a pile height of at least 90% of the fibers of the second type is 20-150% higher than a pile height of the fibers of the first type.

2. Artificial turf mat according to claim 1, **characterized in that** the stretched pile length of the fibers of the first type is 20-30 mm and the pile height of the fibers of the second type is 25-40 mm.

3. Artificial turf mat according to claim 1 or 2, **characterized in that** the fibers of the first type are extruded monofilaments with a dtex of 5000-9000 and a thickness of 150-250 μm.

4. Artificial turf mat according to any of the preceding claims 1-3, **characterized in that** the fibers of the first type and the fibers of the second type comprise and preferably concern polyethylene or polypropylene.

5. Artificial turf mat according to any of the preceding claims 1-4, **characterized in that** the fibers of the second type are monofilaments with a dtex of 10,000-15,000 and a thickness of 250-400 μm.

6. Artificial turf mat according to any of the preceding claims 1-5, **characterized in that** the rotational resistance is between 25 and 50 Nm, measured according to EN 15301-1.

7. Artificial turf mat according to any of the preceding claims 1-6, **characterized in that** the vertical deformation is 4.0-9.0 mm, measured according to EN 14809.

8. A method for manufacturing an artificial turf mat comprising:

- tufting a plurality of fibers into a primary backing cloth having a top surface and a bottom surface;
- obtaining tufted fibers, which extend above the top surface and are attached to the primary backing cloth;
- applying a primary coating to the bottom surface of the primary backing cloth, suitable for fixing the tufted fibers;

characterized in that the tufted fibers comprise a first type of fibers and a second type of fibers, the first type being crimped fibers and the second type of fibers being substantially straight or spiral fibers.

9. Method according to claim 8, **characterized in that** the fibers of the first type are arranged in rows in the primary backing cloth and the fibers of the second type are arranged in rows substantially parallel or coinciding with the rows of fibers of the first type.

10. Method according to claim 8 or 9, **characterized in that** the fibers of the first type are tufted with a stitch count of 15-30 stitches per 0.1 m.

11. Method according to claim 8, 9 or 10, **characterized in that** the fibers of the second type are tufted with a stitch count of 10-15 stitches per 0.1 m.

12. Method according to any of the preceding claims 8 to 11, **characterized in that** 500,000 to 1,000,000 fibers of the first type are applied per m^2 of backing cloth and that 70,000 to 300,000 fibers of the second type are applied per m^2 of backing cloth.

13. Method according to any of the preceding claims 8 to 12 for obtaining an artificial turf mat according to any of the preceding claims 1-7.

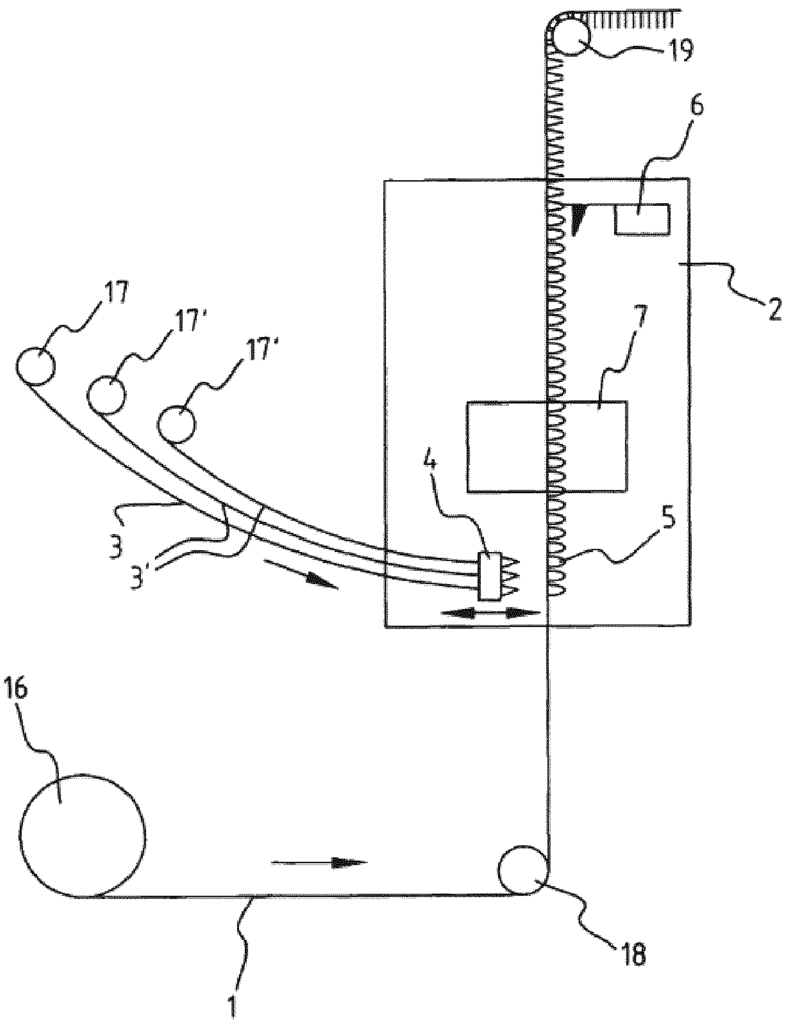

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 23 19 0454

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

E01C

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	29 November 2023	Beucher, Stefan

CATEGORY OF CITED DOCUMENTS

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29-11-2023

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