June 10, 1969 G. H. TESCH 3,448,502

METHOD OF MANUFACTURING FLEXIBLE SHEET MATERIAL

Filed May 25, 1967

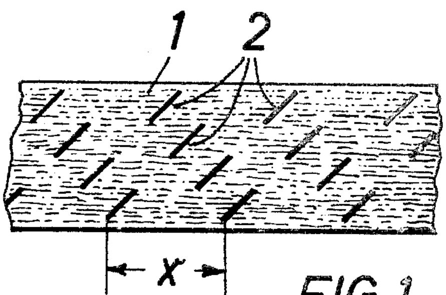

FIG. 1

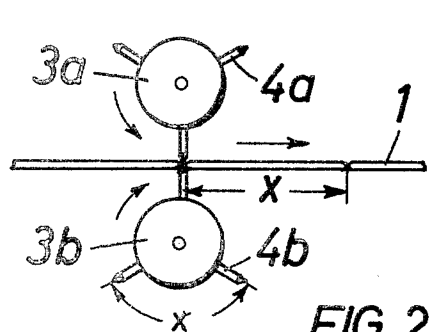

FIG. 2

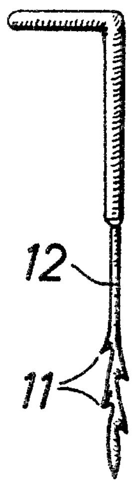

FIG. 5

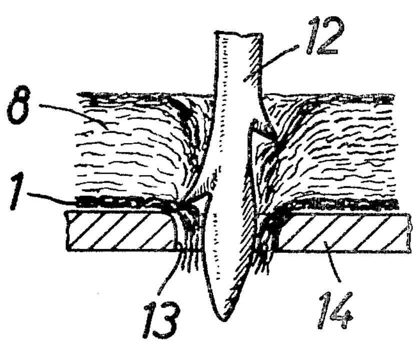

FIG. 6

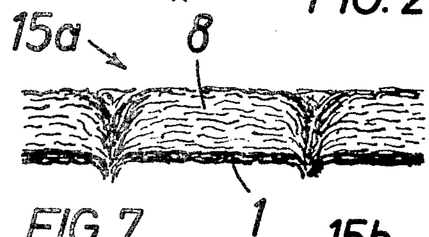

FIG. 7

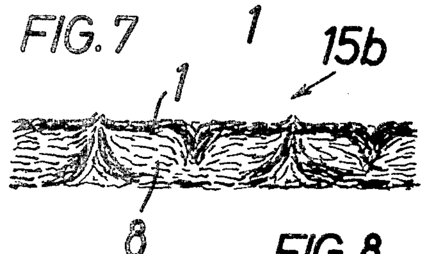

FIG. 8

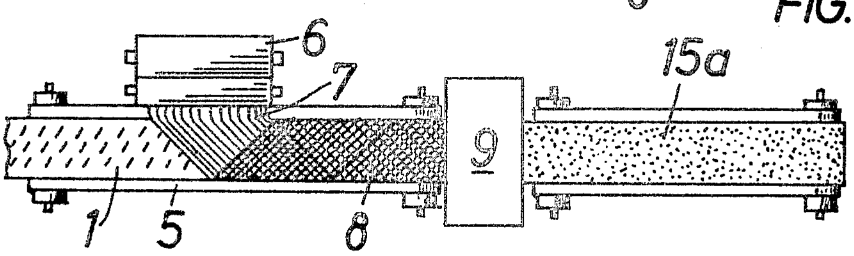

FIG. 3

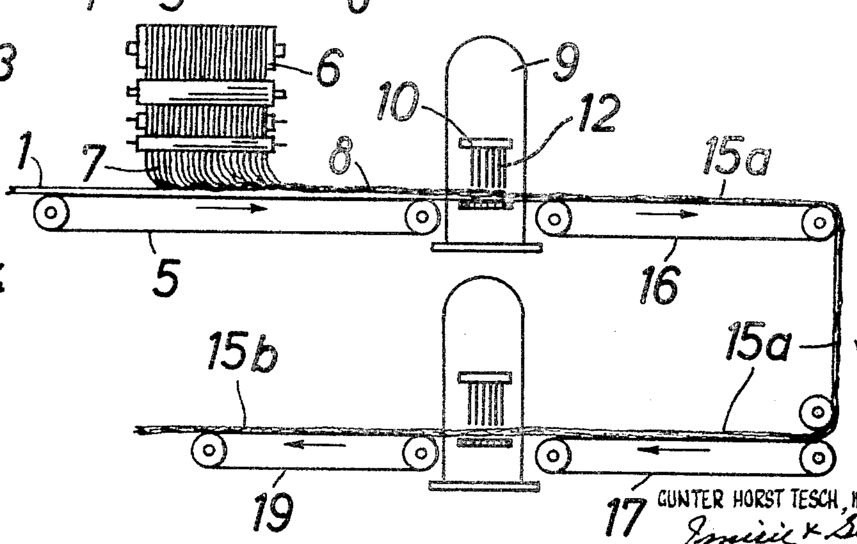

FIG. 4

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METHOD OF MANUFACTURING FLEXIBLE SHEET MATERIAL

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U.S. Cl. 28—72.2 5 Claims

ABSTRACT OF THE DISCLOSURE

A textile material is manufactured from a sheet of solid material and from a loose fibrous web. The sheet of solid material, when needled, has a tendency to split along a predetermined axis into parallel fibrils and a plurality of incisions are first made in the sheet at an angle to the predetermined axis. The incisions are spaced from each other by a predetermined distance. Then the loose fibrous web is placed adjacent to the sheet of base material and the two are needled together. The solid material can be a polypropylene foil which has been stretched from 8 to 10 times its length while heated, and which has a tendency to split into parallel fibrils along the axis of stretching when needled. The fibrous web may include polypropylene fibers or other suitable fibers. The base material and loose fibrous web are preferably needled from both sides to completely shred the base material into separate fibrils which are intermixed with the loose fibrous web. Leaves, paper strips, and the like can also be used as the loose material.

BACKGROUND OF THE INVENTION

The present invention relates to a method for producing textile goods containing at least an upper layer and a base layer by means of needling, and to textile goods produced according to this method.

In needling of textile layers, one must distinguish between active and passive needling. Active needling is the general needling process in which the barbs of needles in needling machines grip fibrous materials and intertwine them with each other. Passive needling, however, is a method in which a fibrous material is attached to a nonfibrous material by needling, the fibrous material being held in position by being engaged in openings formed by the needles in the nonfibrous material.

Foils whose entire surfaces could be used as base layers, or which could be used in part, were previously considered passively needleable materials but, it has not been possible thus far to utilize such foils in an active needling process.

SUMMARY OF THE INVENTION

One object of the present invention is to provide a method for producing textile goods comprising at least an upper layer and a base layer by means of a needling process in which a foil-type layer serves first as a passive base layer, and which is then, in the course of one or a plurality of needling processes, transformed into an actively needleable fibrous layer.

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A further object of the present invention is to provide a method for producing textile goods having at least an upper layer and a base layer by means of needling the layers, in which at least one foil-type layer serves as the only substantially active needling substance from the beginning with the aid of which other passively needleable materials can be joined together.

A further object of the invention is to provide textile goods produced according to the above-noted method of this invention.

The method according to the present invention for producing textile goods is characterized by the use of a "split-fiber" foil, i.e., a foil which, when needled, has a tendency to split along a predetermined axis into parallel fibrils. Split-fiber foil is manufactured, for example, for use in endless, twisted fiber-type strips for weather-resistant harvest tie-up twines by ICI Fibres Ltd. of Harrogate, Yorkshire, England, and is sold under the trade name "Nufil." This foil has the characteristics of great tensile strength and, when subjected to uneven stresses, e.g., when twisted, it tends to partially split in the longitudinal direction into separate fibrils which individually retain a high tensile strength and which loosely adhere to each other.

It has been discovered, in accordance with this invention, that a force perpendicular to the plane of a split-fiber foil can also be used as a fibril-forming force in an unusual manner, i.e., in the form of a multitude of needles provided with barbs, which are preferably disposed in a needle board which performs an upward and downward movement under considerable pressure at right angles to the plane of the foil. The needles penetrate the foil at as many points, and although the sharp needle points can puncture the foil practically without friction, considerable resistance occurs when the barbs hit the foil. At this moment, depending on the arrangement, construction, and impact angle of the barbs on the foil, punch marks and/or cracks appear in the foil. A normal foil, in contradistinction thereto, under the same treatment, will receive tears which generally extend radially from the point of puncture in arbitrary directions so that during an intensive needling process a normal foil will be torn into small, irregular scraps which, however, are never fibrous but are generally more or less jagged in one plane.

In a split-fiber foil, however, because of its particular molecular structure, the splitting action of the barbs is directed into the longitudinally directed splitting axis thereof and leads to unidirectional, practically parallel shredding of the foil into fibrous formations. These fibrils at first are of irregular length and width, but a regulation of size can be achieved by an intensive or repeated needling process.

In the method of this invention, a plurality of spaced incisions are made in a split-fiber foil to define the length of the fibrils that will be formed when the foil is shredded by needling. These incisions are made at an angle to the splitting axis of the foil, i. e., the axis along which the foil will normally split when twisted or needled, and the incisions are separated from each other in staggered groups so that the foil will hold together in the initial step of the process before it is shredded into fibrils by needling. A loose fibrous web is then placed adjacent to the base layer of split-fiber foil, and the base layer and loose fibrous web are then needled from both sides to completely shred the base material into separate fibrils and to actively intermix these fibrils with the loose fibrous web. The invention can also be applied to semi-fibrous or nonfibrous materials such as leaves or paper strips, which can be formed into a cohesive flexible layer by being needled between two layers of the split-fiber foil of this invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a plan view of a sheet of split-fiber foil with spaced, staggered incisions according to this invention.

FIGURE 2 is a schematic diagram of an apparatus for producing incisions in a split-fiber foil.

FIGURE 3 is a plan view of apparatus for manufacturing textile material in accordance with the method of this invention.

FIGURE 4 is a side view of the apparatus shown in FIGURE 3.

FIGURE 5 is a side view of a needle used in the needling process of this invention.

FIGURE 6 shows a needle penetrating a split-fiber foil base layer which supports a loose fibrous web.

FIGURE 7 is a longitudinal sectional view of an intermediate product of the process of this invention.

FIGURE 8 is a longitudinal sectional view of the final product of the process of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A split-fiber foil, shown in plan view in FIGURE 1, whose direction of splitting is longitudinal, is provided with incisions **2** arranged in staggered rows and offset from each other, the distance x between two successive incisions in the same row being selected to determine the length of the fibrils which will be produced by shredding the foil **1**. The value x corresponding to the subsequent fiber length can be selected according to the requirements of each individual application. Generally, however, x will be selected to be in the order of 50 mm. The incisions **2** can be slits punched in the foil by a known punching device. But since the split-fiber foil **1** is a thermoplastic material, however, the incisions can also be made by passing the split fiber foil **1** between two rollers **3***a*, **3***b* having heated knives **4***a*, **4***b* extending radially from the rollers as shown in FIGURE 2. At those points where the heated knives **4***a* of the upper roller, which are spaced at distances x on the circumference of drum **3***a*, meet the knives **4***b* of the lower drum **3***b*, they melt the split-fiber foil **1** except for an extremely thin film which will break under the slightest stress.

The split-fiber foil thus prepared now passes—as can be seen in FIGURES 3 and 4—on a first conveyor belt **5** by a card **6** disposed at right angles to the conveyor belt and periodically moved back and forth across the belt at right angles thereto. By continuously depositing a fibrous web **7** on the split-fiber foil **1** as it moves back and forth, the card **6** forms a cross-paneled web **8** which is brought, together with the supporting split-fiber foil **1**, through a needling machine **9** with intermittent feed. The needling machine **9** contains a prior art needle board **10** (FIGURE 4) which performs quick upward and downward movements and in which several hundred needles **12** provided with barbs **11**, of the type shown in FIGURE 5, are fastened. During the downward movement of the needle board **10**, the needles **12** are punched through the cross-paneled web **8** and through the supporting split-fiber foil **1**, and enter into matching bores **13** of a grating **14**, as is shown in FIGURE 6, each barb **11** gripping a plurality of fibers when the fibrous web **8** is being penetrated and pushing them entirely or partially through the web. During the downward movement, the needle point penetrates the split-fiber foil **1** relatively easily, but as soon as the first barb **11** comes in contact with the split-fiber foil **1**, the latter is split into numerous fibrils in the vicinity of the puncture point; these fibrils, whose length is predetermined by the distance x of the adjacent incisions **2** of the same row (FIGURE 1), are pulled downwardly in the same manner as fibers, by the barbs **11** of the needle **12**. During the upward movement of the needles **12**, the fibers or fibrils, respectively, fall off the barbs **11**. The needling process therefore brings about a reorientation of the fibers within the web **8** and at the same time at least a partial shredding of the split-fiber foil **1**.

The thus resulting intermediate product **15***a*, which leaves the needling machine **9** on the conveyor belt **16**, and which is shown enlarged and in longitudinal section in FIGURE 6, is now turned around (FIGURE 4) and is brought to a second needling machine **18** by means of a third conveyor belt **17**. A second needling process occurs in the second needling machine **18** whereby the split-fiber foil, now on top, is completely shredded into fibrils and these are needled into the web **8**. The final product **15***b*, which is shown enlarged and in longitudinal section in FIGURE 8, is transported away on a third conveyor belt **19**.

The split-fiber foil, which initially serves as a passive base layer, is changed, in the course of the needling processes, into an active needleable layer and then into a needled fibrous layer. The main purpose of such a passive base layer is to transport the fibrous web until the needling process is completed. After the needling operation, the base layer also contributes more or less to increase the tensile strength, often, however, to only a slight extent, and the less so the more structural stability has been lost in the needling process.

The above-described drawback of lowered lateral strength can be relatively easily compensated for by reversing the direction of the base foil. If it is normally intended to have the main emphasis on good tensile strength in order to be able to exert sufficient pull on the textile during the subsequent finishing processes, it is advisable to have the foil feed in the working direction, i.e., longitudinally. Whether the foil is to be arranged to permit utilization of its entire surface, or only parts thereof, as in strips, depends on the production requirements. For example, the same tensile strength is achieved when the entire surface of a foil $50/\mu$ thick is used or when foil strips of a ratio of 1:1 are used, i.e., for example, foil strips 2 cm. wide alternating with empty spaces of 2 cm., the foil strips being $100/\mu$ thick. Generally, this longitudinal arrangement will be sufficient if the actual fibers are not arranged in the longitudinal direction also but are disposed, for example, in the often employed criss-cross pattern diagonally to the direction of the product or in the most favorable case, almost rectangularly.

To increase the lateral strength in special cases, the split-fiber foil can also be disposed at right angles or diagonally to the direction of movement which will result in a corresponding increase in the ultimate tensile strength in the appropriate direction.

For the purpose of continuous production, a slanted position will of course be rather preferred and since these foil strips can be crossed at an angle of 90°, for example, an equal ultimate tensile strength in all directions can be achieved. It must be noted again that in this process the individual fibers are not torn out of their fabric or thread bond by the needling process, as would be the case when strong woven fabrics are being used, and they are not cut into very short fiber pieces because they do not present an equal resistance to the barbs of the needle. If the layer to be utilized is produced to possess optimum characteristics for the needling process, i.e., if it possesses the lowest possible lateral strength and good splittability as well as an extremely high tensile strength of, e.g., 6–10 g./den., the force of the needles will not have a destructive effect but will rather be utilized to form new fibrous elements with almost equal tensile strength and at the same time direct these fibrils partially into a desired new direction, some of them at right angles to their original axis, thus producing an "active" matting effect.

In addition, a second needling process in the reverse direction, and even more so repeated needling processes, will achieve matting and intertwining of the fibers and fibrils with each other to such an extent that the whole product will be of extraordinary stability.

When the split-fiber foil is disposed in any direction other than the longitudinal, it is preferable to use narrower bands which permit easy reversal or change of direction, respectively, when the edge of the supporting layer has been reached. This arrangement can be accomplished in different ways, e.g., by separate placement devices, or by simultaneously adding strips of a suitable width during the criss-crossing process for forming the cross-paneled web of fibrous material on the supporting layer. The strips then have the same direction as the fibers. Furthermore, at the present time this foil can more easily be produced in the form of narrow strips. The layer can be dyed, and when narrow strips are used, a multicolored arrangement can be used to achieve particular color or marking effects. Also, the utilization of individual foil strips only, especially in the longitudinal direction and for marking purposes only, is quite possible.

The split-fiber foil, however, can also be the only or the most active needling substance right from the beginning with the aid of which other, only passive, needleable materials, such as leaves or paper strips, can be joined together.

The following two examples are cited to illustrate several of the varied possibilities of application for the present invention.

Example 1

A polypropylene foil with a weight per unit area of approximately 350 g./m.^{2} is produced by a standard commercial extruder. This foil is then stretched longitudinally to about ten times its length while heated by hot air and infrared radiation, the width of the foil being reduced by 30% by the stretching process and the weight per unit area in the stretched state being reduced to approximately 50 g./m.^{2}. This foil, which now has a tendency to split in longitudinal direction, is provided with offset slanted incisions which are spaced apart (in the same row) by 43 mm. These incisions longitudinally limit the fibrils resulting from shredding of the split-fiber foil to a length of 43 mm. The split-fiber foil is carefully wound and is used as support for a fibrous web in which seven adjacent foil strips having a width of 30 cm. each are brought onto a conventional conveyor belt so that the total width of the split-fiber base layer amounts to 210 cm. The split-fiber foil layer on the conveyor belt is brought past three cards which place a shingled layer of a fibrous web, consisting of polypropylene fibers having a fiber strength of 15 den. and a length of 90 mm., onto the foil by means of a cross-paneling device so that a fibrous web of 800 g./m.^{2} final weight results. The base layer and fibrous web are fed into a needling machine whose needles are spaced at 7 x 14 mm. and which operates at a speed of 500 strokes per minute. The needling process occurs at a conveying speed of approximately 1.5 m./min., and the split-fiber foil bands are split into fibrils which, however, substantially maintain their parallel position. Subsequently, the intermediate product is turned over and the needling is repeated from the other side at a conveying speed of only 0.8 m./min., so that the split-fiber foil bands are completely shredded into fine fibrils which are now pushed through the needled fibrous material in opposite direction. The final product is a totally unsupported needle felt which is completely airtight and entirely synthetic.

When the split-fiber foil is dyed in the same color as the fibrous material, the fibrils resulting from a double needling process can no longer be distinguished from the polypropylene fibers of the fibrous material.

Example 2

A split-fiber foil of polypropylene as described in Example 1 is used, which, however, is stretched only to 8 times its length and which has a final thickness of 80μ. Twenty percent of a vinyl acetate ethylene copolymer containing 25% vinyl acetate is added to the polypropylene before it is extruded so that it can be blown out of the extruder in the form of a continuous tube. After being cut into convenient lengths, the tube is then stretched to eight times its length and is then cut like an orange peel at an angle of 45° into a band of approximately 50 cm. in width. This band has the tendency to split at an angle of 45° to its longitudinal direction and it is provided with incisions spaced 80 mm. apart and disposed at right angles to the direction of splitting and offset against each other. A second band is produced in the same manner, whose direction of splitting is at right angles to the direction of splitting of the first band when it is placed on top of the first band. One of these bands is used as support for a 10 cm. thick layer of a mixture of dry tree leaves and straw, and the second band is placed as a covering layer onto this layer. Under the pressure of several iron rollers which have a diameter of approximately 15 mm., the three layers are evenly and carefully brought into a double action needling machine which operates with coarse needles (approximately 2 mm. in diameter, having 9 barbs disposed in groups of threes above each other and of the conventional triangular cross section) and at a speed of approximately 300 strokes per minute. The cover layer is thus torn into coarse fiber bunch-type strands and pushed through the leaves and through the bottom layer, thus compressing the product to approximately 20 to 25 mm. in thickness. Subsequently, the product is passed over the bar of the double action needling machine which operates from below, and the bottom layer is shredded in the same manner, pushing the resulting fibrils through the layer of leaves and through the already shredded cover layer. The product is thus compressed further to approximately 15 mm. in thickness. The completed product now possesses sufficient cohesion to serve as a leaf cover for gardening purposes.

If paper strips are used instead of leaves, and if the product is appropriately impregnated, the material according to this example of the invention can also be used for insulating purposes on construction sites.

The invention is, of course, not limited to the embodiments described above but can be modified in many ways without departing from the original idea of the invention. The split-fiber foil, for example, can be prepared for the needling process by crimping, embossing or the like to achieve a type of friezing in the subsequently produced fibrils.

I claim:

1. A method of manufacturing flexible sheet material from a loose material and from a sheet of solid material which, when needled, has a tendency to split into fibrils along a predetermined axis, comprising the steps of:

(a) making a plurality of incisions in a sheet of such solid material at an angle to said predetermined axis thereof, said incisions being spaced from each other by a predetermined distance along said predetermined axis to limit the length of fibrils formed therefrom;

(b) placing a layer of such loose material adjacent to said sheet of solid material; and

(c) needling said sheet of solid material and said layer of loose material to split said sheet of solid material into fibrils and to form a composite sheet of flexible material which is composed partly of said loose material and partly of said fibrils.

2. The method as defined in claim 1 wherein said sheet of solid material is used as a base layer and wherein

an upper layer consisting of a loose fibrous web is needled thereon.

3. The method as defined in claim 2 wherein said base layer is needled to the upper layer in a second needling process.

4. The method as defined in claim 1 wherein said sheet of solid material is used as an upper layer and is needled to a base layer of loose material.

5. The method as defined in claim 1 wherein one sheet of solid material is used as an upper layer and another sheet of solid material is used as a base layer, with an intermediate layer consisting of a passive needleable material is disposed between said upper and base layers, and wherein all three layers are joined together by means of needling from both sides.

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U.S. Cl. X.R.

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