TUFTED FABRICS AND METHODS OF MAKING THEM

Filed Aug. 23, 1965

Arthur Joseph Sanders

INVENTOR

By: Bushman, Daily & Cushman

ATTORNEYS
TUFTED FABRICS AND METHODS OF MAKING THEM


Filed Aug. 23, 1965, Ser. No. 481,963
Claims priority, application Great Britain, Sept. 8, 1964, 36,700/64
Int. Cl. D04h 11/08, 18/00
U.S. Cl. 161—67

ABSTRACT OF THE DISCLOSURE

Multi-layer non-woven fabrics are made by sandwiching a mass of intermediate fibres between two layers of different fibres which contain a major proportion of crimpable fibres, needle-punching the assembly to carry fibres from the face layer through the opposite outer layer in the form of tufts, and subsequently causing the crimpable fibres to crimp. The cramped fibre tufts form rivet-like protuberances which press the surface of the structure.

This invention relates to a nonwoven fabric and a method by which it can be made by needle-punching an assembly of relatively loosely associated fibres and to articles derived therefrom.

The making of nonwoven fabrics by the needle-punching in a conventional needle-loom, which may be a single or double bed construction, of an assembly of relatively loosely i.e. unbound or only slightly bonded, fibres is well known. Fabrics made by this simple method suffer from the objection that tensile strength and dimensional stability is only attained by a high rate of needleling which is reflected in a stiffening of the article to an undesirably high level. To overcome this and other disadvantages associated with the fabric produced by simple needleling it has been proposed to incorporate into the fibrous assembly retractable fibres which, following needleling and their orientation into planes normal to the faces of the fibrous assembly, are retracted, thereby compaction the fibrous assembly, the retraction reinforcing the needleling action in imparting strength to the resulting fabrics.

In a modification of the above described proposal, the needling of a sandwich of one fibrous layer between two other fibrous layers containing retractable fibres, followed by retraction of the outer layer fibres, has been suggested.

We have found that in such a sandwich structure more needling of the fibres of each fibrous web outer layer through the central layer and into the opposite outer layer, followed by retraction of the fibres, does not produce a fabric with the dimensional stability, tensile strength and resistance to delamination necessary in the application of the fabric to a wide variety of end uses.

Our observations have shown, that a superior dimensional stability, tensile strength and resistance to delamination can be attained by needling to such a depth that fibres pass through the opposite outer layer, and project beyond the face of that layer as fibre tufts, and then crimping the tufts so that, in collapsing upon themselves, they spread over the surface of the outer layer. The appearance of the fabric resulting from needling to this depth is quite different to the fabric which is obtained when the depth of needling is such that fibres do not protrude beyond the surface thereof. The latter fabric resembles a felt, having a flat, drab surface of poor aesthetic appeal and is limited in its applications to situations where conventional felts are suitable. The former fabrics on the other hand, because of the presence of fibre tufts resemble in appearance, certain conventional pile fabrics and consequently have a wider range of applications.

The action of the needled fibres and fibre tuft projections in imparting dimensional stability, tensile strength and resistance to delamination the possession of which properties permits the utilisation of the fabrics in an extensive range of applications finds an analogy in the field of conventional riveting, for the needleled fabric, being extending through the fabric in planes normal or substantially so to the faces thereof may be compared to the shank portion of a rivet, while the cramped, bent-over integral tufts constitute the head portion. Apart from structural considerations the needled fibres, in securing the central layer to the outer layers with a corresponding improvement in dimensional stability, tensile strength and resistance to delamination, behave functionally in a manner similar to rivets.

Needling to the depth, and in the manner described produces articles with novel surface effects, since the face of one or both of the outer layers carries tufts derived from the opposite outer layer. The extent to which the face of each of the outer layers is covered by tufts depends to a large extent on the effective number of fibres which are oriented per square inch of surface and it may vary from almost total coverage, when the tufts form a new outermost surface hiding the existence of the face of the outer layer from visual discernment, to less than twenty percent of the total surface.

Thus, the invention in one of its aspects provides a nonwoven fabric which comprises three superimposed fibrous layers, the fibres constituting the central layer being different from the cramped fibres of which the two outer layers consist of, or comprise to a major extent, said central layer being keyed in position by needled fibres which extend in the thickness direction of the fabric from a fibrous outer layer to the opposite outer layer and which project beyond the face of the opposite outer layer as cramped fibre tufts.

Although the nonwoven fabric which results from this tufting and crimping has good dimensional stability, tensile strength and resistance to delamination we find that for certain end uses in which the nonwoven article is, for example, subjected to prolonged hard wear, it is advantageous to bond together fibres in the outer fibrous layers and also the needled fibres extending therethrough. Thus, in another aspect of this invention the nonwoven fabric is modified by bonding together some or all of the fibres in the outer layers and the needled fibres extending therethrough.

Bonding in this manner ensures that the needled fibres are secured in position and thereby provides a more effective anchoring of the central layer to the outer layers. It also provides reinforcement for the needled fibres in their role of retaining fibres of the outer layers in position.

This invention also provides a method for making a nonwoven fabric in sheet form from three superimposed layers with both of the outer layers comprising an assembly of relatively loosely arranged fibres of which the major proportion at least are crimped fibres, and the central layer being in the form of an assembly of relatively loosely arranged fibres which are different to the fibres constituting the major proportion of the fibrous assemblies of the outer layers, the method comprising needle-punching fibres in either or both of the outer layers through the central layer and the opposite outer layer so that they extend beyond the face of one or both outer layers as fibre tufts, and thereafter subjecting said
needle-punched structure to a treatment to crimp the crimpable fibres.

In those circumstances in which a fabric of enhanced dimensional stability, tensile strength and resistance to delamination is required, fibres in the outer layers and the needleled fibres extending therethrough, may be bonded together by subjecting either or both of the fibrous layers or the entire article to a bonding operation.

Needling of the fibres of the outer layers in the manner described is effectively achieved by passage through a layered structure through a conventional single or double-bed needle loom. Thus, the layers arranged in superimposed fashion may be passed through a single-bed needle loom twice, the fabric being turned over between passes through the machine. Alternatively, in a double-bed needle loom, needling of the two outer fibrous webs may be carried out in a single passage through the loom.

Whether a single or double-bed needle loom be used, the loom is adjusted, and this can readily be effected, so as to give a depth of needling sufficient to cause the needled fibres to project, as fibre tufts through the outer layer opposite to the layer which the needles initially entered. A wide variety of fibres can be made in such a way that they possess the ability to crimp when subjected to a suitable treatment and thus are useful in the practice of this invention. Good results in the production of the fabrics of this invention have been obtained by using heterofilaments. Heterofilaments are unitary filaments consisting of one or more polymeric components contiguous and adherent to one another continuously along the length of the filament, and they possess potential crimp as a result of the difference in the physical properties of the two components. If the two components of the heterofilament possess, for example, substantially different residual shrinkage properties, a crimp is caused by the differential shrinkage of the two components developed by a suitable treatment.

Since practically all artificial filaments can be made so as to have the ability to crimp, it follows that many other types of fibre including polyamides, polyesters and polypropylene can be used in forming the fibrous assemblies of the outer layers.

The fibres from which the fibrous assembly constituting the central layer is formed must be inert (or at least substantially so) to the particular treatment by which fibres in the outer layers are cramped and bonded. For example, viscose rayon, ceramic, glass or cellulose triacetate fibres may be used. Alternatively, fibres in the central layer may be fully cramped either before the assembly constitutes that layer is sandwiched between the other two layers, or subsequently to sandwiching, but prior to needling.

Each fibrous assembly may be derived from a single fibrous web of relatively loosely associated fibres or a plurality of such webs. The thickness of the various layers may vary quite considerably and the factors which may enter into their determination include the desired end use for the fabric and the penetration density at which it is intended to needle punch the assembly.

The fibrous webs may be made by the air deposition of fibres, by knitting processes, by carding fibres followed by the cross-layering of the carded webs, by fluid paper-making processes and indeed by any method whereby a web of loosely associated fibres may be formed.

Continuous filament webs in which the filaments may be quite independent of one another or intermingled in the form of a yarn may be conveniently prepared by drawing off the filaments directly from a spinning unit using, for instance, an aspirator jet, or they may be formed from a package or other storage device for yarn already spun.

The treatment by which fibres in the outer layers are cramped may involve, for example, the application of heat or a swelling agent to the relevant fibrous assemblies or to the entire structure.

The bonding treatment may, for example, be accomplished by impregnating the whole of the outer fibrous layers with a natural or synthetic resin, by incorporating therein synthetic resins in the form of a powder or thermoplastic fibres having a lower softening point than the fibre constituting the fibrous assemblies and then applying heat, and normally pressure also, to the structures.

In a very convenient embodiment of this invention the fibrous assemblies which form the outer layers of the fabric consist of, or comprise a major proportion of heterofilaments which contain a potentially adhesive component, that is to say, a component which may be rendered adhesive (activated) under conditions which leave the other component or components substantially unaffected, and thereby serve to bond together the fibres.

Heterofilaments as components of the outer fibrous webs possess a number of advantageous properties. For instance, the ability of the heterofilaments to crimp is inherent and is not attributable to, and dependent upon, a special method of making them, as in the case with crimpable homofilaments. Furthermore, the heterofilaments may possess a "built-in-binding action" on account of the presence of the potentially adhesive component therein so that fibre bonding may be accomplished readily and conveniently in what is, in effect, an in situ development of the bonding agent through activation.

Yet another advantage of using heterofilaments in the outer layers is the opportunity which is then afforded for accomplishing crimping and bonding in the same treatment. Thus, in a modification of the process of this invention, fibres of the outer layers and the needle fibres which pass therethrough are cramped and bonded in the same treatment.

Activation is normally accomplished without destruction of the heterofilament fibres for the activated component is maintained in association with the other component or components of the fibre and does not migrate throughout the fibrous web.

Examples of heterofilaments containing such a potentially adhesive component are polyhexamethylene adipamide-polypolyolactam copolymers (nylon 66/66) fibres in which polypepoylactam copolymers is the potentially adhesive component, polyhexamethylene adipamide polyomogamoinoundecaneoic acid (nylon 66/11) fibres in which the polyglycoaaminoundecaneoic acid is the potentially adhesive component, and polyhexamethylene adipamide/polyhexamethylene adipamide-polypepoylactam copolymers in which the copolymer is the potentially adhesive component. In each case the potentially adhesive component may be activated by a heat treatment. Heterofilaments other than those based on different polyamides may also be used. Thus, heterofilaments formed, for example, from polymers based on polyesteramides, polyesters, polyhydrocarbons and polyurethanes may be suitable.

For the purpose of facilitating a better understanding of this invention, a method of making the novel non-woven fabric will now be described in conjunction with the drawing in which:

FIG. 1 is a schematic elevational view of apparatus suitable for carrying out the present invention;

FIG. 2 is an enlarged fragmentary view of the three-layer assembly being fed to the needle bed of the apparatus of FIG. 1;

FIGS. 3 and 4 are enlarged fragmentary views of the three-layer assembly showing a fibre tuft after needling and after crimping, respectively.

Three fibrous assemblies 10, 12, 14 formed in each case from a plurality of fibrous webs were superimposed one on the other. The individual webs were produced by any technique suitable for fabricating a fibrous web, for example, by air deposition, cards or garnets (for fibres of staple length). The fibrous assemblies of the outer layers 10 and 14 consist of crimpable fibres, in this
particular instance, heterofilaments, while the fibrous assembly of the central layer 12 consists of fibres inert to the treatment by which crimping of the heterofilaments is effected, serve as viscose rayon fibres.

The fibrous structure is then fed through a single bed needle loom 16 of conventional design which comprises a horizontal surface 18 and a needle board 20 arranged to reciprocate in the vertical plane and provided with the usual barb needles which pass in and out of the sandwich structure. In the course of their movement into the sandwich structure, the needles pass initially through the top fibrous layer 10, some of the fibres of which are engaged by the barbs, after which the needles penetrate the central fibrous layer 12 and pass into the bottom fibrous layer 14. The bars of the needles are generally completely filled by fibres from the top fibrous layer and few, if any fibres, are picked up from the fibrous central layer.

The fibres carried by the barbs of the needles from the top layer can pass entirely across the bottom fibrous layer and protrude a variable distance beyond its outer surface as fibre tufts 22 (FIG. 3). The disposition of the needle fibres in this way is ensured by the depth of the needle-punching which is readily adjusted to punch to the necessary depth in a known manner. The fibre tufts 22, may, provided there is a sufficient density thereof, being directly related to the penetration density, form a pile surface.

The needle-pierced fibres which pass from one fibrous layer through the fibrous central layer and through the opposite fibrous layer, serve to key together the three layers. The keying together of the layers and the fibre entanglement resulting from the needle punching gives the needle-punched assembly a useful tensile strength, dimensional stability and resistance to delamination. These properties may be improved by subjecting the assembly to a further needle-punching operation in the opposite direction, relative to the arrangement of the layers, to the first needle-punching operation. This may be achieved by everting the needle assembly, for instance, by passage around a series of rollers, and then taking it through the same, or another, but similar, needle loom. In this needling operation the needles encounter initially the fibrous outer layer which, during the first needle-punching operation, was on the bottom of the sandwich, and, consequently, fibres are carried by the needles, from the top fibrous layer through the fibrous central layer and through the opposite fibrous outer layer which is now the bottom layer of the structure. Instead of effecting the two needle-punching operation as separate stages in the manufacturing process, they can be accomplished in one stage by passing the sandwich through a double-bed needle loom. The extent to which the surface of the outer layer is covered by fibre tufts 22 depends, to a large extent, on the number of needle penetrations for a given area. This coverage may be almost complete, when the tufts effectively form a new outermost surface hiding the existence of faces from visual display. Needling in this manner provides the fabric with novel and interesting surface effects and an appearance resembling a conventional pile fabric.

Fibres in the outer layers and the needled fibres which pass therethrough and project beyond their base as fibre tufts are crimped and bonded in the same treatment, which may, for example, involve exposing the tufted structure to the action of heat from an oven 24, or a chemical medium.

As a result of development of crimp in the heterofilaments the tufts crumples-up into mushroom-shaped, (dome-like) protuberances 26 (FIG. 4) which press against the faces of the outer layers, which themselves retract in area as fibres crimp.

Structurally and functionally the needled fibres are analogous to ordinary single-headed rivets. In this connection, that portion of each needle fibre which is embedded in the structure, is equivalent to the shank of the rivet, while the crumpled-up crimped fibre tuft which forms the mushroom-shaped protuberance 26 is equivalent to the head portion of the rivet.

The needle fibres, like rivets in another, but analogous context, secure the three layers of the structure to one another and provide the resulting fabric with good dimensional stability, tensile strength and resistance to delamination. Crimping of the tufts of the needle fibres into mushroom-shaped protuberances which press against the faces of the outer layers provides for a more effective "keying" action. The crimping of the tufts in the manner described results in a greater spread of the tufts over the faces of the outer layers so that a greater area thereof is covered and a more attractive appearance conferred upon the fabric.

The needle-punched fabric comprises five layers arranged in the following sequence:

(i) A layer of crimped fibre tufts 26.
(ii) A fibrous layer 10 which contains vertically disposed fibres and fibres arranged in the plane of the layer.
(iii) A fibrous central layer 12 traversed by vertically disposed fibres.
(iv) Another fibrous layer 14 which contains vertically disposed fibres and fibres arranged in the plane of the layer.
(v) A layer of crimped fibre tufts, if the structure has been needled in both directions.

The dimensional stability, tensile strength and resistance to delamination are all enhanced by the bonding together of the fibres, this being achieved (in the same treatment by which crimp was effected) by the activation of the potentially adhesive component of the heterofilament fibres. In respect of the needle fibres the effect of bonding is to anchor them more firmly in position, while in relation to the outer fibrous layers generally it reinforces the effect of crimp in imparting to the layers dimensional stability and a reduced susceptibility to "pickiness."

This invention provides fabrics wherein properties such as handle, wear resistance and abrasion resistance are largely attributable to the nature of the fibres in the fibrous web outer layers. Such outer layers need constitute only a small proportion of the total volume and/or weight of the final fabric and the central layers may be formed of fibres which, although deficient in wear and abrasive resistance properties and possessing a poorly developed textile-like handle i.e. harsh, are more readily available and/or less expensive.

Alternatively, fibres in the central layer may be chosen for a particular property they possess, and which commands fabrics containing such fibre in the central layer to particular end uses. For instance, the fibres, or the fibrous web formed therefrom and which constitutes the central layer of the fabric, may be highly absorbent, and hence particularly adapted for use in surgical dressings, sanitary napkins and diapers, in towelling, wiping cloth and filter materials. Cotton fibres provide an example of suitable absorbent fibres.

The fabrics are particularly well suited for use in the making of sanitary napkins, for which end use, the central layer, in the form of an absorbent fibrous (for example, cotton) web, is covered by a thin envelope or casing of crimpable fibres, to which it is secured by tufting a proportion of the crimpable fibres through the structure and then developing crimp and optionally bonding the fibres.

The fabrics are also useful in a host of other applications which do not necessarily demand an absorbent central layer. They include for example, their use as blanket materials, as laundry or paper-maker felts, or as wedding materials.

The following examples illustrate the invention but are not to be construed as limiting or as indicating that the products are in any sense equivalent.
EXAMPLE 1

A layered structure which consisted of the following superimposed layers was constructed.

(1) Top layer

A fibrous web weighing two ounces per square yard and made by carding, using a Shirley Cotton card, a quantity of 6 denier, six inch heterofilaments formed from equal proportions by weight of poly(hexamethylene adipamide) as one component and an 80:20 random copolymer of poly(hexamethylene adipamide) and poly(epsilon caprolactam) as the other, the two components being arranged in a side-by-side arrangement.

(2) Central layer

A fibrous web weighing six ounces per square yard and made by carding, using a Shirley Cotton Card, 3 denier, two inch cellulose triacetate fibres sold under the trade name "Tricel."

(3) Bottom layer

A fibrous web identical to that used as the top layer.

The layered, sandwich structure after being passed between the nip of a pair of co-operating rollers was passed twice through a needle loom using regular barbed needles (32 gauge) supplied by the Textile Machine Works, Leicester, England as Type N5/2350/1. The needle loom was set so that the structure, which was turned over between passes through the loom, received 300 penetrations per square inch of surface and depth of needling was half an inch. The depth of needling represents the distance which the point of the needle projects beyond the surface of the structure, opposite the surface it entered, and it is an approximate indication of the actual fibre tuft height.

The tufted product was then heated in an air oven at a temperature of 250°F. for a period of three minutes. Under these conditions, the heterofilament fibres in the webs of the outer layers crimped, as did the re-oriented tufted fibres, and bonded together as a result of activation of the copolymer component of the heterofilaments.

An identical layered structure, after being passed between the nip of the co-operating roller, was passed twice through the same needle loom using the same needles but, on this occasion the loom was set so that fibres from the outer layer were merely re-oriented through the central layer and into the opposite outer layer i.e. the needle fibres did not project as tufts beyond the face of the opposite outer layer.

The latter structures were then subjected to the same treatment to crimp and bond the heterofilament fibres as the structure containing the fibre tufts.

The strength of each fabric determined on an Instron Tensile Tester by clamping a 5 cm. length of sample between the jaws of the tester and elongating the sample at a rate of 5 cm./min. i.e. 100 percent/min., at a temperature of 21°C. and a relative humidity of 60%. The tufted fabric had a tensile strength of 72 g./cm. and was approximately 100 percent stronger than the needle fabric which had a strength of 37 g./cm.

These measurements demonstrate the efficacy of needle-punching to give fibre tufts and subsequently crimping of the tufts in improving the tensile strength of the fabric. There is corresponding improvement in dimensional stability and resistance to delamination.

EXAMPLE 2

A quantity of 15 denier two inch staple fibres formed from heterofilaments consisting of equal proportions by weight of poly(hexamethylene adipamide) as one component and an 80:20 random copolymer of poly(hexamethylene adipamide) and poly(epsilon caprolactam) as the other, the two components being arranged in a side-by-side relationship was carded on a cotton card.

A fibrous assembly having a weight of approximately 4 ounces per square yard was then formed from the carded layers using a cross-lapping machine which laid the laps on top of one another with successive laps disposed at an angle of 90° with respect to the previous lap. The assembly which consisted of loosely associated fibres is hereinafter in this example referred to as Assembly A.

A second fibrous assembly (hereinafter referred to as Assembly B) having a weight of approximately 6 ounces per square yard was prepared by carding and cross-lapping a quantity of 3 denier, two inch cellulose triacetate fibres sold under the trade name "Tricel."

A third assembly (hereinafter referred to as Assembly C) identical to Assembly A was prepared by the method described for making that assembly.

The three fibrous assemblies were superimposed one on another in the form of a sandwich of Assembly B between Assemblies A and C.

The layered sandwich structure after being passed between the nip of a pair of co-operating rollers was passed twice through a needle loom using regular barbed needles (32 gauge) of the type used in Example 1. The structure was turned over between passes through the loom, which was set so that the depth of needling was half an inch and the structure received 300 penetrations per square inch of surface.

The structure so produced was a coherent, nonwoven pliable product, beyond the faces of which there projected fibre tufts derived from the needle punching.

The needle-punched product was then heated in an air oven at a temperature of 230°~240°C. for a period of 3 minutes. The effect of this heating was two-fold. In the first place, the heterofilament fibres of Assemblies A and C, and the needle fibres re-oriented thereafter, crimped. This crimping was accompanied by a shrinkage of approximately 6 percent in the area of the needled product. As a result of crimping, the tufts of the fibre tufts crumpled-up to form mushroom-shaped protuberance which pressed against the face of each outer Assembly A and C. The needle fibres in shape and function resembled ordinary single head rivets and served to hold the inner Assembly B securely in position. The mushroom-shaped protuberances in effect formed new surface layers which at least partially hid the old surface layers of the structure from visual discernment.

The second effect of the heating was to activate, i.e. render adhesive, the copolymer component of the heterofilaments so that fibres in, and passing through the outer fibrous assemblies were bonded together, the bonding being accomplished by a "build-in-bonding" action. This in situ bonding together of fibres served to anchor the needle fibres securely in position and give the resulting fabric superior dimensional stability and tensile strength.

The surface layers and tufts were dyed with Solway Blue B.N. It had a final weight of 12 ounces per square yard, a tensile strength of 130 kg./cm. and a good resistance to delamination. It was very suitable as a hard wearing blanket material.

EXAMPLE 3

The procedure of Example 2 was repeated except that the fibrous assembly of the central layer was formed from 1/4 inch cotton fibres and it had a weight of 19.2 ounces per square yard. The rate of needling was set to give 600 penetrations per square inch of surface and the depth of needling was half an inch.

The final product had a weight of 21.4 ounces per square yard and on account of the highly absorbent nature of the central layer was eminently suited for use in the making of sanitary napkins.

The resulting napkins were not only highly absorbent but also air-permeable, conformable and non-irritant to the wearer.
EXAMPLE 4

The layered structure of Example 3 after needling twice from each side to give a depth of needling of half an inch and 600 penetrations per square inch was immersed in boiling water for 3 minutes, as a result of which, the heterofilament fibres crimped. In consequence of this crimp development, the structure shrunk 12 percent in area and the fibre tufts crumpled-up into mushroom-shaped protuberances which pressed against the face of each of the outer layers. Although the product was much softer in texture than that of Example 2 above, the cotton fibres in the central layer were less securely held.

EXAMPLE 5

A layered structure which consisted of the following superimposed layers was constructed:

(1) Top layer

A fibrous assembly, weighing 4 ounces per square yard and made by carding and cross-lapping 12 denier, two inch heterofilaments formed from equal proportions by weight of poly(hexamethylene adipamide) as one component and poly(omegaaminoundecanoic acid) as the other, the two components being arranged in a side-by-side relationship.

(2) Central layer

A fibrous assembly weighing 17.1 ounces per square yard and made by carding, using a Shirley Cotton Card, 12 denier, two inch viscose rayon fibres.

(3) Base layer

A fibrous assembly identical to that used as the top layer. The layered structure after being passed between the nip of a pair of co-operating rollers was passed four times through the needle loom using regular barbed needles (32 gauge) of the type used in Example 1 so that the structure, which was turned over between passes, received 600 penetrations per square inch. The depth of needling was half an inch. Needle-punching in the above manner had the effect of re-orienting fibre in the assemblies which formed the top and bottom layers. In their re-oriented position the fibres, crimped from one outer layer, through the central layer and the opposite outer layer and projected as tufts beyond the face of that outer layer. The needle-punched product was thereafter heated in an air oven at a temperature of 200° C. for a period of three minutes. Under these conditions, the heterofilament fibres in the outer layers crimped, as did the needled fibres, and bonded together as a result of activation of the poly(omegaaminoundecanoic acid) component of the heterofilaments. The resulting fabric was a coherent, dimensionally stable, nonwoven fabric which possessed a tensile strength of 90 kg./cm. and had the appearance due to the presence of two layers of fibre tufts of certain conventional pile-surface fabrics.

EXAMPLE 6

A layered structure identical to that used in Example 5 was needle-punched by the procedure set forth in that example.

The needle-punched structure was immersed in boiling water when the heterofilament fibres of the outer layers crimped and the fibre tufts crumpled-up into mushroom-shaped protuberances. The area shrinkage was 7.9 percent. The final fabric had a weight of 18.4 ounces per square yard, and a softer texture than the fabric of Example 5, although it was less strong, and it made an excellent laundry felt.

EXAMPLE 7

A layered structure which consisted of the following superimposed layers was constructed:

A fibrous assembly weighing 23.7 ounces per square yard made from 12 denier, two inch viscose rayon fibres using a cotton card.

(2) Central layer

A fibrous assembly identical to that used as the top layer. This layered structure was needle-punched 4 times using a conventional needle loom having regular 32 gauge barbed needles of the type used in Example 1 and adjusted so that there were 600 needle penetrations per square inch with a depth of needling of half an inch; the structure was turned over after each passage through the loom. The needle-punched product, the longitudinal surfaces of which contained fibre tufts as the projections of needle fibres from the top and base layers, was heated in an air oven at a temperature of 230° C. for a period of 4 minutes. This heat treatment cramped the heterofilaments fibres so that there was a 4.4 percent reduction in the area of the structure and the tufts of the needled fibres crumpled up into mushroom-shaped protuberances which pressed against the face of each of the outer layers, and also activated the copolymer component of the heterofilaments thereby bonding together fibres in the outer layers and securing the needled fibres in position. The resulting fabric had a final weight of 21.4 ounces per square yard and made a useful resilient wadding.

EXAMPLE 8

A layered structure which consisted of the following superimposed layers was constructed:

(1) Top layer

A fibrous assembly weighing 4 ounces per square yard and made by carding and cross-lapping the heterofilaments used in the structure of Example 7.

(2) Central layer

A fibrous assembly weighing 7.5 ounces per square yard was made by carding, on a Shirley Card, 6 denier, two inch poly(hexamethylene adipamide) staple fibres. A loosely woven poly(hexamethylene adipamide) scrim fabric having 20 ends per inch and 20 picks per inch and consisting of 6 denier one and a half inch staple fibres spun to 20° cotton count was also placed in the central layer to give the resulting fabric added strength.

(3) Base layer

A fibrous assembly identical to that of the top layer. This layered structure was tufted 4 times using a conventional needle loom having regular 32 gauge barbed needles of the type used in Example 1 and adjusted so that there were 600 needle penetrations per square inch. The depth of needle punching was half an inch and the structure was turned over after each passage through the loom. The needle-punched structure, the longitudinal surfaces of which contained fibre tufts representing projection of needled fibres from the top and base layers, was heated in an air oven at a temperature of 230° C. for a period of 3 minutes. The cramped and fused fabric had a final weight of 14.4 ounces per square yard and was eminently suitable for use in the making of blankets since it had good abrasion resistance and wear properties.
What I claim is:

1. A non-woven multi-layer structure having improved dimensional stability, tensile strength and resistance and exhibiting a pile-like appearance on at least one side, said structure comprising two opposite surface layers, said intermediate fibres being keyed in position by needle fibres extending in the thickness direction of the structure from at least one of the surface layers through the intermediate layer and beyond the opposite surface layer, a major proportion of said needle fibres being cramped and producing rivet-like protruberances having shank portions within said opposite surface layer and head portions which press against said outer surface and impart a pile-like appearance thereto, said protruberances being the inherent result of crimping the needle fibres after needling.

2. A non-woven multi-layer structure as in claim 1 wherein said mass of intermediate fibres is made up of un-crimped fibres and constitutes the major proportion, by weight, of said structure.

3. A non-woven multi-layer structure as in claim 2 wherein said crimped fibres are heterofilaments which comprise at least two polymeric components contiguous and adherent to one another continuously along the length of the filaments, one of said components being a potentially adhesive component, said heterofilaments being bonded to adjacent filaments by said adhesive component.

4. A method for making a non-woven fabric in sheet form from at least three superimposed fibrous layers with both outer layers comprising an assembly of relatively loosely arranged fibres of which the major proportion of fibres are crimpable by a crimp-activating treatment, and the fibres which are intermediate the two outer layers being inert to the activation treatment which causes said first-mentioned fibres to crimp, said method comprising needle-punching fibres in at least one of said outer layers through the intermediate fibres and through the opposite outer layer so that they extend beyond the outer face of said opposite outer layer as fibre tufts; and thereafter crimping said first-mentioned fibres by subjecting the needle-punched structure to a crimp-activating treatment which leaving the intermediate fibres unaffected by said treatment to thereby collapse the fibres in said tufts into dome-like protruberances which press against the outer face of said opposite outer layer and impart a pile-like appearance to said structure while at the same time keying said layers together and improving dimensional stability, tensile strength and resistance to delamination.

5. A method as claimed in claim 4 wherein the fabric is modified by subjecting it to a treatment to bond together fibres in the outer layers and extending therebrough.

6. A method as claimed in claim 4 wherein one treatment both crimps the crimpable fibres and effects the bonding together of fibres in the outer layers and the needle fibres which extend therethrough.

7. A method as claimed in claim 6 wherein fibres are cramped and bonded together by heat.

8. A method as claimed in claim 4 wherein fibres are bonded by impregnating the whole of the outer layers with a bonding agent.

References Cited

UNITED STATES PATENTS

3,347,736 10/1967 Sissons 161—67
2,840,881 7/1958 Bateman 28—72.2 XR
2,964,039 12/1960 Johnson et al. 128—290
3,125,140 2/1964 Crowe 156—148 XR

FOREIGN PATENTS

17,322 4/1934 Australia.
643,420 2/1964 Belgium.

ROBERT F. BURNETT, Primary Examiner
R. H. CRISS, Assistant Examiner

U.S. Cl. X.R.

28—72.2; 156—148; 161—62, 154